PROCEEDINGS

OF THE

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OF

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FOR 1935.

VOL. XLVII.

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2. Papers must be complete and in a form suitable for publication when communicated to the Society and should be as concise as possible.

3. Papers must be accompanied by an abstract of not more than one hundred words.

4. Papers should be in double-spaced typescript on one side of the paper with ample margins.

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8. All references should be listed at the end of each paper and arranged alphabetically under authors' names, *e.g.*,

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VOLUME XLVII.

Vol. XLVII., No. 1.

Proceedings of the Royal Society of Queensland.

Presidential Address.

BY

J. S. Just, M.I.E.E., M.I.E., Aust.

(*Delivered before the Royal Society of Queensland, 25th March, 1935.*)

The Council's report, presented this evening, whilst indicating satisfactory progress, also discloses the smallness of our numbers.

There are Queenslanders who should be sufficiently interested in the work of this Royal Society to make association with it both instructive and of interest, and we would like to welcome them as members.

Your Council's report also refers to the loss by death of two of its members.

Professor B. D. Steele, F.R.S., who in 1910 was appointed first holder of the Chair of Chemistry, University of Queensland, and the first president of the Board of Faculties.

Professor Steele made some notable contributions to science, and during the war served his King and country.

In the passing of Sir Edgeworth David, K.B.E., C.M.G., D.S.O., D.Sc., LL.D., a corresponding member of this Society, the world mourned the loss of a great scientist and explorer, the army the loss of a great and gallant soldier, whilst those who were privileged to know him, study under him, or serve under him, the loss of a very dear and understanding friend.

Professor David's researches in the Hunter River district contributed greatly to the material wealth of the Commonwealth, and through the inspiration of his teaching and the nobility of his character he stimulated the thought and won the affection of all.

Australia has lost two esteemed scientists and worthy citizens.

One obligation attached to the high honour of being your President during the year just closed is that I shall to-night present to you what time-honoured custom has been pleased to call a "presidential address."

The Royal Society of Queensland is, first and foremost, a scientific society, and the interchange and advancement of scientific knowledge may rightly describe the ambit of our activities. Many past presidents, in presenting their addresses, have placed before you valuable research work of great scientific interest—work with which they personally have been very closely associated.

Since my association is rather with the commercial application of scientific findings, as applied to engineering problems than with purely scientific research work, I am prevented from following such excellent examples.

My term as your President commenced with the completion of the first fifty years of this Royal Society of Queensland, and I feel that it would be appropriate to review, in the limited way which time will permit, the progress during those fifty years of scientific research and its commercial application, especially in the field of engineering, and to touch lightly upon the economic and social obligations arising therefrom, including problems arising from the apparent effect of scientific progress in relation to our social welfare. These are questions occupying the present attention of all thinking people.

Scientific advancement has crowded into a short space of fifty years a greater amount of applied science of economic importance than can be credited to a similar previous period. These scientific attainments have brought with them a greater amount of social change than can be credited to many times fifty years in all preceding history. It is because these social changes are so closely allied with our commercial and economic existence that I am taking the liberty, towards the close of my address, of going beyond science and of touching lightly on social and economic changes.

Believing the laws of nature have ordered that progress or change is not made by leaps or revolutions, but rather, like the growth of a snowball, by a multitude of minute additions to our knowledge, perhaps some useful purpose might be served by looking backwards and briefly touching on those material achievements or additions to our knowledge which have come into the everyday lives of the people, and selecting from the very wide variety available a few typical examples.

In its attempt to create more comfort and leisure for mankind, the combined scientific and economic advance is a striking, concrete, convincing, and tangible evidence of the value of scientific knowledge, as such, when applied to everyday affairs.

I think it may safely be stated that all electrical progress, excepting the great initial discoveries of Faraday, Kelvin, and their contemporaries, is the direct result of man's activity during the past five decades; in fact, electricity was scarcely more than a thing in embryo when this Society held its first meeting during 1884.

In other fields of applied science we find that fifty years ago there were no internal combustion engines of commercial note or worthy to be called tools of marked utility, no automobile or aircraft industry, no steam turbines; and that steam, although an enormous source of mechanical power, was inefficiently employed in relatively small units very akin to the things evolved by Watt.

Chemistry, perhaps the oldest of the sciences as adapted to human interest, was still an industry dealing in simple processes with a relatively limited list of materials largely inorganic in nature.

Photography as we know it to-day did not exist, whilst such industries as the manufacturing of paper and pottery, ancient though they may be, had not advanced very far from the progenitors of ancient times.

Agriculture was still practised by primitive methods handed down from generation to generation. There was little real understanding of the chemical control of the soil or soil mechanics, or of the possibilities of producing new species almost at will, whilst disease or insect control and the vast markets of the world, now made possible by refrigeration and fast transport by land and sea, and even through the air itself, were beyond the horizon of the imagination.

Such gigantic progress did not happen by pure chance; likewise, substantially nothing of great value happened merely through the operation of the so-called inventive faculty—that unnatural burst into the unknown. Nor can it be suggested that these vast and important changes have come about by a general awakening of the masses. Their very magnitude and the diversity of results obtained in fields so widely separated and unrelated bespeaks some source common to them all.

A careful investigation indicates that the common source—the impelling force—behind the rapid progress in all these varied interests, is scientific method and scientific technique, applied through organised and co-ordinated research. These findings are modified to suit the peculiar conditions of the particular industries.

In research laboratories each problem that seems worthy of consideration, whether arising from past experience or promise of future possibilities, is carefully analysed and its component parts attacked by specialists. It is the supervised, directed, and the combined efforts of the scientific investigators which give us the proven new ideas and enable the engineer, the chemist, the physicist, the biologist, the geologist, and others to build the new structure. Royal societies, by bringing together those interested in the different branches of science, do much to further such organised effort.

Perhaps no better illustration of the power of organised research can be given than by referring to the progress made in the solution of engineering problems, especially those to be found in the field of electrical engineering. In this field the engineer, the chemist, the physicist, the mathematician, the geologist, and other scientfic workers have played leading parts.

If we could subtract from our present knowledge that which we have gained during the past thirty years, our usages of electricity would be considerably diminished, and the whole structure of industry changed. Employment would be diminished, and our social and economic outlook altered in a marked manner.

Perhaps one of the greatest benefits to mankind is the improvement in lighting. How we would have managed to keep pace with the rush and stress of business life, as conducted to-day, if compelled to depend on the tallow "dip," or even the open gas jet, need not be enlarged upon.

Here scientific investigation has come to our aid. In electric lighting we first had the open arc lamp, followed by the carbon filament vacuum lamp. Then followed such improvements as enclosed arc lamps and other passing types. About twenty-eight years ago the metal filament lamp, with voltages below 100, came into commercial use. This lamp was rapidly improved to suit normal public supply pressure. The most marked departure in recent years has been the substitution of gas-filled globes for vacuum globes, and a change in method of filament design and manufacture.

Then came the tube lighting, known to the public as "Neon," a survival of the old vacuum tube filled with various conducting gases.

This brought further advance, and to-day we have the gas-filled tube through which energy is passed, giving high light intensity and a reasonable absence of glare. These lamps, although not suitable for indoor lighting purposes, have an important claim for use on public highways, where anti-glare, combined with maximum illumination, is highly desirable.

The transformer and the induction motor make it no longer necessary to confine industry to areas where coal and water power are available. To-day we are able to use the scientific knowledge of electricity obtained during the past few decades to transmit electrical energy over long distances, and to control it almost at will.

So great is the power and so delicate the control of commercially distributed electrical energy that heavy industries and rapid transport systems derive their energy from a common generating and distributing system, which, in addition, lights our homes and reproduces sound through our wireless equipments.

So satisfied are we with the control of this power that, whilst using hundreds of horse-power of energy in industry we, with confidence, allow our dentist to utilise the same source of energy to drill a tiny hole in our tooth—this without the least thought of the contrast between the high-powered physical unit transforming stored energy into electricity and the small dental motor rotating a drill within a cavity of our tooth.

Our knowledge of the mysterious X-ray has been enlarged. It is well known that these rays, which have no electromagnetic properties, blacken photographic plates, and when they impinge upon certain chemicals and minerals, these substances glow with a visible light.

These rays are used in the practice of medicine, and also play an important part in industry for the purpose of determining the soundness of structures. Much expensive machining can be voided by detecting faulty castings whilst they are in their crude state. In addition, these rays are our best and surest method of examining welds in materials.

They are useful in examining rolled or drawn metal parts for the presence of slag or for overdrawing by cold work. Many materials, such as coal, rubber, wood, bakelite, etc., can be examined for defects or for the presence of foreign materials. The field for useful employment of these rays in industry is being daily enlarged.

As previously pointed out to this Society by Professor Bagster, the use of X-rays is now well established in the examination of oil paintings and objects of art.

The electrical engineer has contributed to matters associated with X-rays: Diathermy, high-frequency currents, ultra-violet radiation, and other miscellaneous electrical treatments of the human body—all valuable aids to the skilled surgeon and physician.

The radiology developments include the means of preventing the emergence of the unwanted X-radiations, the wide application of shockproofing X-ray tubes, generators, cables, etc., and the production of high-power tubes and rectifying valves.

In the practice of medicine the all-important protection of the patient and of the operator is now given by shrouding the tube itself, thereby preventing the emergence of the ray except through a properly controlled window.

During the past four years important developments have occurred in the X-tubes themselves, and most modern tubes are now vacuum type—not gas-filled, as was previously the case. High-voltage tubes are common, the rectified current reaching 100,000 volts (peak value).

Diathermy is being applied over an increasingly wide range of diseases, including internal secretions, rheumatic disorders, deafness, skin trouble, and nervous complaints. This increased use has given an impetus to improve the efficiency and compactness of the necessary apparatus.

The introduction of the continuous-wave valve and oscillator has added a new surgical instrument of high power; yet in competent hands it is flexible and easy to control.

The use of very high frequencies has permitted the production of artificial fever without the necessity of placing the patient in contact with electrodes.

Violet and ultra-violet rays are still being produced by electrostatic machines, although the mercury-vapour-quartz lamp is the most powerful and efficient source of ultra-violet radiation at present available.

Infra-red rays from banks of carbon lamps and radiating from bowl fires are being utilised increasingly for the relief of rheumatic and similar ailments.

Yet another advance relates chiefly to the theory of electrical transmission by telegraph and telephone.

The problem of electric and magnetic flux, which crowds into the most important chapter in the history of electrical science, is based on the foundations laid by Faraday and Maxwell, although these fathers of electrical science failed to realise that the electro-magnetic flux represented electromagnetic energy of an electromagnetic field.

It was not until Hertz, in 1888 (four years after our Society was formed), propounded his clasiscal experiments that the value of, and possibilities arising from, Faraday's and Maxwell's theories dawned upon the engineer.

With the appreciation of the new factor "reactance," and later a second new factor ("inductance") commenced the commercial application of electricity. From the appreciation of these new factors followed the under-ocean telegraph cable, the dynamo for the supply of light and power, and the commercial use of the telephone.

The radio development of to-day elegantly describes what electromagnetic theories, enlarged upon by later knowledge, have done for the transmission of music, speech, and pictures across oceans and continents.

To-day the youngest schoolboy realises that messages are carried on the wings of the electrical waves, and most of them use the terms "reactance" and "inductance" in connection with the wireless receiving sets without realising their significance or even giving a thought to the works of the various scientists whose combined efforts have made wireless broadcasting possible.

In 1886 the British Navy carried out its earliest commercial experiment with wireless telegraphy, and during the next thirty years all naval ships were fitted with wireless signalling equipment, it being the only long-range means of communication available to them.

By 1900 about forty-three ships in the British Navy were equipped with wireless telegraph apparatus, but it was not until five to six years later that the wireless branch of the Navy was formed.

Perhaps one of the most useful applications of electrical sound-recording is that used to ascertain the depth of the sea. There are at present several types of marine sounding devices in regular use, but there has recently been developed what is known as the magnetostriction echo depth recorder. This device produces a continuous record of the sea's depth whilst the ship is travelling at full speed, and is claimed to be commercially accurate when used in water from 2 ft. to 200 ft. in depth. The sea depths can be transmitted to the bridge, where they are recorded as a well-defined line on a scale chart of chemically prepared paper.

This apparatus is installed within the steel hull, and is not interfered with by the nature of the cargo carried. The system is at present being thoroughly tested by the British Navy.

The use of this or similar information-recording devices on merchant ships when in foreign waters, during darkness or fog, and in the location of sunken objects will be apparent to all, and should considerably reduce the loss of life and property now occasioned by shipwreck.

The thermonic valve was rapidly developed during the great war, and at its close was adapted for modern wireless broadcasting purposes. This valve has improved our broadcasting programmes, and such fine limits of control have been obtained that, quite recently and from this city, our Royal visitor, the Duke of Gloucester, although a distance of 12,000 miles away, used this type of valve to launch a mighty ocean liner from its cradle into the waters of the Clyde.

We now have a world-wide commercial telephone service. We are able to use our local telephone instruments to communicate with other countries, and also are able to carry on two-way conversations with those on board liners a thousand or more miles from land.

To-day the picturegram is being sent the length and breadth of the globe per medium of this thermonic valve.

Television, now in the experimental stage, may rapidly rise to the commercial stage, and make still more striking the wonderful progress of electricity.

Turning now to other fields of scientific research, we have the automobile industry made possible by the development of the internal combustion engine. The scientific research work on this engine has practically all been done during the life of this Society, although a few principles, as in the case of electricity, go back to before 1884. Collateral with and closely allied to the automobile engine is the research work that has been involved in the development of various liquid fuels—the life-blood of this type of machine. Were it not for the joint result of these two scientific research activities, the internal combustion engine could not have advanced, and we could not have had the aviation industry, which to-day is making such rapid progress and has bridged the gap between England and Australia. To-day we have the air mail between the mother country and ourselves, and even the time now taken will seem extraordinarily slow when compared with the aeroplane of the future, which will probably reach undreamt-of speed when traversing the stratosphere.

The dream of the heavier-than-air machine could not have been realised had not the engineer and allied scientists combined in producing large reliable power units of small weight.

The great advance in the chemical industry has come during our fifty years of existence, and, again, is the direct result of organised scientific research applied to materials and to the various processes by which new materials are evolved. Not only have materials and processes of inorganic chemistry been amplified enormously, but the whole field of organic chemistry has also been substantially created.

When we consider the large number of so-called elements and the incredible number of their possible permutations and combinations, it seems to indicate that in the years ahead continuation and amplification by scientific methods of the activities in the field of chemistry are likely to dwarf into insignificance its surprising progress during the last half-century.

Agriculture, although more ancient than engineering or chemistry, and with an origin lost in the mists of antiquity, is practically a repetition of scientific advancement of engineering and chemistry during the last fifty years.

Apart from the application of mechanical power for the purpose of labour-saving appliances, there is no other economic section of our civilisation where the result of the application of scientific research has been more marked than in the field of agriculture, and where, perhaps, the effect on human welfare is more far reaching.

During the life of the Royal Society of Queensland more has been learnt of soil chemistry and soil mechanics than ever before; yet our knowledge is still far from complete. Through intensive organised research in the field of botanical and biological science we have learnt to combat plant disease and plant pests which, in past years, destroyed many forms of agriculture and laid waste fertile land. Perhaps the prickly-pear destruction in Queensland may be quoted as an important example.

We have learnt to control the mosquito (we do not apply our knowledge locally, but some day we will be forced to do so) and thereby to remove one of the discomforts and dangers to health. We have yet to learn, biologically or otherwise, the economic control of various forms of fly pests so damaging to human health as well as to animal and plant life. The control of ticks and other insect pests is in hand; yet many more branches remain to be investigated and conquered.

Rapid transport has considerably altered some of the world's marketing problems. Science has opened a market for our produce and the produce of other countries, and has made apparent the advantages and disadvantages of international interchange of trade.

We have learnt to hold Queensland chilled beef over the necessary period to enable its transport to overseas markets, and we are proud to record that much of the scientific research work in connection with chilled beef transportation has been carried out in Queensland and under the personal direction of one of our members.

The outcome of scientific research has brought into the economic life of the nations problems which we, as a scientific Society, should not altogether leave to others to solve.

It has been repeatedly stated that the present world-wide economic difficulties are largely due to the vast scientific advancements of recent times.

As scientists, we are told that we have so mechanised industry that to-day we are the direct cause of unemployment and a contributing cause to the social unrest which is so prominent in Europe, and, in fact, all parts of the civilised world.

Surely such a charge, so frequently repeated, is of sufficient importance to make us inquire whether such is or is not the case! If we are the direct cause, then it is reasonable to expect us to provide the remedy or else close down our scientific progress. If we are not wholly, or even partly responsible, the social condition is such that we surely cannot pass by without making some effort towards its improvement nor allow the stigma to remain because of our unwillingness to assist in combating it!

Cannot we, by scientific and organised research, help to dispel the unhealthy influence which we have directly or indirectly created, and which has assumed larger proportions than, perhaps, would otherwise have been the case had we earlier thrown our training and thought into its solution?

Perhaps this is a field where, apart from our purely scientific work, we can work together with the other leaders of thought, the statesmen, the banker, and the economist in the common cause of uplifting mankind and teaching him how to use the greater comforts which we have helped to create, and employ usefully the greater leisure we have made available to him.

Our scientific training teaches us that by combination the elements grow in size and strength, and that by separation we can reverse that process. As surely as division means destruction, so surely will scientific amalgamation of facts and forces create that which will grow in size, strength, and beauty.

From the dawn of history, and until a few generations ago, the world's work was done by manual labour. From dawn till dusk man toiled with his hands simply to obtain sufficient food, clothing, and shelter to keep body and soul together. To-day science has so improved conditions that the material comforts of the masses greatly exceed even those of the privileged few in olden days.

Has the advancement been for the country's good? Has the growth of ten ears of corn where previously only one grew been to our advantage? Have the modern methods of preparing food and clothes, the rapid and distant transport of our grown or manufactured products, the wider knowledge of the peoples of the globe, and freer intercourse caused unemployment and unrest? These are the questions which we, as scientists, should face and answer satisfactorily.

As previously stated, it has been repeatedly claimed that the scientist, and through him the engineer, is the principal cause of unemployment because he has so mechanised industry and increased productivity as to create over-production and unemployment by utilising machinery instead of manual labour.

Let us examine such a statement. To-day the requirements of the individual are far greater than previously; different and more complicated food and more clothing than ever before are now required. These increases demand an advance in science and in labour. It is beyond question that industry has been mechanised, and also, unfortunately, that we have been compelled to push aside from certain classes of work those individuals who have not fitted themselves for the greater work made available in other industries.

Looking along some of these mechanised industries and starting with transport, we do not find it far to glance back upon poorly constructed roads and horse-drawn vehicles on land, or wind-driven ships at sea. Yet have these transport changes caused universal or even partial unemployment?

Instead of unemployment, they have given employment by creating a wider field of use and a greater demand for comfort and leisure, together with a desire to travel. It does not require a reference to statistics to prove that the employment given to-day by railways and steamships, automobile factories and filling stations, aerodromes, and the supplying of fuel to the various forms of mechanical transport far exceeds that given by the stage coach, the livery stable, and sailing ships of fifty years ago. The mining and manufacture of metals for the construction of, and obtaining fuel for use in, transport units give far greater employment than growing food for horses.

The same can be said of our food and clothing. To-day our foodstuffs are so highly refined that much labour is required for their preparation. I could go through clothing, housing, and other necessary commodities in a similar manner—all of which show increased employment to supply present-day individual wants.

Apart from necessary commodities, we have an important industry which, whilst perhaps a partial luxury, is fast becoming an everyday necessity. I refer to artificial air-conditioning. We have our air-conditioned factories, stores, offices, homes, and public halls, and we also use air-conditioned rooms for the storage of foodstuffs, thereby materially assisting in the preservation of our food for daily consumption and the regular marketing of our perishable products. We also use air-conditioned rooms to control the ripening of our fruit.

Ventilation with conditioned air is a great aid to personal comfort, since adequate ventilation maintains conditions which ensure the health and comfort of occupants in any given space. The essential comfort factors of efficient ventilation are the control of the temperature, humidity, and the motion of the air.

An ordinary thermometer is of only relative value for indicating personal comfort. The sense of warmth experienced by the human body is not due alone to the temperature registered by the dry-bulb thermometer; neither does it depend solely upon that recorded by the wet-bulb thermometer. Human comfort depends largely on body temperature, which is in turn affected by—

(*a*) Loss of heat by convection and radiation;
(*b*) Loss of heat by evaporation;
(*c*) The motion of the air aiding both these factors.

Scientific research as applied by industry in controlling air temperatures and humidity has made the artificial preservation of our food and of our personal comfort an every day activity of maximum importance. We also have our purely luxury or non-essential requirements, embracing rapid transport systems, radio, cable and telephone service, the distribution of news service, picture theatres, organised amusements, and a host of other similar things. These are all additions which, during the last fifty years, have definitely created new avenues of employment.

Even in this enlightened age we hear some proclaim that it would be better if machinery disappeared. This is equivalent to asking that homespun garments be used and that everyone should grow his own spinach and potatoes, because, by so doing, all would be employed.

How many of these complainants would appreciate going back to the rush light, to slow instead of rapid transport, to stairs instead of elevators, to the drawing of water and hewing of firewood, and the absence of places of amusement? I venture to say that few, if any, who hold these retrograde views are old enough to understand or appreciate what they are suggesting or can even in part visualise the disadvantages and discomforts involved.

The luxury and convenience of the telephone at our elbow, when, with as little effort as is taken to light the occasional cigarette, we may talk to friends far apart, and, by even less personal exertion, we are entertained by music through the radio loud speaker! These enjoyments were not available fifty or even thirty years ago.

Luxuries previously non-existent create new avenues of employment.

The scientist is not a destructor of civilisation, but a creator of comfort, leisure, and, indeed, luxury. By comfort and leisure I do not mean a life of idleness, but rather a process of education so that we may have more opportunities to do those things which we want to do for pleasure or interest, and not because the doing of them is required to enable us to earn our food, clothing, and housing.

In addition to scientific production and distribution, are we not now required to teach people how best they may employ that comfort and leisure which the scientist has made available?

Our politicians, merchants, and others have failed to market the products available. They have failed to distribute or fully utilise the wealth at their disposal. Scientific advance has added to their work by giving greater production coupled with distribution problems.

The prosperity of the nations depends on increasing production until a point is reached when there is sufficient to supply the needs and desires of everyone.

Statistics show that our present production is inadequate and unbalanced. There are too few of some goods and too many of others. If we interest ourselves in production only, we leave the most important work undone. We must also distribute. I do not mean that we shall by scientific methods evolve means of transportation, but I use distribution in the much wider sense which includes everything necessary to place the products of industry within the reach of every worker.

Distribution should not be excluded from scientific thought and methods of investigation, and it is here, in conjunction with the statesman, the economist, the banker, and others, that the scientist can attempt to influence the methods of investigation and research.

As a section of the community trained to test and investigate in a thoroughly scientific manner the many problems of nature and science, the Royal Society of Queensland, if not as a collective body, then through and by its individual members, has an important part to play in maintaining national prosperity.

The Significance of pH Putrefactive Grade Test in Bacteriological Water Analysis.

By W. T. Robertson, Bacteriologist, Water Supply Department, Brisbane City Council.

(*Read before the Royal Society of Queensland, 23rd April,* 1935.)

What is the most reliable evidence on which to judge a potable water? Present authorities are in favour of the results of a bacteriological analysis in respect, firstly, to numbers of total micro-organisms per cubic centimetre, and secondly, to the presence or absence of the colon bacillus or its allied forms in quantities of water up to 10 c.c. It is claimed that the presence of the *B. coli* in such a water may suggest the likelihood of the presence also of *B. typhosus*. To test for *typhosus* is a very arduous business in routine work, but to test for *B. coli* and its allies is a far simpler task; hence it is on this organism's appearance or non-appearance in water supplies that the standard of purity is based.

Many and varied are the methods which have been adopted in order that investigators may have concrete evidence of these *coli-forms* in the supplies. In ordinary practice a plate of lactose-bile salt agar with neutral red added is used for isolation purposes. I have found, however, that eosin-methylene blue agar with lactose added gives better results in water routine and is more in keeping with the results obtained in sugar broth tests. Some investigators—MacConkey, for instance—discovered that typical *Bacillus coli* preferred ox bile to grow in, whilst at the same time it was observed that the bile inhibited the free growth of other bacteria which are of no consequence.

It is well known to bacteriologists that certain bacteria have the ability to split up certain sugars, thus causing fermentation, which produces acid and gas (carbon dioxide and hydrogen mainly), the quantities depending on the type of putrefactive micro-organisms present.

My experience has been, however, that the bile salt broth does not exhibit all the positive tests it should for total putrefactives, so it leads one to wonder if the inhibiting power possessed by the ox bile does not also inhibit certain lesser members of the *coli-aerogenes* group. This means, therefore, that this test by itself leaves a lot to be desired, so that for water giving negative results erroneously other tests must be run concurrently, in order to check one test against the other. By a long series of routine experiments I claim to have eliminated much of the possibility of this error.

Take an ordinary 2 per cent. peptone broth and adjust its pH to approximately 7·10; add 2 per cent. lactose to the broth; tube in 5-c.c. quantities and sterilise at 15 lb. per sq. in. for ten minutes. When the test is being made add 10 c.c. of water to be tested, and incubate for forty-eight hours at 37 degrees C., but definitely *no longer* than forty-eight hours, or the significance of the test will be lost.

Divide the incubated water and broth into two equal portions; try one portion for a low pH reading and the other for a pH between 6·2 and 7·2. When the correct reading for comparative purposes is reached by means of prepared buffer solutions, and an appropriate indicator added to test solution, the result obtained can be at once classified.

I grade the water under test, for convenience, into five groups, viz.:—A, B, C, D, and E, according to the following ranges of pH:—

A Grade	..	..	pH 7.1 or 7.2 — 7.0
B Grade	..	..	6.9 — 5.9
C Grade	..	..	5.8 — 5.1
D Grade	..	..	5.0 — 4.8
E Grade	..	..	4.70 and under if necessary.

Now, as a rule, it will be found that fæcal strains of *B. coli* ferment lactose freely, and therefore a low pH can be expected (there are a *few* exceptions to this, such as types with slow fermenting powers leaving the reduction of lactose incomplete at the end of forty-eight hours).

The fæcal types, therefore, are included mainly in groups D and E, non-fæcal types occur in group C and the early part of group B, and *B. œrogenes* in the later part of group B, pH 6·60 to 6.90. *B. œrogenes,* as a rule, ferments the lactose, causing an increased acidity for half the incubation period; fermentation then ceases, and the broth gains in alkalinity for the latter half of the period; hence the range suggested here. If a culture gives at the end of forty-eight hours a reading greater than the *initial* reading of the adjusted broth, *aerogenes* still may be the cause. Group A covers quality water of good potability and beyond suspicion.

It can be seen from the above grouping that the water can definitely be graded; thus the entire test has been named the "pH Putrefactive Grade Test," the putrefactive bacteria, in this case, being the lactose fermenters. One of the most important uses to which this test can be applied is in the checking of the effective chlorine dose; that is to say, the absence of *any* fermentation in such a broth test would prove chlorination effective. On the other hand, where residual chlorine has decreased owing, for instance, to colour factor or increased demand, putrefactive readings will appear to decline, slowly, perhaps, on the first day, and reach the vicinity of 6·40, decreasing then to 5·90, and again later to 5·40, finally reaching the lower colon range (non-fæcal) of 5·20 to 5·00, and so on.

When the first decline in pH is noticed, doses of chlorine should be increased at once so as to prevent any further lowering effect.

It is understood, of course, that other groups of bacteria, also certain coccal forms, have this lactose-fermenting power—for example, members of the lactic acid group, which includes *M. acidi-lactis,* also the sulphite-reducing bacteria which are found in many polluted waters, these waters as a rule containing high concentrations of sulphates and sulphites; thus hydrogen sulphide is produced on incubation, due entirely to bacterial action in a sugar broth medium. If such bacteria as the above were present in a raw water, it is almost certain the *B. coli* would also be present in fair numbers.

It might be said here that this test is particularly suitable for the grading of raw waters in order to decide if they are potable without treatment. Now, some actual figures will help us to value this test. A certain number of tests on filtered waters were grouped together at random, and 18·3 per cent. of these gave positive *B. coli* results (both fæcal and non-fæcal types) in this special peptone lactose broth, whilst for the same tests done in lactose *bile salt* broth only 4·6 per cent. were positive. This would indicate that the test is four times as effective as that of the ox bile broth for *B. coli* and its allied forms.

Figures appended here concern, firstly, a survey of *raw* water samples from the Upper Brisbane River collected during the year 1933. Of the total number of tests made, 4 per cent. were negative in regard to *B. coli-ærogenes* or any of its allied forms.

B. coli fæcal showed in 38 per cent. of the tests;
B. coli non-fæcal showed in 47 per cent.; and
B. ærogenes showed in 11 per cent.

These figures demonstrate the effectiveness of this test alone; the *positive* totalled 96 per cent. of the tests done. Comparing these figures with those obtained after *immediate* filtration and chlorination for the same period, we have the following:—

B. coli fæcal types showed in 1·20 per cent. of the tests.
B. coli non-fæcal types showed in 8·40 per cent. of the tests.
B. ærogenes are included in the 8·40 per cent.; therefore, 90·4 per cent. of these tests were negative.

To sum up, the claims put forward here are that this simple test is highly effective in (*a*) grading waters, (*b*) checking purification effect, both filtration and chlorination, and (*c*) checking the potability of raw waters where treatment has not definitely been decided upon. The grading will give the investigator knowledge concerning types of bacteria of a polluting character likely to be present. It must be remembered, however, that quite a number of nitrifying bacteria gathered by river waters during high flow over ploughed farm land are capable of fermenting lactose, and this test may reveal them. However, this still is an indication of possible pollution, which is what was aimed at when I introduced this test into our bacteriological water practice.

Appended here will be found an experiment carried out in order to demonstrate the use of the so-called pH putrefactive grade test.

Six (6) samples were made up from polluted water drawn from a waterhole, and this water diluted with various quantities of sterile tap water. A total "count" was made on the raw sample, also a plate "count" taken on eosin-methylene blue lactose agar, for typical *B. coli* colonies. In order to grade the degree of pollution, chemically as well, nitrogen determined as free and albuminoid ammonia was estimated on all six samples, also the raw sample. The pond-water had a chloride (as Cl) value of 156 parts per million, and a total alkalinity (as $CaCO_3$) of 68 parts per million.

In Experiment I., I venture to state, after looking through the results obtained, had there been a dilution sample between 1 in 100 and 1 in 200, a reading may have been obtained in the early part of the *coli* non-fæcal range, say, between 5·2 and 5·7.

Another point this experiment demonstrates very particularly is that comparative relation between total micro-organisms and nitrogen contents means very little unless correlated with the absence or presence of *B. coli* or its allied forms.

This is illustrated amply in samples D and E, E containing *no B. coli,* but other less fermentative bacteria are evidently present.

Experiment I.—

No. of Sample.	Dilution of Sample.	Free Ammonia as Nitrogen Parts per Million.	Albuminoid Ammonia (as N.).	Total Micro-organisms per 1 c.c. Nutrient Agar at 37° C. in 48 hours.	B. coli (as indicated on cosin-methylene-blue Agar plate.)	Peptone Lactose Broth, Result as Acid and Gas Production. 24 hours.	48 hours.	pH Readings 48 hours ending. pH	Grade.	Lactose Bile Broth (Neutral Red) Acid and Gas Production. 24 hours.	48 hours.
Raw sample	Nil	·040	·434	680	5 per 10 ccs	+	+	4·8	D	+	+
A	1 to 2	·025	·435	280 at least	10 in total sample	+	+	4·8	D	+	+
B	1 to 5	·020	·400	150 at least	5 in total sample	+	+	4·9	D	+	+
C	1 to 10	·016	·270	120 at least	5 in total sample	+	+	4·6	D	—	+
D	1 to 100	·020	·125	36 at least	1 in total sample	+	+	4·9	D	—	—
E	1 to 250	·020	·120	14	Nil in total sample	—	—	6·4	B	—	—
F	1 to 500	·020	·125	10	Nil in total sample	—	—	7·1	A	—	—

Samples C, D, and E, are of interest for comparative purposes in respect to the two broth tests, *Experiment II.*—

Five dilution bottles taken, and $\frac{1}{10}$ c.c. of broth culture containing *B. putridum* (a type nearly resembling *B. fluorescens*) was placed in the first dilution bottle.

Sample.	Dilution.	Number of Organisms in Dilution.	Lactose Bile Broth. Acid and Gas Production.		Lactose–Peptone Broth.		Grade.
			24 Hours.	48 Hours.	24 Hours.	pH in 48 Hours.	
0	1 to 1,000	At least 6,000	+	+	+	5·70	C
A	1 to 1,200	2,200	+	+	+	5·60	C
B	1 to 1,500	20	Acid	only	+	5·80	C
C	1 to 1,900	Nil	—	—	—	7·10	A
D	1 to 2,400	Nil	—	—	—	7·10	A

A cultural feature was the large quantities of gas generated in the peptone lactose broth in twenty-four hours. This had completely disappeared at the end of forty-eight hours.

Two sub-cultures were made, and one after twenty-four hours incubation gave pH of 5·40, the other of 5·8; so the results regarding a decreased pH over the final twenty-four hours are rather conflicting.

I have appended here sub-cultural data which will more fully bear out my conclusions in connection with the pH putrefactive grade tests.

Experiment I.—The cultural medium was an adjusted lactose-peptone broth.

A pure culture of *B. ærogenes* cultured originally from a raw water supply.

(*a*)

pH	Time cultured in hours.
7.10	Initial
6.80	17 hours
6.80	23 hours
7.6	40 hours

(*b*)

pH	Time cultured in hours.
7.10	Initial
6.90	4 hours
6.90	8 hours
6.90	24 hours
6.90	32 hours
7.30	48 hours

Another culture originally isolated from Enoggera Reservoir and subsequently was proven to be *B. lactis-ærogenes.*

This culture gave the following additional sub-cultural results:—

Voges-Proskauer reaction ..	+
Methyl red	—
Indol production	+
Saccharose broth	+ acid and gas only.

pH	Time cultured in hours.
7.10	Initial
6.70	16 hours
6.60	20 hours
6.60	24 hours
7.00	40 hours
6.90	48 hours
6.90	64 hours

Another culture taken from the same source as the one above gave the following results:—

Voges-Proskauer reaction ..	+	
Methyl red	—	
Indol production	—	
Saccharose broth	+	acid and gas and fluorescence.

pH	Time cultured in hours.
7.10	Initial
6.70	16 hours
6.80	20 hours
6.80	24 hours
7.10	40 hours
7.10	48 hours
7.50	64 hours

This culture has proven itself to be *B. lactis-ærogenes* also. Both these cultures, due to their pH figures, in forty-eight hours would be very difficult to detect.

Cultures under the heading of "Fæcal Types" also show interesting cultural features.

A culture originally taken from a plate-culture of water drawn from Brisbane River raw supply:—

Voges-Proskauer reaction ..	—
Methyl red reaction	+
Lactose bile salt broth reaction	+
Saccharose broth reaction ..	—
Indol production	+

pH	Time cultured in hours.
7.10	Initial
6.30	16 hours
6.20	20 hours
6.00	24 hours
5.20	36 hours
5.0	48 hours
5.20	64 hours

This is apparently a *B. coli* fæcal strain.

Another culture with *apparently* the same cultural characteristics as the previous one gave the following results:—

Voges-Proskauer reaction ..	—	
Methyl red reaction	—	(?)
Lactose bile salt broth ..	+	
Saccharose broth	+	acid only
Indol production	+	

pH	Time cultured in hours.
7.10	Initial
6.40	16 hours
6.10	20 hours
5.20	24 hours
5.0	36 hours
4.9	40 hours
5.0	72 hours

This culture, in order to be satisfactorily classified, should have given a *positive* methyl-red reaction as a fæcal type. All other tests bear out this conclusion.

However, another type was cultured from the same source and gave results more in keeping with classification:—

Voges-Proskauer reaction ..	.. —	
Methyl red reaction ..	.. —	
Lactose bile salt broth	.. +	
Saccharose	.. +	acid only
Indol production ..	.. +	
Glucose fermentation	.. —	(?)

pH	Time cultured in hours.
7.10	Initial
6.40	16 hours
6.20	20 hours
5.80	24 hours
5.50	40 hours
5.80	48 hours

This looks to be a type of *anærogenes.* A pH reading was taken of this culture in eighty-eight hours, and a reading of 6·20 was obtained, showing that back-to-alkalinity reaction characteristic of the *ærogenes.* The above group of tests, however, do not bear out this conclusion, showing as they do a negative Voges-Proskauer test but a positive saccharose broth test; so a non-fæcal colon type will be the classification in this case.

B. anærogenes is a probability here, as very little gas was produced in the fermentation reactions, and this feature is characteristic of the *anærogenes.*

A culture of interest to the waterworks bacteriologist might be outlined here.

A gull "dropping" was taken from the surface of an open filter-bed and placed in an extract broth and cultured, and then a spread-culture made, and the predominating type was again recultured. The following results were obtained:—

Methyl red reaction ..	.. —	
Voges-Proskauer reaction	.. +	
Glucose fermentation	.. +	
Lactose bile salt broth	.. +	
Saccharose broth ..	.. +	acid, gas, and fluorescence
Indol production ..	.. +	

pH	Time cultured in hours.
7.0–7.10	Initial
5.90	16 hours
5.90	20 hours
5.90	24 hours
5.50	40 hours
5.50	48 hours
5.90	72 hours
6.90	1 week

In our classification at the end of forty-eight hours this culture would appear in our C grade as a *coli* non-fæcal type; it is apparently of the "grain" type. Large numbers of grass seeds were apparent in the excreta on examination.

These tests will in some way help to bear out the classification and grading which I have made earlier concerning the pH putrefactive grade tests.

The grade does not always, unfortunately, settle the question as to the type or types of polluting organisms present, but gives us a very good idea of the type of water and the degree of pollution with which we are dealing.

A Suggested Co-Enzyme Hypothesis for the Ripening of Fruits, by Ethylene Gas Treatment.

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(*Read before the Royal Society of Queensland, 24th June, 1935.*)

INTRODUCTORY.

The artificial ripening of fruits by ethylene gas treatment has in recent years assumed such proportions that it is now regarded as part and parcel of the marketing process in many branches of the fruit industry. By reason of the commercial importance of the procedure, it is imperative that a complete understanding of the basic scientific principles of ethylene treatment should be made available, since in the absence of such knowledge we cannot hope to obtain a maximum return for energy expended. It is, therefore, with the hope of passing another milestone towards the ultimate goal that this paper is presented.

A number of theories of a more or less tentative nature have been advanced to account for the induction of edible maturity in many fruits by the use of ethylene gas. It was early suggested that the sole effect of the treatment amounted to a disorganisation of the chlorophyll of the outer tissues of the fruit, the destruction of the green pigment making visible the previously disguised yellow colour of the carotinoids—*e.g.*, as in the banana. Such a theory does not account for the internal ripening changes which are simultaneously induced in the banana, while, on the other hand, it is tenable in the case of citrus fruits, in which the ripening of the pulp is not accelerated by gas treatment. Precipitation of tannins by ethylene gas is another suggestion advanced to account for the removal of astringency in the fruit—*e.g.*, persimmon—but this explanation ignores the bulk of the changes which take place during the ripening process. The rise in the respiratory rate of treated fruits has led to the theory of permeability change (Regeimbal, Vacha, and Harvey (1927)[6]), whereby increased membrane permeability allows of the more rapid diffusion of oxygen and in consequence a rise in the rate of tissue oxidations. In view of the work of Denny (1924)[2], this explanation does not appeal, for, if ethylene in a concentration of 1 part in 1,000,000 of air is of sufficient potency to increase permeability, as evidenced by the intensified respiration of gas-treated lemons, then a concentration of 1 part of this gas in 1,000 of air would surely induce irreversible change in the plasma membrane. Other theories as to the mechanism of ethylene ripening include the stimulation of oxidising enzymes both with respect to quantity and activity, and, while it is not proposed to review *in extenso* the suggestions which have been put forward, it is considered that these latter theories have much to commend them.

SOME PHYSICAL AND PHYSIOLOGICAL EFFECTS OF ETHYLENE TREATMENT OF FRUITS IN THE PRESENCE OF OXYGEN.

From the purely physical aspect, the effect of ethylene gas upon fruits may be twofold. It hastens the production of the normal ripe colour in such fruits as the banana, the tomato, and the pineapple, while internally it brings about changes in texture, flavour, and degree of sweetness or other characteristic property such that we regard the fruit to be in an edibly mature condition. This internal effect, however, is not uniformly produced in all ethylenised fruits, and it is a peculiarity of citrus fruits that no internal ripening occurs as a result of commercial gas treatment. The inability of citrus fruits to respond to ethylene is of the greatest importance, and provides evidence which will be discussed in a later section of this paper.

From the physiological point of view, commercial gas treatment would appear to accelerate the general metabolism of the fruit, as shown by the rise in the rate of respiration; or, alternatively, we may regard the acceleration of metabolism to be due to a direct intensification of respiration, since it is owing to this phenomenon that energy is derived for expenditure in vital processes.

An increase in the respiration rate of lemons was reported by Denny (1924)[2] as a result of the use of ethylene in air in concentrations ranging from 1 part of gas in 1,000 of air to 1 part in 1,000,000. The percentage increase ranged from 100 per cent. to 250 per cent.

Lot No.	Weight of Fresh Fruit.	Treatment.	Rate of Respiration Mg of CO_2 per Kg per Hour.				
			1 (Day).	2 (Days.)	4 (Days).	6 (Days.)	8 (Days).
C	698	Ethylene	10·5	21·0	22·0	41·1	30·6
D	649	Ethylene	11·3	15·4	29·8	28·8	32·9
E	658	Control	10·1	7·1	10·1	10·1	10·1
F	693	Control	11·5	9·1	8·7	12·5	9·6

Effect of Ethylene upon the Rate of Respiration of Lemons (Denny, 1924)[2].

EFFECT OF ETHYLENE UPON THE RATE OF RESPIRATION OF LEMONS (DENNY, 1924).[2]

I have measured, upon a number of separate occasions, the rate of respiration of late Valencia oranges in air and in a gas mixture of 1 part of ethylene in 1,000 parts of air, and the following is a typical result. (Figures represent tenths of an inch, and are measurements of manometric heights, and are purely comparative. Identical weights of fruits were used in chambers of equal capacity) :—

Days.	Ethylene.	Control.
1	16.2	7.5
2	15.9	6.5
3	17.3	3.6
4	17.8	6.0
5	16.6	7.1
6	17.0	6.8
7	15.7	6.9

EFFECT OF ETHYLENE UPON THE RATE OF RESPIRATION OF LATE VALENCIA ORANGES.

It will be seen that this work provides confirmation of that of Denny with respect to citrus fruits. At the conclusion of the experiment ethylenised oranges were ripe-coloured but sour, while the controls were both sour and green. During the same experiment the effect of ethylene gas upon the respiration of bananas was also investigated (measurements are in sixteenths of an inch, and are purely comparative):—

Days.	Ethylene.	Control.
1	27	16
2	39	17
3	32	15
4	34	16
5	26	16
6	25	16
7	—	10

Effect of Ethylene upon the Rate of Respiration of Bananas.

Regeimbal, Vacha, and Harvey (1927)[6] noted an initial stimulation in the respiration rate of bananas treated with 1 part of ethylene in 1,000 of air, but record a subsequent decrease in less than half an hour. They deduce from this result that oxidation rather than permeability rate is increased. The fall in respiration rate following upon an initial intensification has been observed by a number of workers when bananas are subjected to a single dose of ethylene gas for a comparatively brief period of time. Under commercial ripening conditions in Australia, however, the treatment is repeated twice daily up to the "half-colour" stage (Young, Bagster, Hicks, and Huelin, 1932)[8], and it would appear from my experimental results that the series of respiratory stimulations thus induced raise the mean level of the respiration rate of treated bananas above that of the controls.

The rise in the rate of respiration of gas-treated fruits is not confined to those fruits already discussed. Davies and Church ( )[1] report an increase in the respiration rate of Japanese persimmons during ethylene ripening, and regard their results as similar to that obtained by Denny with lemons. It may therefore be concluded that the acceleration of respiration during treatment with ethylene gas is a phenomenon of general occurrence.

SOME PHYSICAL AND PHYSIOLOGICAL EFFECTS OF VARYING OXYGEN CONCENTRATION UPON FRUITS IN THE PRESENCE AND ABSENCE OF ETHYLENE.

In 1924 Denny attempted to colour lemons with ethylene in the absence of oxygen by the use of a gas mixture of 1 part of ethylene in 1,000 of nitrogen. Under these conditions no colouration was developed, and it was hence deduced that the presence of oxygen is necessary for the development of ripe colour. I repeated this experiment with bananas, and the result was in entire agreement with that of Denny.

The concentration of oxygen in the intercellular space system of fruits is frequently below that of the atmosphere. In the case of the coconut (Herbert, 1923)[3] the gas analysis of the internal atmosphere of the fruit was as follows:—

Very Young Coconut.	Per cent.	Old Coconut.	Per cent.
Nitrogen	81.3	Nitrogen	99.8
Oxygen	18.7	Oxygen	0.2
Carbon dioxide	trace	Carbon dioxide	trace

This consideration leads to the view that oxygen concentration may be a limiting factor in the respiration of fruits, and, since respiration rate is intimately connected with the ripening process, it was decided to test the effect of increasing the oxygen concentration of the storage atmosphere upon the rate of ripening of fruits. After preliminary trials a concentration of 80 per cent. oxygen was decided upon, and in this atmosphere oranges were found to colour within five days, whereas there was no change in the colour of the control fruit. Oxygen-treated oranges showed no tendency to ripen internally—a result in agreement with ethylene-treated fruits.

Days.	Oxygen, 80 per cent.	Control.
1	14.0	7.5
2	16.5	6.5
3	11.0	3.6
4	12.0	6.0
5	16.5	7.1
6	16.0	6.8
7	16.0	6.9

EFFECT OF OXYGEN 80 PER CENT. UPON THE RATE OF RESPIRATION OF LATE VALENCIA ORANGES.

An increase in oxygen concentration to a similar extent was likewise found to accelerate the ripening and respiration of bananas. The fruit coloured nicely, and, while the internal flesh softened quickly, it was found to be of poor flavour as compared with ethylene-treated fruits.

It was deduced from this result that a more appropriate oxygen concentration might be used for bananas with better result:—

Days.	Oxygen, 80 per cent.	Control.
1	24	16
2	26	17
3	28	15
4	30	16
5	32	16
6	34	16
7	30	10

EFFECT OF OXYGEN 80 PER CENT. UPON THE RATE OF RESPIRATION OF BANANAS.

The two foregoing experiments were repeated, using, in addition, ethylene gas at the rate of 1 : 1,000 of gas mixture, but no appreciable differences were recorded in the results.

From the experimental data set out in this section we may assume that ripening is essentially an oxidative process, and that the effect of ethylene in accelerating and ripening depends upon its ability to assist, either directly or indirectly, in the tissue oxidations. Moreover, since internal oxidations are the direct result of respiratory activity, and, as we have seen, artificial ripening results in intensified respiration, we may conclude that the ripening process is primarily a respiratory phenomenon. Respiratory studies on bananas from the time of picking to edible maturity show that two separate and distinct phases occur—(1) pre-ripening stage, in which respiratory activity is low and the fruit is in a quasi-dormant condition; (2) ripening stage, in which respiration attains a maximum and then declines.

The effect of ethylene upon the respiration rate of bananas is most evident when applied to fruit in the pre-ripening stage. Once the fruit has commenced to colour, little or no acceleration either of respiration or of ripening is apparent. The reason for this may not be at once obvious, but the work of the Cambridge Low Temperature Station

(1932)[7] would suggest an explanation of such anomalous behaviour. It was shown that ethylene is evolved from ripening apples, and may be detected by its ability to induce malformation in germinating pea embryos, and also by causing retardation of germination of pea seeds. I confirmed the result of this work by passing the storage atmosphere of ripening Granny Smith apples over peas in a germinator, the following statistically significant retardation being obtained:—

NUMBER OF DAYS TO GERMINATION.

Experiment 1.				*Experiment 2.*			
Treated.		Check.		Treated.		Check.	
3.10	0.041	2.63	0.035	4.04	0.005	3.80	0.037

Observations made during the investigation of Bagster, Hicks, and Huelin (1932)[8] into the ripening and transport of bananas shows that the ripening of bananas may be accelerated by storing them in a chamber containing ripe bananas. One may reasonably conclude, therefore, that ethylene is evolved from ripening bananas and other fruits, though it is suggested that further investigation be undertaken in this direction.

RESPIRATORY ENZYMES IN FRUITS.

In order to elucidate the reason for the non-ripening of the central pulp of the orange with ethylene treatment, Herbert and Lynch (1934)[4] approached the problem from the point of view of non-penetrability. As a result of this work, it was shown that the rates of penetration of the tissues of the orange and bananas by ethylene are approximately the same, and hence failure of the orange to ripen cannot be ascribed to this cause. A consideration of the importance of respiration in relation to the ripening process has led me to approach the problem from that aspect, and the fruits were, in consequence, examined with the idea of determining the presence or otherwise of respiratory enzymes and their distribution within the tissues of the fruit. By the use of standard methods, oxidising enzymes were found to occur in the peel and pulp of the banana, and in the peel but not in the pulp of oranges. Investigation into other fruits upon similar lines showed that fruits which may be coloured externally and ripened internally by commercial gas treatment possess oxidising enzymes in both skin and pulp—*e.g.*, bananas, apples, pears, pineapples, etc.—whereas those fruits which colour externally while the internal pulp shows no indication of ripe maturity contain oxidising enzymes in the skin alone, and not in the pulp—*e.g.*, orange and mandarin. I would suggest that herein lies the solution of the problem of ethylene ripening of fruits.

DISCUSSION AND CONCLUSION.

It has been shown in the earlier portions of this paper that internal and external ripening of the pre-ripe banana is induced by ethylene treatment, and that these changes are accompanied by intensified respiration. The replacement of the ethylene gas mixture by an 80 per cent. oxygen atmosphere produces similar results. On the other hand, pre-ripe bananas will not ripen in the absence of oxygen, despite the presence of ethylene in appropriate concentration, and yet again the ripening of bananas which have passed the pre-ripe condition is not necessarily accelerated by traces of ethylene. From these data it is deduced that ripening is a respiratory phenomenon, the intensification of which provides energy for an acceleration of metabolism, which, in turn, cuts down the length of the pre-ripening, semi-dormant phase of the fruit. It has been shown further that ethylene is capable of hastening the ripening of fruits or of certain tissues of the fruit only when those fruit or tissues contain oxidising enzymes, and, since the prime outward manifestation of ethylene treatment is a rise in the rate of respiration, it would appear that the gas exerts its effect through the oxidising enzymes. Finally, it may be deduced from (*a*) the low concentration of ethylene necessary to accelerate ripening, and (*b*) the fact that ethylene is itself generated in the fruit once the pre-ripening period is passed, that ethylene is responsible for the acceleration of the ripening process by a direct stimulation of the oxidising enzymes. It would therefore appear that ethylene plays the role of co-enzyme, together with the oxidising enzymes, not only in the artificial process, but also in the natural ripening of fruits. If this hypothesis be correct, one should be able to predict with certainty those fruits which are and those which are not amenable to artificial gas-ripening. Fruits which contain oxidases, either as laccases or as peroxidases, distributed evenly throughout their tissues, should respond entirely to gas treatment. Fruits coming within this category—*e.g.*, banana, apple, pineapple—certainly do so, though the pineapple is frequently marketed in a coloured but immature condition, due to difficulty of penetration owing to the mass of the fruit. Conversely, if the respiratory theory of fruit-ripening be correct, then a retardation of respiration should tend to prolong storage life by lengthening the duration of the pre-ripening stage. That this is so has been shown by Kidd and West,[5] who, by decreasing oxygen and increasing carbon dioxide concentration of the storage atmosphere, have increased the effective storage life of apples by 150 per cent. It is suggested, in view of the co-enzyme hypothesis, that gas storage should be far more effective for fruits which contain the oxidising enzymes distributed throughout all parts of their tissues than for fruits in which the respiratory enzymes are deficient.

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SUMMARY.

1. Ethylene and oxygen each accelerate the ripening of fruits, and in the process respiration is accelerated.

2. In the absence of oxygen, ripening cannot be induced, and hence the ripening process is essentially a respiratory phenomenon.

3. Ethylene ripening is only successful in the presence of oxidising enzymes, and is related to the distribution of such enzymes in the tissues of the fruit.

4. Ethylene is naturally present in the tissues of fruits which have passed the pre-ripening period.

5. It is suggested that ethylene acts as co-enzyme to oxidase both in the natural and artificial process of ripening.

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New Australian Lepidoptera.

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For most of the eleven genera and forty-one species here described as new, I am greatly indebted to Mr. W. B. Barnard and other valued correspondents. Even in comparatively well collected localities there have been unexpected discoveries, and in any untouched district new species are sure to be found by anyone who searches for them.

Fam. Saturniadae.

Antheraea rhythmica n. sp.

ρυθμικος, neat—

♂♀ 70-72 mm. Head grey-whitish. Palpi fuscous-brown. Antennæ pale ochreous; pectinations in male 6. Thorax reddish-orange; anteriorly pale purple-grey. Abdomen reddish-orange; towards apex and beneath pale purple-grey. Legs pale purple-grey. Forewings broadly triangular, costa straight to $\frac{3}{4}$, thence strongly arched, apex rounded, termen nearly straight, scarcely sinuate beneath apex, slightly oblique; orange-brown; costa broadly suffused with grey to beyond middle; lines purple-reddish; first from $\frac{2}{5}$ costa to $\frac{1}{3}$ dorsum, gently waved; second from apical blotch to $\frac{2}{3}$ dorsum, broad, preceded by a slender parallel line; ocellus oval with axis longitudinal, pale crimson, slenderly edged anteriorly with whitish, posteriorly with yellow, with an outer ring anteriorly dark reddish, posteriorly fuscous, in its centre a hyaline dot; apical blotch ill-defined, irregular, whitish mixed and edged with crimson, containing a blackish spot beneath costa; a brown terminal line; cilia yellow, apices grey. Hindwings strongly rounded; colour and markings as forewings; postmedian line curved and crenate; ocellus smaller and more circular. Underside ochreous suffused with whitish-crimson; outer ring of ocellus exaggerated posteriorly. The female is less brightly coloured, and has the markings less pronounced.

Queensland: Mount Tambourine in January and March; three specimens received from Mr. E. J. Dumigan. We owe this interesting species to the well-known naturalist Mr. Bartlett, whose sons found the larvæ feeding on *Litsea reticulata* (*Lauraceæ*). It forms a small dark-brown, thin-shelled cocoon.

Fam. Larentiadae.

Chloroclytis embolocosma n. sp.

ἐμβολοκοσμος, with wedge-shaped ornament—

♀ .18 mm. Head, thorax, and abdomen grey. Palpi $1\frac{1}{4}$; grey, sprinkled with fuscous. Antennæ grey. Legs pale grey; anterior and middle pairs sprinkled with fuscous. Forewings triangular, costa moderately arched, apex pointed, termen very slightly rounded, oblique; whitish-grey partly ochreous-tinged; markings fuscous; a sub-basal costal dot; fine oblique lines in basal area; a large truncate dark fuscous wedge, its centre paler, extending on costa from $\frac{2}{5}$ to $\frac{3}{5}$, outwardly oblique; reaching half across disc, its outer edge being part of postmedian line, edged posteriorly by a fine white line; postmedian from wedge to $\frac{2}{3}$ dorsum, dentate, edged by a white line and this by a fine fuscous line; two finely dentate subterminal lines; a terminal line; cilia whitish with obscure grey bars. Hindwings with termen rounded; grey with two obscurely darker subterminal lines; cilia whitish-grey.

Queensland: Brisbane, in February; one specimen.

Euphyia propinqua n. sp.

propinquus, similar—

♂♀. 36-40 mm. Closely allied to *E. anthracinata* from Victoria and Tasmania, but in both sexes the termen of forewings is straight. The male of the latter is immediately distinguished by its falcate forewings, with strongly projecting apex and slightly concave termen, a unique character in the genus. The females of the two species are difficult to distinguish. In *E. propinqua* the transverse lines are more crenulate, the antemedian and postmedian lines less strongly marked, but partly edged with white, and there is a fine crenulate whitish subterminal line, but these characters might not hold for a long series. I can detect no structural differences in antennæ, palpi, or neuration.

West Australia: Denmark, in March; three specimens (2♂ 1♀) received from Mr. W. B. Barnard, who has the type.

Euphyia phaulophanes n. sp.

φαυλοφανης, mean-looking—

♂♀. 22-24 mm. Head and thorax fuscous. Palpi $2\frac{1}{2}$; fuscous. Antennæ fuscous; in male slightly serrate and minutely ciliated. Abdomen grey. Legs fuscous. Forewings triangular, costa straight except at extremities, apex pointed, termen gently rounded, oblique, wavy; pale fuscous; a moderate slightly darker basal patch; a slightly darker median band defined by very slender whitish lines; anterior line slightly curved, wavy, indistinct; posterior from $\frac{4}{5}$ costa to $\frac{2}{3}$ dorsum, wavy, scarcely projecting in middle, followed closely by one or two parallel lines; an interrupted dark fuscous terminal line; cilia fuscous. Hindwings with termen strongly rounded; pale grey; cilia pale grey.

West Australia: Denmark, in March; two specimens received from Mr. W. B. Barnard, who has the type.

Fam. Sterrhidae.

Chrysocraspeda eumeles n. sp.

εὐμελης, harmonious—

♂. 20 mm. Head rosy; face whitish-rosy. Palpi less than 1, slender, appressed to lower end of face, terminal joint minute; rosy. Antennæ rosy; pectinations in male 1, whitish. Abdomen whitish, partly rosy on dorsum. Legs rosy; posterior pair whitish. Forewings triangular, costa slightly arched, apex rounded, termen slightly rounded, slightly oblique; rosy finely and uniformly stringulated with yellow, except on a broad costal streak, which extends to about $\frac{3}{4}$; cilia yellow. Hindwings with termen rounded; as forewings but without costal streak.

The genus *Chrysocraspeda* contains a fair number of species in the Eastern Tropics. This is the second Australian species, and may readily be distinguished from the variable *C. cruoraria* by the differently shaped hindwings, which in that species are quadrate with strongly angled termen.

North Queensland: Cape York, in April and May; two specimens received from Mr. W. B. Barnard, who has the type.

Fam. Geometridae.

Gen. *Oxyphanes* nov.

ὀξυφανης, sharply formed—

Face smooth, not projecting. Tongue well developed. Palpi very short (less than 1), slender, ascending, closely appressed to face. Antennæ in male bipectinate, towards apex simple. Thorax with a moderate rounded posterior crest; hairy beneath. Abdomen with crests on third and fourth segments. Femora hairy. Posterior tibiæ with middle spurs. Forewings with 3 and 4 separate, 5 from above middle of cell, 6 from upper angle, 7, 8, 9 stalked, 9 separating before 7, 10 and 11 from cell by a common stalk. Hindwings with 3 and 4 separate; 5 from much above middle of cell, 12 approximated to cell at $\frac{1}{3}$, thence diverging. Frenulum and retinaculum in male well developed.

Probably a derivative of *Sterictopsis*. The stalking of 10 and 11 of the forewings is a peculiar character.

Oxyphanes thiobapta n. sp.

θειοβαπτος, sulphur-tinged—

♂ .25 mm. Head white sprinkled with fuscous. Palpi fuscous, towards base white. Antennæ fuscous; pectinations in male 5, apical $\frac{1}{5}$ simple. Forewings sharply triangular, costa straight, slightly arched towards apex, apex round-pointed, termen slightly rounded; white densely irrorated with fuscous, appearing grey; markings dark fuscous; a subdorsal line broad to $\frac{1}{5}$, thence narrower to termen; short oblique streaks from costa before and after middle, the latter continued as an obscure finely dentate line, bent inwards in mid-disc and continued to dorsum; cilia fuscous with white bars. Hindwings with termen rounded; pale yellow; a sharply defined broad dark fuscous terminal band, containing some white scales near termen; cilia as forewings. Underside whitish with dark fuscous discal marks and terminal bands on both wings.

Queensland: Talwood, in November; one specimen received from Mr. W. B. Barnard, who has the type.

Fam. Oenochromidae.

Taxeotis euryzona n. sp.

εὐρυζωνος, broadly banded—

♂♀ .28-30 mm. Head pale grey; face blackish. Palpi $1\frac{1}{2}$; blackish, base sharply white. Antennæ grey; in male slightly laminate, ciliations 1. Thorax and abdomen grey. Legs grey. Forewings triangular, costa scarcely arched, apex pointed, termen almost straight, moderately oblique; 12 connected by a bar with areole (1♂ 1♀); pale grey; fine fuscous lines from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum, slightly curved, and from $\frac{3}{4}$ costa to $\frac{3}{4}$ dorsum, curved outwardly beneath costa, finely crenulate; included space between lines fuscous except on costa; within this median band a short median transverse subcostal blackish discal streak; subterminal and terminal series of blackish dots; cilia pale grey. Hindwings with termen rounded; pale grey; a terminal series of blackish dots; cilia pale grey.

The fuscous median band may not be a constant character.

Queensland: Mitchell and Charleville, in September; two specimens.

Taxeotis notosticta n. sp.

νωτοστικτος with dorsal spots—

♀ .26-30 mm. Head grey-whitish or grey; face blackish. Palpi 1¼; blackish, base sharply white. Antennæ grey, often whitish towards base. Thorax and abdomen grey with a few blackish scales. Legs grey, sprinkled with fuscous. Forewings triangular, costa gently arched, apex pointed, termen almost straight, moderately oblique; 12 connected by a bar with areole (44♀); grey; markings and some scattered scales blackish; an interrupted line from ¼ costa ending in a spot on ¼ dorsum; a second line from ¾ costa ending in a spot on dorsum at ¾; followed by some obscure brownish dots; a well-marked median subcostal discal dot; subterminal line scarcely indicated; a terminal series of dots; cilia grey. Hindwings with termen slightly rounded; grey; cilia grey.

Queensland: Mitchell, in September; Charleville, in August; four specimens.

Taxeotis pachygramma Low.

♂ ·20-22 mm. Antennæ shortly bipectinate (1½) nearly to apex. Forewings with vein 12 free.

The discovery of this sex necessitates the removal of the species from *Epidesmia*. It is somewhat anomalous in the genus *Taxeotis,* but has no characters justifying generic separation.

Queensland: Milmerran, in March; two specimens received from Mr. J. Macqueen.

Gen. *Phrixocomes* Turn.

This genus now includes five known species. It appears to be characteristic of the more or less arid regions of the continent, in which further discoveries may be expected. The species are all of sombre colouring, and nearly allied.

Phrixocomes gephyrea n. sp.

γεφυρεος, bridged—

♂♀ .20-26 mm. Head grey. Palpi in male 5, in female 6; grey, sprinkled with fuscous. Antennæ fuscous; pectinations in male 6. Thorax grey, sprinkled with fuscous. Abdomen grey, with a few fuscous scales. Legs grey-whitish, sprinkled with fuscous. Forewings triangular, costa straight to near apex, apex pointed, termen slightly rounded, slightly oblique; grey-whitish, sparsely sprinkled with fuscous; markings fuscous; a short subcostal streak and a longer median streak from base, the latter reaching first line; first line strong; from ¼ costa obliquely outwards, acutely angled inwards in middle, ending on ¼ dorsum; second line nearly straight, acutely dentate, from ¾ costa to ⅔ dorsum;

a strong median longitudinal streak connects first line with second; a sharply dentate subterminal line, ill-defined anteriorly, sometimes interrupted; short interneural streaks running into termen; cilia grey whitish barred with fuscous. Hindwings with termen rounded; pale grey; cilia whitish-grey.

Probably near *P. nexistriga* Warr. I have not seen that species, but according to Warren it has a sinuous longitudinal line running from base of costa to termen.

Queensland: In September and December; four specimens received from Mr. J. Macqueen.

Phrixocomes hedrasticha n. sp.

ἑδραστιχος, with basal streaks—

♂♀. 19-25 mm. Head grey. Palpi 8; grey, sprinkled with fuscous, base beneath whitish. Antennæ fuscous; pectinations in male 8. Thorax grey, sprinkled with fuscous. Abdomen pale grey. Legs fuscous; posterior pair grey. Forewings triangular, rather elongate, costa rather strongly arched, apex obtusely pointed, termen slightly rounded, slightly oblique; grey-whitish, with rather dense fuscous irroration and markings; two short longitudinal sub-basal streaks; first line obsolete, or indicated by two or three dots only; second line from $\frac{5}{6}$ costa to $\frac{3}{5}$ dorsum, slender, crenulate, white-edged posteriorly; a subterminal line from apex slender, slightly dentate, white-edged posteriorly; from this run interneural whitish lines to termen; cilia grey with some whitish bars beneath apex. Hindwings with termen rounded; pale grey; a fuscous terminal line; cilia pale grey.

Closely allied to *P. steropias* Meyr. and *P. ptilomacra* Low., both of which lack the basal and terminal streaks and have a sharply angled first line.

Queensland: Milmerran, in August and December; four specimens received from Mr. J. Macqueen.

Fam. NOTODONTIDAE.

Gen. *Parameces* nov.

παραμηκης, oblong—

Tongue strongly developed. Frons with a triangular anterior tuft of scales. (Palpi broken off in type). Antennæ in male pectinated to apex. Abdomen with small crest on basal segment. Forewings smooth; 5 from middle, areole long, 7 and 10 arising separately before its end. Hindwings with 5 from middle, 6 and 7 connate, 12 anastomosing with cell at $\frac{1}{4}$, thence gradually diverging.

Near *Polychoa* Turn., with which it agrees in 6 and 7 of hindwings not being stalked, but the forewings are smooth and 12 of hindwings anastomoses with the cell.

Parameces glauca n. sp.

glaucus, bluish-green—

♂ ·45 mm. Head fuscous, with a few green scales on crown. Antennæ fuscous; pectinations in male 6. Thorax fuscous. Abdomen grey. Legs grey; anterior pair fuscous. Forewings suboblong, costa slightly arched, apex round-rectangular-rectangular, termen straight not oblique; bluish-green; a transverse brown fascia from costa near base not reaching tornus; a double antemedian line at $\frac{1}{3}$, fuscous, irregularly dentate; posterior line at $\frac{2}{3}$, also double, finely dentate; two-thirds of the area included between these lines is occupied by a square brown costal blotch containing three fuscous dots forming a nearly equilateral triangle; a subterminal line of white dots margined with fuscous; an interrupted fuscous submarginal line; cilia fuscous with obscure whitish bars. Hindwings with termen rounded; grey; cilia grey, apices whitish.

North Queensland: Kuranda; one specimen received from Mr. F. P. Dodd.

Fam. Syntomidae.

Syntomis intensa Butl.

Journ. Lin. Soc. Zool. xii., p. 353 (1876).

Although this is distinguishable from *S. annulata* by a practised eye, I have hitherto regarded it as a form of that species, but am now satisfied, that it is a good species. *S. intensa* has proportionately longer and narrower wings, and the spots are more transparent, except the basal spots on both wings. These last often contrast with the peripheral spots in their deeper colour. Both species show analogous variations in the size of the spots. Both vary in size, but on the average *S. intensa* is the smaller. What is of more importance is that in *S. intensa* the females are the larger, but in *S. annulata* the males. This difference, which is much more striking to the eye than is shown by the following measurements should be decisive. In a series of 22 male *S. intensa* the expanse varies from 30 to 40 mm.; in 11 females from 30 to 48 mm. In 17 male *S. annulata* the expanse varies from 34 to 48 mm.; in 11 females from 30 to 42 mm.

North Queensland: Herberton, Queensland; Nambour; Brisbane; Toowoomba; Bunya Mountains (3,500 ft.); Mount Tambourine; National Park (2,000-2,500 ft.); Tweed Heads; Killarney. New South Wales: Lismore; Gosford; Moruya.

Syntomis melitospila Turn.

This species may be distinguished from *S. pyrocoma* by the following characters:—Wings without iridescence; spots large, thinly scaled, pale yellow, not orange; proximal and distal spots of hindwings usually confluent or closely approximated on vein 2; females much smaller than males. *S. melitospila* (8♂), 36-44 mm. (3♀), 28-32 mm. *pyrocoma* (26 ♂), 32-52 mm. (14. ♀), 38-46 mm.

Queensland: Gayndah; Toowoomba; Dalby; Milmerran; Inglewood. New South Wales: Murrurundi. It appears to be an inland species.

Fam. Noctuidae.

Subfam. Melanchrinae.

Sideridis cryptargyrea B-Bak.

Ann. Mag. Nat. Hist. (7), xv., p. 197 (1905). Hmps. Cat. Lep. Phal. v., p. 499. Pl. 91, f. 32.

North Queensland: Cape York; one specimen received from Mr. Geo. Lyell. Also from New Guinea.

Subfam. ACRONYCTINAE.

Xenopseustis poecilastis Meyr.

Trans. Ent. Soc. (1897), p. 370—

Having taken an example of this species I find that it is referable to the *Acronyctinæ,* though aberrant in structure. Perhaps it has some affinity with *Azenia* Grote and *Aegle* Hb.

Queensland: Duaringa, in February; Inglewood, in November.

Gen. *Thalatha* Wlk.

I have come to the conclusion that *Molvena* Wlk. and *Hedymiges* Turn. are not distinguishable from this genus. Its chief characteristics (I refer to the Australian species) are the strongly projecting face with slight central depression, the long cell of hindwings ($\frac{3}{5}$), the thorax with posterior and sometimes slight anterior crest, and the more or less developed dorsal crests on first three abdominal segments. There are six known Australian species, the two here described, *aridoxa* Turn., *melanophrica* Turn., *guttalis* Wlk., and *psorallina* Low.

Thalatha hippolopha n. sp.

ἱππολοφος, strongly crested—

♂ .28 mm. Head white. Palpi 1; fuscous, terminal and apex of second joint white. Antennæ white annulated with blackish; ciliations in male minute. Thorax with prominent bifid posterior crest, white, a precentral dot, lateral edges, and apex of crest blackish. Abdomen with a small crest at base and a strong erect crest on third segment; white, crests and irroration blackish. Legs white with blackish rings except on posterior pair. Forewings elongate-triangular; costa gently arched, apex round-pointed, termen slightly oblique, rounded beneath; white sprinkled with pale grey-green; markings blackish; a transverse basal line; a line from costa near base forming an oblong posterior projection and ending near base of dorsum; a suffused oblique fascia from $\frac{1}{4}$ costa to mid-dorsum, where it is broader and darker, preceded by some brown scales in mid-disc; a medium oblique bar from costa not reaching middle; four or five dots on apical half of costa; a fine acutely dentate line from costa near apex parallel to termen, beneath middle bent inwards to join fascia above dorsum; a series of short streaks on veins running into termen; cilia white with blackish bars. Hindwings with termen rounded; white densely sprinkled with fuscous; a postmedian detate line faintly indicated; cilia as forewings.

New South Wales: Murrurundi, in April; one specimen received from Dr. B. L. Middleton.

Thalatha artificiosa n. sp.

artificiosus, artificial—

♀ .35 mm. Head white; a spot between antennæ and a transverse crescent on face blackish. Palpi $1\frac{1}{4}$; blackish, apices of basal and terminal joints narrowly white. Antennæ fuscous, basal joint and dorsum slightly beyond, white. Thorax white; two pairs of spots, a transverse line on patagia, and two spots on each tegula, blackish. Abdomen white, bases of segments blackish. Legs blackish with white rings. Forewings elongate-triangular, costa nearly straight, apex rounded, termen rounded, slightly oblique; white, with blackish dots and markings; nine costal, one basal, and three sub-basal dots; from fifth costal dot at $\frac{1}{3}$ a transverse series of dots, first posterior, second anterior, fourth opposite fifth on $\frac{1}{4}$ dorsum; sixth costal dot on middle, double, giving origin to an angled line of dots ending on $\frac{3}{5}$ dorsum; this is followed by a postmedian transverse series; an apical collection of dots, largely confluent, extending to midtermen; a subterminal series from this to tornus; terminal edge alternately white and blackish; cilia white, with blackish bars. Hindwings with termen rounded; white, with fuscous markings; a median dot, faint antemedian and postmedian lines, and an apical blotch; cilia white, with fuscous bars except on dorsum.

Queensland: Toowoomba, in February; one specimen received from Mr. W. B. Barnard, who has the type.

Chasmina lispodes n. sp.

λισπωδης, smooth—

♂ .28-30 mm. ♀ .38-40 mm. Head and thorax whitish-brown. Palpi reaching vertex; pale grey-brown. Antennæ grey, towards base whitish; ciliations in male extremely minute. Abdomen whitish-ochreous. Legs brown-whitish; posterior pair whitish. Forewings elongate-triangular; costa slightly arched, apex rounded-rectangular, termen slightly rounded, slightly oblique, slightly crenulate; glossy whitish-brown; a faint pale line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum; a minute pale fuscous median subcostal dot; a whitish-ochreous line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum; a very pale fuscous crenulate subterminal line edged posteriorly with whitish-ochreous; a submarginal series of pale fuscous dots; cilia pale fuscous, apices whitish. Hindwings with termen rounded; whitish-ochreous; cilia whitish.

Varietal form. Forewings sparsely sprinkled with fuscous; markings more distinct; antemedian line fuscous-edged posteriorly; postmedian line fuscous-edged anteriorly. One female.

North-west Australia: Wyndham, in November and January; four specimens received from Mr. T. G. Campbell.

Caradrina eupolia n. sp.

εὔπολιος, grey—

♂♀ .30-36 mm. Head pale grey. Palpi grey-whitish; external surface of second joint except anterior edge and apex dark fuscous. Antennæ fuscous; in male with fascicles of cilia (1). Thorax pale grey, in female darker. Abdomen grey. Legs grey-whitish, sprinkled with dark fuscous; tarsi dark fuscous, with whitish rings. Forewings elongate-triangular, costa almost straight, apex rectangular, termen slightly rounded, hardly oblique; pale grey in male, dark grey in female; numerous wavy, indistinct fuscous transverse lines; postmedian from costal dot at $\frac{3}{5}$, outwardly oblique, angled beyond reniform, beneath this angled slightly inwards, ending on $\frac{2}{3}$ dorsum, indistinct or dotted; subterminal nearly straight; orbicular obsolete; reniform small narrow transversely oval, brownish edged with fuscous; in female sometimes obsolete; a series of small fuscous terminal dots; cilia grey, apices whitish. Hindwings with termen rounded, sinuate; whitish with grey suffusion towards termen and some grey scales on veins; cilia whitish. Underside of forewings grey; of hindwings grey-whitish; forewings with obscure postmedian discal and dotted subterminal line; hindwings with fuscous median dot and postmedian line of dots.

Queensland: Jericho, in May; Barcaldine and Aramac, in June; six specimens.

Subfam. ERASTRIANAE.

Eublemma stereoscia n. sp.

στερεοσκιος, straightly shaded—

♀ .14-20 mm. Head and palpi brownish-ochreous. Antennæ grey. Thorax and abdomen grey-whitish. Legs pale brown; posterior pair whitish. Forewings triangular, costa straight, apex rectangular, termen strongly bowed, sinuate beneath apex, not oblique; a strong oblique straight fuscous shade from $\frac{2}{3}$ dorsum to apex, sharply defined posteriorly; fuscous costal dots at $\frac{1}{3}$ and middle; from the latter an oblique series of four dots to $\frac{1}{3}$ dorsum; a fine fuscous line from $\frac{2}{3}$ costa angled in middle, ending on $\frac{3}{4}$ dorsum, sometimes reduced to a series of dots; oblique shade at apex ochreous-fuscous, with three minute whitish marks on costa and a dark fuscous spot beneath; terminal area suffused with grey; subterminal line indicated by some fuscous dots; a grey submarginal and a whitish terminal line; cilia ochreous-grey. Hindwings with rounded apex, termen straight to near tornus; whitish; a small triangular fuscous blotch touching dorsum above tornus; traces of dotted postmedian and subterminal lines; terminal area and cilia as forewings.

North Queensland: Cape York, in April and June; two specimens received from Mr. W. B. Barnard, who has the type.

Catoblemma trigonographa n. sp.

τριγονογραφος, with triangular marking—

♂♀ .18-20 mm. Head whitish. Palpi in male $2\frac{1}{4}$, in female 3; whitish-grey. Antennæ grey-whitish; ciliations in male 3. Thorax whitish; patagia brownish-tinged. Abdomen grey-whitish. Legs whitish; anterior tibiæ and tarsi pale grey. Forewings triangular, costa straight, apex rectangular, termen strongly rounded, slightly oblique; whitish-grey very faintly pinkish-tinged; slight fuscous irroration on costa to $\frac{2}{3}$; a paler triangle based on costa from $\frac{2}{3}$ to apex, less distinct in female, its apex ill-defined; an obscure suffused discal spot at $\frac{2}{3}$; a short oblique fuscous streak from apex, preceded by a white costal dot; sometimes a subterminal series of dots from apex of this streak; cilia concolorous. Hindwings with termen rounded; colour and cilia as forewings.

Near *C. acrosticha* Turn. and *C. aplecta* Turn., but almost devoid of colour. The costal triangle, though obscure, is a good character. In *C. acrosticha* the male antennæ are slightly laminate with very short ciliations.

North Queensland: Charters Towers, in June; one male. Queensland: Rosewood, in September, one male; Roma, in November, two female examples bred by Mr. W. A. Summerville from larvæ feeding on scale insects.

Gen. *Ecnomia* nov.

ἐκνομιος, unusual—

Tongue present. Face smooth, not projecting. Palpi short, curved upwards and appressed to face, not reaching vertex; second joint moderately stout, smooth-scaled; terminal joint minute. Antennæ in male simple. Thorax and abdomen not crested. Legs smooth. Forewings without areole, 8 and 9 stalked, 7 and 10 separate. Hindwings with 3 and 4 long-stalked, 5 remote, 6 and 7 separate, diverging, 12 anastomosing with cell to beyond middle.

Easily recognised by the neuration.

Ecnomia hesychima n. sp.

ἡσυχιμος, quiet—

♂ .15 mm. Head, palpi, and thorax pale grey. Antennæ pale fuscous. Abdomen whitish-grey. Legs pale grey; posterior pair whitish. Forewings elongate-triangular, costa straight, apex rounded, termen slightly rounded, slightly oblique; pale grey; fuscous costal dots near base and at ⅓; a triangular white dorsal spot before middle, preceded by some brown and fuscous suffusion; a broad suffused brown median fascia, its posterior and lower half of anterior surface edged by fuscous lines, the former preceded by a similar line; these postmedian lines connected beneath costa and preceded by a fuscous dot; beyond fascia a white line, suffused and broadened towards costa, where it touches apex; a faint whitish line from apex to tornus; a terminal series of fuscous dots; cilia whitish. Hindwings with termen gently rounded; pale grey; cilia whitish.

North Queensland: Kuranda, in June; one specimen.

Gen. *Amblyzancla* nov.

ἀμβλυζαγκλος, with blunt sickles—

Tongue present. Frons rounded, somewhat projecting. Palpi long, ascending, appressed to face, exceeding vertex; second joint long, much thickened with appressed scales, especially posteriorly, apex broad, abruptly quadrate; terminal joint minute. Antennæ of male minutely ciliated. Thorax smooth, without crest. Abdomen with small crests on first two segments. Legs smooth-scaled. Forewings without areole, 7, 8, 9, 10 stalked, 7 separating before 10. Hindwings with 5 closely approximated to 4 at origin, 12 anastomosing with cell near base.

Probably nearest *Euthytoma* Turn. *Himerois* Turn. has 10 of forewings separating before 7.

Amblyzancla declivis n. sp.

declivis, oblique—

♂♀ .15-20 mm. Head brownish-ochreous. Palpi reddish-purple. Antennæ grey. Thorax fuscous-brown, anteriorly brownish-ochreous. Abdomen grey. Legs whitish; tarsi grey, with whitish rings; anterior and middle tibiæ reddish-purple. Forewings elongate-triangular, costa straight to ⅔, thence strongly arched, apex rounded-rectangular, termen rounded, slightly oblique; reddish-purple, with some fuscous suffusion towards basal half of dorsum and before postmedian streak; this runs from mid-dorsum nearly to apex, and is there acutely angled inwards to costa, slender, whitish, preceded by an ochreous-fuscous suffused line; a fuscous terminal line; cilia pale ochreous-fuscous. Hindwings somewhat elongate, termen gently rounded; dark grey; cilia grey-whitish.

North Queensland: Cape York, in October, November, and April; four specimens received from Mr. W. B. Barnard, who has the type.

Corgatha molybdophaës n. sp.

μολυβδοφαης, leaden-shining.

♂♀ ·20-22 mm. Head and thorax white. Palpi 3; ochreous. Antennæ ochreous, with some fuscous scales; ciliations in male 1½. Abdomen brown; apices of segments fuscous; two basal segments and underside whitish-ochreous. Legs ochreous. Forewings triangular, costa straight to near apex, apex pointed, termen angled on vein 3; basal area white; an interrupted costal line of leaden-metallic scales to beyond middle; costa edge ochreous; a narrow fascia from costa beyond middle to mid-dorsum, with a strong posterior tooth, reddish-brown with some fuscous scales and a subcostal leaden-metallic spot; this is preceded towards dorsum by a pale grey suffusion, and edged posteriorly by a white line; beyond this a pale-grey parallel fascia edged posteriorly by a white line; terminal area pale-grey, with reddish-brown subapical and supratornal and white median spots; cilia reddish-brown, with some ochreous bars. Hindwings with termen rounded; reddish-brown, towards base and costa whitish-ochreous; transverse fasciæ at middle and ¾, leaden-metallic mixed with fuscous, not reaching costa; cilia reddish-brown, on dorsum ochreous.

New South Wales: Murrurundi, in December and February; three specimens received from Dr. B. L. Middleton.

Corgatha ancistrodes n. sp.

ἀγκιστρωδης, hook-shaped—

♂ ·22 mm. Head and thorax reddish-brown. Palpi 3; reddish-brown. Antennæ grey; ciliations in male 2. Abdomen reddish-brown; underside grey. Legs grey. Forewings triangular, costa straight to near apex, there strongly arched, apex strongly produced in a hook-shaped point, termen strongly sinuate, not oblique; reddish-brown, with a few scattered fuscous scales; a fine pinkish-white line from midcosta outwards, forming an acute angle, thence inwards to mid-dorsum; some fuscous suffusion on costa before middle; subcostal fuscous dots at ¼ and middle; cilia white, on apex and tornus fuscous. Hindwings with tornus prominent, dorsum long, termen slightly rounded; as forewings, but median line straight.

Queensland Toowoomba, in October; Bunya Mountains, in February; two specimens received from Mr. W. B. Barnard, who has the type.

Corgatha pleuroplaca n. sp.

πλευροπλακος, with costal plates—

♂ ·23 mm. Head and thorax white. Palpi 2½; pale-grey. Antennæ grey; ciliations in male 1½. Abdomen white, partly suffused with grey. Legs grey; tarsi fuscous, with white rings; posterior femora and tibiæ white. Forewings triangular, costa straight, apex round-pointed, termen bowed on vein 4; sinuate beneath apex, oblique; white, suffused with pale fuscous; a large irregular blackish costal blotch extending from base to ⅓; a smaller oblong median blotch just beyond; a short streak on dorsum near base; a white transverse line beyond first blotch; a slightly dentate white line from ⅗ costa, outwardly curved, strongly angled inwards above dorsum, edged anteriorly by a pale fuscous line; some fuscous suffusion containing two white dots on costa before apex; small fuscous blotches on termen beneath apex and above tornus; a terminal series of blackish dots; cilia fuscous-brown, narrowly barred with white. Hindwings with termen slightly rounded; pale fuscous becoming whitish towards base; a transverse fuscous line at $\frac{1}{3}$; a transverse white line at $\frac{2}{3}$; a terminal series of fuscous dots; cilia white, with a median fuscous-brown line.

West Australia: Busselton, in February; one specimen received from Mr. W. B. Barnard, who has the type.

Metasada pleurosticta n. sp.

πλευροστικτος, with costal dots—

♂ ·24 mm. Head and thorax brown. Palpi 2; brown, sprinkled with fuscous. Antennæ grey; ciliations in male 1. Abdomen brown; crest and apices of postmedian segments blackish. Legs pale ochreous; anterior pair brownish, with tibiæ partly fuscous, tarsi fuscous, white-ringed. Forewings triangular, costa straight to $\frac{3}{4}$, thence slightly arched, apex pointed; termen slightly rounded, slightly oblique, slightly crenulate; brown; white fuscous-edged dots on costa at $\frac{1}{4}$ and middle; other markings fuscous; a basal costal spot; a transverse series of minute dots at $\frac{1}{4}$; a small median subcostal dot; an outwardly bowed postmedian series of dots; a small subterminal blotch beneath costa; a terminal series of dots; cilia brown, with three fuscous bars beneath apex. Hindwings with termen rounded; brown; a transverse series of dots at $\frac{1}{4}$ and two or three postmedian; an irregular tornal suffusion; a terminal series of dots; cilia brown.

As vein 10 of forewings arises separately from the areole, this is hardly a true *Metasada,* and it will probably be necessary to form a new genus, but I prefer to await further material.

North Queensland: Cape York, in November; one specimen received from Mr. W. B. Barnard, who has the type.

Metasada sideropasta n. sp.

σιδεροπαστος, steel-sprinkled—

♂ ·22-24 mm. Head and thorax fuscous, with some white scales. Palpi pale-brown. Antennæ grey; cilia in male 2. Abdomen fuscous-brown, towards apex sprinkled with white. Legs fuscous, with white tarsal rings. Forewings triangular, costa straight to near apex, there strongly arched, apex pointed, termen bisinuate, oblique; fuscous-grey, becoming fuscous on costa; a basal dorsal spot and transverse lines white; first line from $\frac{2}{5}$ costa to $\frac{2}{5}$ dorsum, dentate; second from $\frac{4}{5}$ costa to $\frac{3}{4}$ dorsum, finely dentate, angled outwards beneath costa and inwards above dorsum; reniform transversely oblong, fuscous sprinkled with lustrous steel-grey scales; similar scales precede first line and also form a wavy subterminal band; disc preceding and following second line partly whitish; a small subapical pale ochreous costal blotch, separated from costal edge by a white dot between two fuscous dots; a narrow terminal band ochreous strigulated with fuscous; cilia fuscous, with several ochreous-whitish dots. Hindwings with termen rounded; grey; basal area grey-whitish, with a grey median dot at $\frac{1}{4}$; a slender wavy whitish transverse median line; cilia as forewings.

This is a true *Metasada,* and 10 of forewings is connate with 7, 8, 9 from areole.

Queensland: Milmerran, in October; two specimens received from Mr. J. Macqueen.

Oruza crocotoschema n. sp.

κροκωτοσχημος, saffron-patterned—

♂♀ ·18-21 mm. Head ochreous. Palpi 1; ochreous. Antennæ ocreous; ciliations in male minute. Thorax ochreous-whitish, anteriorly ochreous. Abdomen and legs ochreous. Forewings triangular, costa slightly arched, apex rectangular, termen straight, rounded beneath; ochreous-whitish; markings orange-brown-ochreous; a dot on costa near base; a broad wavy transverse line at $\frac{1}{3}$; postmedian line from midcosta, strongly curved outwards and then inwards to $\frac{2}{3}$ dorsum, slightly dentate, partly enclosing and sometimes confluent with an oblong reniform; a subterminal line, interrupted above middle, and a terminal line connected with it by streaks on veins; cilia whitish-ochreous. Hindwings with termen rounded; whitish-ochreous, darker towards termen, with a faint postmedian line; cilia whitish-ochreous.

North Queensland: Cape York, in April and May; four specimens received from Mr. W. B. Barnard, who has the type.

Oruza maerens n. sp.

maerens, mournful—

♀ ·25 mm. Head and thorax grey, sparsely sprinkled with fuscous. Palpi $2\frac{1}{2}$; fuscous sprinkled with white. Antennæ grey. Abdomen grey. Legs whitish, finely sprinkled with fuscous. Forewings triangular, costa slightly arched, apex subrectangular, termen slightly rounded; slightly oblique; grey, with scanty fuscous irroration; costal edge reddish to $\frac{2}{3}$, beyond this whitish-ochreous, interrupted by two fuscous dots; a fuscous mark on $\frac{2}{3}$ costa, giving rise to a very obscure slender dark line sinuate to $\frac{2}{3}$ dorsum; a white discal dot immediately precedes this; a very slender crenulate dark subterminal line; cilia fuscous, apices white. Hindwings with termen rounded; as forewings, but with a straight median transverse line not reaching costa.

Nearest *O. lithochroma* Turn.

Queensland: Mitchell, in September; one specimen.

Gen. *Pediarcha* nov.

πεδιαρχος, lord of the plains—

Tongue present. Frons with rounded prominence. Palpi short, porrect, moderately thickened, with appressed scales, slightly rough beneath; terminal joint short, obtuse. Thorax not crested. Abdomen with a small basal crest. Legs smooth-scaled. Forewings with areole present, 2 from $\frac{2}{3}$, 3, 4, 5, well separate, 3 from angle, 5 from below middle, 6 from upper angle, 7 from areole closely approximated, connate, or short-stalked, with 8, 9, 10 separate from areole, 11 from $\frac{2}{3}$. Hindwings with 3 and 4 connate, 5 from well above angle ($\frac{1}{3}$), 6 and 7 connate, or short-stalked, 12 anastomosing with cell from $\frac{1}{4}$ to $\frac{1}{3}$.

Pediarcha singularis n. sp.

singularis, unique—

♂♀ ·24-28 mm. Head orange, with anterior and posterior bars on crown blackish. Palpi 1; blackish, inner surface except apex orange. Antennæ fuscous. Thorax blackish; anterior edge and a large posterior spot orange; Abdomen orange; basal crest and a spot on second segment blackish; penultimate segment in female grey; beneath dark fuscous. Legs fuscous; posterior tibiæ ochreous. Forewings triangular, costa straight, apex pointed, termen slightly rounded, slightly oblique; blackish, with pale ochreous markings; a narrow costal line from base almost to apex; a large oblique suboval spot from base of dorsum to beneath $\frac{1}{4}$ costa; an incomplete fascia from just before tornus, ending in a rounded extremity beneath costa beyond middle; a broad terminal line, narrowing towards extremities, not quite reaching apex and tornus; cilia blackish. Hindwings with termen rounded; orange, with blackish markings; a supratornal blotch, sometimes continued into a broad line to costa; a narrow terminal band; cilia blackish.

Queensland: Cunnamulla, in September and March; four specimens received from Mr. W. B. Barnard, who has the type.

Subfam. SARRHOTHRIPINAE.

Nanaguna orbiculigera n. sp.

orbiculigerus, bearing a small circle—

♂ ·22 mm. Head white, with a few fuscous scales. Palpi long, ascending, appressed to face; second joint reaching vertex; terminal joint $\frac{3}{4}$, obtuse; white, sprinkled with reddish, a subapical fuscous dot on external surface of terminal joint. Antennæ fuscous; ciliations in male minute. Thorax white, posteriorly sprinkled with grey; a broad dark fuscous transverse bar on patagia. Abdomen dark grey; apices of segments narrowly whitish. Legs white; anterior tibiæ and tarsi mixed with fuscous. Forewings suboblong, costa strongly arched to $\frac{1}{3}$, thence nearly straight, apex rounded-rectangular, termen not oblique, rounded beneath; whitish, with patchy grey and fuscous suffusion; a dark fuscous triangular basal patch edged by a white line from $\frac{1}{5}$ costa to $\frac{1}{5}$ dorsum; a median transverse fascia containing a large circular spot, slightly brownish-tinged, defined by whitish fuscous-edged lines, anterior from $\frac{2}{5}$ costa to mid-dorsum, forming a posterior tooth beneath spot, posterior from $\frac{2}{3}$ costa to $\frac{3}{4}$ dorsum, outwardly curved in middle; a sinuate dark fuscous subterminal line from apex to tornus; a terminal series of longitudinally elongate dots; cilia grey, obscurely barred with whitish. Hindwings with apex strongly rounded, termen only slightly; dark grey, paler towards base; cilia as forewings.

North Queensland: Tully, near Innisfail, in July; one specimen.

Gen. *Lathraeolis* nov.

λαθραιολις, fitted for concealment—

Tongue present. Palpi moderate, obliquely ascending, not reaching vertex, moderately thickened with rather rough scales; terminal joint very short, obtuse. Antennæ of male bipectinate nearly to apex, pectinations long. Thorax with a posterior crest. Abdomen with dorsal crest on basal segment only. Forewings with raised scales; 2 from angle, 3 and 4 well separate, 5 closely approximated to 4 at origin, 6 from above middle of cell, 10 and 11 free from cell, 10 approximated to 9. Hindwings ample; 2 from $\frac{3}{4}$, 4 absent, 3 and 5 connate, 6 and 7 connate, 12 approximated to cell to beyond middle.

Perhaps nearest to *Elesma* Wlk., but the relationship appears rather remote.

Lathraeolis spodochroa n. sp.

σποδοχροος, ash-grey—

♂ ·28-35 mm. Head, palpi, and thorax fuscous, sprinkled with white, appearing grey. Antennæ grey; pectinations in male 5. Abdomen whitish-ochreous; basal tuft grey. Legs fuscous, sprinkled with whitish; posterior pair mostly whitish. Forewings elongate-triangular, costa strongly arched, apex rounded, termen obliquely rounded; fuscous densely irrorated with white, appearing grey; markings fuscous; an outwardly oblique line from $\frac{1}{6}$ costa, below middle angled inwards, and then shortly outwards to $\frac{1}{4}$ dorsum; a similar line from $\frac{2}{5}$ costa to mid-dorsum, sometimes obsolete; a third from $\frac{3}{4}$ costa, inwardly oblique, but soon bent outwards, then sharply angled, beneath angle straight and finely dentate to $\frac{4}{5}$ dorsum; an obscure wavy whitish subterminal line; a fine terminal line; cilia concolorous. Hindwings broad, termen bisinuate, rounded; grey, paler towards base; cilia whitish.

Queensland: Milmerran, in May; two specimens received from Mr. J. Macqueen.

Gen. *Dysapura* nov.

δυσαπουρος, anomalous—

Tongue present. Face smooth, not projecting. Palpi recurved, appressed to face, reaching vertex; second joint thickened with smoothly appressed scales; terminal joint short, acute. Antennæ in male shortly ciliated. Thorax smooth. Abdomen with lateral incurved tufts on basal segment. Forewings with 2 from before angle, 3, 4, 5 closely approximated at origin, 6 from well below angle, 7 and 8 stalked, 9 and 10 separate, 11 from $\frac{2}{3}$. Hindwings with 2, 3, 4 separate, 5 approximated to 6, 6 and 7 stalked, 12 approximated to cell as far as middle.

This unusual neuration is hard to interpret.

Dysapura xanthosticha n. sp.

ξανθοστιχος, yellow-streaked—

♂ ·22 mm. Head ochreous-yellow; side-tufts and a spot on face reddish. Palpi ochreous-yellow. Antennæ ochreous-yellow; ciliations in male 1. Thorax dull reddish; a posterior spot and longitudinal streaks on tegulæ ochreous-yellow. Abdomen grey; underside whitish. Legs whitish; anterior pair ochreous-tinged; posterior tibiæ of male with a dense inferior tuft of pale ochreous hairs before middle spurs. Forewings suboblong, costa straight to middle, thence arched, apex rounded-rectangular, termen nearly straight, scarcely oblique; dull reddish, with ochreous-yellow markings and streaks on veins; a large irregular median spot; an apical crescent containing a subterminal reddish line; cilia grey, bases reddish. Hindwings with termen rounded; fuscous; a whitish costal blotch before $\frac{2}{3}$ extending narrowly to base, cilia whitish, bases fuscous.

North Queensland: Cape York, in May; one specimen received from Mr. W. B. Barnard, who has the type.

Subfam. ACONTIANAE.

Gen. *Pseudalea* nov.

ψευδαλεος, counterfeit—

Tongue strong. Palpi smooth, very long, recurved, sickle-shaped, exceeding vertex; second joint moderately thickened, not reaching vertex; terminal joint $\frac{4}{5}$. Antennæ not much shorter than forewing ($\frac{4}{5}$); in male with tufts of short cilia. Thorax smooth-scaled, but with small bifid posterior crest. Abdomen smooth, slender, nearly as long as forewing. Legs smooth; (posterior pair missing). Forewings with areole present, 2 from before middle, 3 from before angle, 4 and 5 approximated, from angle, 8 and 9 stalked from apex of areole, 6 and 10 separate from before its apex, 11 from $\frac{3}{4}$; retinaculum bar-shaped. Hindwings with 2 from $\frac{3}{4}$, 3, 4, 5 approximated, 6 and 7 connate, 12 anastomosing with cell near base, thence diverging.

Probably related to *Cacyparis*, with which it agrees in essential points of structure, but in appearance strongly suggestive of the *Pyraustinæ.*

Pseudalea macrogastris n. sp.

μακρογαστρις, long-bellied—

♂ ·36 mm. Head and thorax fuscous. Palpi pale grey. Antennæ grey; ciliations in male $\frac{2}{3}$. Abdomen 15 mm. in length; grey. Legs grey; anterior pair fuscous, with whitish tarsal rings. Forewings elongate-triangular, costa straight, except near base and apex, apex round-pointed, termen obliquely rounded; fuscous; an obscure whitish transverse line at $\frac{1}{3}$, with a strong posterior tooth beneath costa and another above dorsum; a similar line from $\frac{2}{3}$ costa to $\frac{5}{6}$ dorsum, at first outwardly oblique, soon bent to become transverse, below middle inwardly curved, with a posterior tooth above dorsum; traces of a pale subterminal line; a median fuscous discal dot above middle, cilia fuscous. Hindwings over 1, apex and termen strongly rounded; orange; suffused with fuscous at apex, along dorsum, and on terminal edge; cilia fuscous.

North Queensland: Cape York, in June; one specimen received from Mr. W. B. Barnard, who has the type.

Subfam. OPHIDERINAE.

Alophosoma pallidula n. sp.

pallidulus, rather pale—

♂ .39-40 mm. Head and palpi whitish-brown. Antennæ grey, minutely ciliated with longer bristles (1). Thorax brown-whitish, anteriorly brown. Abdomen whitish-ochreous. Legs whitish-ochreous; anterior tibiæ sprinkled and barred with fuscous; tarsi with fuscous rings. Forewings elongate-triangular, costa slightly arched, apex rounded-rectangular, termen slightly rounded, slightly oblique, crenulate; whitish or brown-whitish, with antemedian and terminal areas suffused with brown; fine transverse dark fuscous lines; a double irregularly dentate sub-basal line; a double antemedian line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum, with a slight posterior tooth beneath costa and another stronger above dorsum; postmedian from $\frac{2}{3}$ costa, first outwardly oblique, then transverse and inwardly curved, above dorsum bent inwards in a double loop touching lower end of reniform, thence outwardly oblique and dentate to $\frac{3}{4}$ dorsum; a fine dentate whitish line in brown terminal area; a crenulate terminal line; reniform bilobed, lower lobe larger, grey, narrowly edged with fuscous; cilia whitish, with slender fuscous bars, bases partly brownish. Hindwings wtih termen rounded; crenulate; whitish-ochreous; a broad fuscous terminal band narrowing to a point on tornus; cilia ochreous-whitish.

♀ ·38 mm. Forewings whiter; antemedian brown area smaller, sharply defined, limited to a triangular area, with a rounded apex reaching from costa to slightly below middle; subterminal white line, preceded by several dark fuscous dots; terminal brown suffusion absent.

The sexes differ markedly. The male differs little from *A. syngenes* Turn., which has similar sexes, except in colour; but there is a difference in the terminal palpal joint being longer (*pallidula* male $\frac{4}{5}$, female $\frac{2}{3}$, *syngenes* both sexes $\frac{1}{2}$).

North Queensland: Cape York, in June; four specimens received from Mr. W. B. Barnard, who has the type.

Prorocopis orthogramma n. sp.

ὀρθογραμμος, with straight markings—

♀ ·32-33 mm. Head and thorax fuscous. Palpi $2\frac{1}{2}$; whitish, sprinkled with fuscous. Antennæ grey. Abdomen whitish-ochreous; dorsum grey-suffused; basal crest fuscous. Legs fuscous, mixed with whitish; posterior pair mostly whitish. Forewings suboblong, costa slightly arched, apex rectangular, termen not oblique, rounded beneath; grey, with blackish markings; a sub-basal transverse line cut by a short longitudinal streak from base of costa; an almost straight line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum; a very short transverse streak from mid-costa; postmedian line from $\frac{3}{4}$ costa, transverse and nearly straight to below middle, thence looped backwards and upwards to unite with lower edge of reniform, thence looped downwards and ending on $\frac{2}{3}$ dorsum; reniform slenderly outlined, large and deeply indented posteriorly so as to form two lobes, some white irroration on its posterior edge; an oblique streak from apex, continued as a subterminal line to tornus, with an obtuse posterior projection below middle; a crenulate terminal line posteriorly filled in partly with white; cilia grey, sprinkled with white. Hindwings broad, termen rounded; ochreous-whitish; a moderate suffused terminal band; cilia ochreous-whitish, with a grey sub-basal line.

Very similar to *P. peratoscia* Hmps., but differs in detail. The antemedian line is not dentate, the reniform more deeply indented, the hindwings much whiter.

New South Wales: Scone, in January; two specimens received from Mr. H. Nicholas.

Stenoprora eurycycla n. sp.

ευρυκυκλος, with broad circles—

♀ ·30 mm. Head and thorax grey, sprinkled with fuscous. Palpi 2; grey, sprinkled with fuscous. Antennæ grey. Abdomen pale grey. Legs fuscous sprinkled, and tarsi ringed, with whitish; posterior pair mostly whitish. Forewings suboblong, costa strongly arched, apex rectangular, termen obliquely rounded; fuscous sprinkled with whitish, appearing grey; markings fuscous; a short subcostal streak at base; a line from $\frac{1}{4}$ costa obliquely outwards, slightly toothed beneath costa, more strongly below middle, indented above dorsum, on which it ends on $\frac{2}{5}$; reniform narrow, crescentic, outlined in fuscous; a line from $\frac{2}{3}$ costa above reniform, outwardly oblique, soon angled, transverse, and concave to below middle, then looped backwards to touch lower end of reniform, again looped and ending on dorsum before tornus; one or two short longitudinal streaks from and beneath apex; a crenulate terminal line; cilia grey. Hindwings with termen rounded; white with a broad fuscous terminal band narrowing to a point at tornus; cilia white, on apex fuscous.

Queensland: Charleville and Quilpie, in August; two specimens.

Pandesma quenavadi Gn.

Noct. ii., p. 438, Hmps. Moths Ind. ii., p. 466.

Moore, Lep., Ceyl., iii., Pl. 156, f.l.

North Queensland: Cairns, Palm Is. Also from Ceylon and India.

Gen. *Epigrypodes* nov.

ἐπιγρυπωδης, somewhat hooked—

Tongue strong. Face smooth, not projecting. Palpi ascending, closely appressed to face, not reaching vertex; second joint long, thickened with appressed scales; terminal joint very short, obtuse. Antennæ about $\frac{3}{5}$ length of forewings; in male with a double row of tufts of moderately long cilia (2), apical $\frac{1}{4}$ simple. Thorax and abdomen smooth without crests. Legs clothed with long dense hairs; midtibiæ of male, with a large basal expansile tuft of long ochreous hairs. Forewings with neuration normal. Hindwings with cell about $\frac{2}{5}$; 5 from slightly above angle.

In shape of wings similar to *Amphigonia* Gn., but that genus has much longer palpi and antennæ.

Epigrypodes amplipennis n. sp.

amplipennis, large-winged—

♂ ·50 mm. Head and face pale brown. Palpi brown; inner surface ochreous-whitish. Antennæ grey. Abdomen brown. Legs ochreous-whitish; anterior coxæ pale brown. Forewings elongate-triangular, costa straight, apex pointed, somewhat produced, termen angled on vein 4; pale reddish-brown; a fine fuscous sub-basal line angled outwards; a similar line at $\frac{1}{4}$, obsolete towards costa, beneath angle edged with whitish; a white median subcostal dot; an obscure fuscous line from midcosta obliquely outwards, bent beneath costa, thence dentate to mid-dorsum; a short white streak on costa at $\frac{3}{4}$; a pale transverse line from costa beyond this, curved inwards below middle, then angled and again transverse to dorsum before tornus; disc beyond this grey; cilia grey, with a whitish dot beneath apical hook. Hindwings with termen produced and acute on vein 3, straight above this, excavated beneath; basal half pale reddish-brown; terminal area grey; a discal dot before middle and a finely dentate line at $\frac{2}{3}$ fuscous; a whitish subterminal line strongly angled on vein 3, preceded by fuscous dots on veins; cilia above angle fuscous-brown, beneath white, with fuscous apices, on dorsum wholly white.

North Queensland: Cape York, one specimen received from Mr. Geo. Lyell. Type in National Museum, Melbourne.

Anomis steremochla n. sp.

στερεομοχλος, straight barred—

♂ ·36 mm. Head and thorax pale ochreous. Palpi reaching vertex, terminal joint $\frac{1}{3}$; brown. Antennæ pale ochreous; in male minutely ciliated with short bristles ($\frac{1}{2}$). Abdomen ochreous-whitish; tuft pale ochreous. Legs brown-whitish; anterior pair brown, with white tarsal rings. Forewings triangular, costa straight, apex rectangular, termen strongly angled on vein 4; pale ochreous, with a few scattered fuscous scales; a minute median subcostal fuscus dot; a straight fuscous line from beneath costa near apex $\frac{2}{3}$ dorsum, closely followed by a parallel line; a small irregular white subapical spot edged with fuscous; cilia fuscous. Hindwings angled, with an acute tooth on vein 4; as forewings, but without discal dot and subapical spot; a double post-median line from beneath $\frac{2}{3}$ costa almost to tornus.

North Australia: Darwin, in November; one specimen received from Mr. F. P. Dodd.

Gen. *Niphosticta* nov.

γιφοστικτος, snow-spotted—

Tongue well developed. Palpi moderately stout, smooth ascending, about reaching vertex; second joint thickened with appressed scales; terminal joint moderate, obtuse. Antennæ in male minutely ciliated with short paired bristles. Thorax not crested. Abdomen with small dorsal crests on first two segments. Forewings normal. Hindwings with 5 from well above lower angle of cell ($\frac{1}{3}$).

In the neighbourhood of *Anticarsia* and *Mecodina,* but with different origin of 5 of hindwings as well as abdominal crests.

Niphosticta apicipuncta n. sp.

apicipunctus, with apical spot—

♂ ·32 mm. Head and thorax fuscous. Palpi reaching vertex, terminal joint $\frac{1}{2}$; whitish, densely sprinkled with fuscous. Antennæ fuscous; in male with extremely minute ciliations and short bristles ($\frac{1}{2}$). Abdomen grey; crests fuscous. Legs whitish, sprinkled with fuscous; anterior tarsi dark fuscous, with white rings. Forewings triangular, costa gently arched, apex rectangular, termen slightly rounded, scarcely oblique; fuscous with scattered white dots, one at base, 5 or 6 on costa, a larger spot at apex; reniform 8-shaped, white, upper lobe with fuscous centre, intermediate neck ochreous; an extremely fine dentate postmedian line, outwardly curved from $\frac{2}{3}$ costa to $\frac{3}{4}$ dorsum, with white dots on apices of dentations; a terminal series of blackish dots, each preceded by a white dot; cilia fuscous, apices white. Hindwings with termen rounded; fuscous; cilia fuscous.

Queensland: Yeppoon, in March; one specimen received from Mr. E. J. Dumigan.

Gen. *Bertula* Wlk.

Cat. Brit. Mus. xvi., p. 162 Hmps. Moths Ind. iii., p. 44—

Type *B. adjudicalis* Wlk. from India. The following characters are drawn from the two Australian species:—The first of these has been usually referred to *Pseudaglossa* Grote, but from the characters given by Hampson it seems to be undoubtedly a *Bertula.* That genus is placed by Hampson as a section of *Bleptina* Gn.; whether this is advisable, I cannot say.

Tongue strong. Face not projecting. Palpi long, ascending, recurved, in male very long and curved backwards over thorax; second joint thickened with appressed scales, in male curved over head, in female scarcely reaching vertex; terminal joint long, acute, in male, with a very long expansile tuft of pale ochreous hairs. Antennæ of male moderately ciliated, sometimes with longer bristles. Forewings with areole narrow; 7, stalk of 8, 9, and 10 closely approximated, 10 sometimes stalked with 8, 9. Hindwings with cell $\frac{1}{2}$; 5 arising from shortly above angle.

Bertula sordescens Rosen.

Queensland: Brisbane; Stanthorpe. New South Wales: Sydney. Victoria: Gisborne; Dunkeld.

Bertula nyctiphanta n. sp.

νυκτιφαντος, appearing by night—

♂♀ ·38-·42 mm. Head, palpi, and thorax dark fuscous. Antennæ fuscous; in male with moderate ciliations ($1\frac{1}{2}$) and longer paired bristles (3). Abdomen and legs fuscous. Forewings triangular, costa slightly arched, apex rounded-rectangular, termen rounded, not oblique; fuscous; markings blackish, partly edged, with ochreous-whitish; a subbasal line; a slender irregularly dentate line at $\frac{1}{6}$; a strongly-marked acutely dentate line from $\frac{1}{3}$ costa to mid-dorsum; a slender sinuate wavy line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum; a strongly-marked irregularly dentate subterminal line; cilia fuscous. Hindwings with termen strongly rounded; fuscous suffused with whitish towards base; cilia whitish, with fuscous bars.

New South Wales: Scone, in January, February, and March; six specimens received from Mr. H. Nicholas.

Prionopterina modesta n. sp.

modestus, unassuming—

♂♀ ·23-25 mm. Head and thorax grey. Palpi 4, obliquely ascending; second joint long, smooth, with a strong posterior tuft of scales on apical $\frac{1}{2}$; terminal joint short, obtuse; grey. Antennæ pale grey; in male moderately ciliated (1), with long paired bristles (5). Abdomen pale grey. Legs grey; posterior pair grey-whitish. Forewings elongate-oval, costa moderately arched, apex rounded, termen very obliquely rounded; whitish, with more or less grey suffusion, sometimes reddish-tinged; three outwardly curved, slender, wavy, grey lines more or less distinct; first from $\frac{1}{6}$ costa to $\frac{1}{4}$ dorsum, second from $\frac{1}{3}$ costa to mid-dorsum, third from $\frac{3}{5}$ costa to $\frac{2}{3}$ dorsum; two dark fuscous discal dots, sometimes white-centred, at $\frac{2}{5}$ and $\frac{3}{5}$; a submarginal series of dark fuscous dots before termen; cilia grey, sometimes reddish-tinged. Hindwings with termen bisinuate; pale grey; cilia whitish, bases sometimes reddish-tinged.

North Queensland: Banks Island, in May; Cape York, in November; seven specimens received from Mr. W. B. Barnard, who has the type.

Subfam. HYPENINAE.

Gen. *Sarobela* nov.

σαροβελος, with brush-like palpi—

Tongue strongly developed. Palpi in male very long, ascending, densely thickened with appressed scales, with a posterior pencil of long hairs from base; second joint exceeding vertex, rough-haired on anterior edge; terminal joint with long rough hairs anteriorly; in female porrect, but terminal joint obliquely ascending; second joint without basal pencil; terminal without long anterior hairs. Antennæ in male shortly ciliated, with longer paired bristles. Thorax with anterior and posterior crests. Abdomen with dorsal crests on first two segments. Forewings with a small areole, 7 connate with 8, 9. Hindwings with 5 from well above lower angle of cell ($\frac{1}{3}$).

√*Sarobela spectabilis* n. sp.

spectabilis, handsome—

♂♀ ·34-36 mm. Head brownish-grey. Palpi brownish-grey; anterior margin and apex whitish-brown. Antennæ grey; ciliations in male $\frac{1}{2}$, bristles 1. Thorax pale brown, darker anteriorly. Abdomen grey.

Legs fuscous; posterior pair ochreous-grey. Forewings elongate-triangular, costa straight almost to apex, apex pointed, termen rounded, slightly oblique, wavy; dark fuscous-brown; basal, dorsal, and terminal areas whitish, sprinkled with fuscous-brown; dark area defined anteriorly by a slender oblique white line from costa near base to above mid-dorsum, there angled towards apex; reniform very large, extending from near midcosta to dorsal pale area, except where continuous with this edged by an irregular white line; a fuscous crenulate terminal line; cilia whitish-grey. Hindwings ample, termen rounded, wavy; fuscous; cilia as forewings.

North Queensland: Cape York, in November, April, and June; four specimens received from Mr. W. B. Barnard, who has the type.

Hypertrocta pallida n. sp.

pallidus, pale—

♂ ·18 mm. Head whitish. Palpi $3\frac{1}{2}$, terminal joint $\frac{1}{6}$; pale brown. Antennæ whitish; ciliations in male $\frac{1}{2}$. Thorax and abdomen brown-whitish. Legs whitish, sparsely sprinkled with fuscous; anterior pair fuscous. Forewings triangular, costa straight, apex acute, termen angled and strongly toothed on vein 4; whitish-brown, with a few fuscous scales; a slender brown transverse line at $\frac{1}{5}$; a brown spot on midcosta, from which a similar line proceeds to $\frac{2}{5}$ dorsum; a larger brown costal triangle between this and apex, edged posteriorly by a whitish line, which proceeds to tornus, being strongly toothed outwards opposite terminal angle; a slender whitish terminal line edged anteriorly by an interrupted fuscous line; cilia whitish-brown. Hindwings subquadrate, sharply angled on vein 4; 3 and 4 connate; whitish-brown; a slender brown transverse line at $\frac{1}{3}$; an indistinct, irregularly dentate whitish line at $\frac{2}{3}$; terminal lines and cilia as forewings.

In *H. variabilis* Swin. the terminal joint of palpi is much longer ($\frac{2}{5}$), and 3 and 4 of hindwings are stalked.

Queensland: Yeppoon, in October; one specimen received from Mr. E. J. Dumigan.

Naarda coelopis n. sp.

κοιλωπις, hollowed—

♂ ·22-26 mm. Head, thorax, and abdomen fuscous. Palpi $3\frac{1}{2}$, laterally compressed, the dense hairs appearing grooved above and below central stem; fuscous. Antennæ not laminate, a small dorsal hair-tuft beyond middle, cilia 1, bristles $1\frac{1}{2}$; fuscous. Legs fuscous; anterior femora and tibiæ heavily clothed with dense hair. Forewings elongate-triangular, costa slightly concave to beyond middle, thence sinuate, apex round-pointed, termen slightly rounded, oblique; fuscous; obscurely darker wavy transverse lines at $\frac{1}{3}$ and $\frac{2}{3}$; a pale orange dot close below $\frac{1}{4}$ costa; two spots of the same colour, each with a central fuscous dot, forming a figure 8 beyond middle; a terminal series of dots; cilia fuscous. Hindwings with termen rounded; fuscous; markings as forewings, but without spots.

Very similar in markings to *N. xanthonephra* Turn., though they are less distinct, but very different in shape of forewings and in structure of palpi, antennæ, and forelegs, at least in male.

North Queensland: Cape York, in October, November, and May; Kuranda, in March and June; seven specimens.

Fam. LYMANTRIADAE.

Lymantria diversa n. sp.

diversus, different—

♂ ·58 mm. Head and thorax brown. Palpi $1\frac{1}{4}$; brown. Antennæ whitish-grey; pectinations 16, fuscous. Abdomen reddish. Legs ochreous-fuscous; anterior coxæ, anterior, and posterior femora red. Forewings triangular, costa straight to $\frac{2}{3}$, thence arched, apex rounded, termen straight, moderately oblique; pale ochreous-grey; markings pale fuscous; a sub-basal line not reaching dorsum; an angulated line of dots slightly beyond; a suffused transverse line at $\frac{1}{4}$; suffused slightly dentate lines at $\frac{3}{5}$ and $\frac{4}{5}$; a darker series of spots forming a subterminal line; a dark fuscous subcostal dot at $\frac{2}{5}$, followed by a medium lunule with concavity forwards just preceding fourth line; cilia whitish, with dark fuscous bars. Hindwings with termen strongly rounded; ochreous-whitish suffused with grey towards termen; cilia ochreous-whitish.

♀ ·85 mm. Head and thorax white. Palpi $\frac{1}{2}$; fuscous, whitish beneath towards base. Antennæ fuscous; pectinations 2. Abdomen whitish-ochreous, sometimes reddish-tinged towards base. Legs fuscous; middle tibiæ whitish; (posterior pair missing). Forewings elongate-triangular, costa strongly arched, apex rounded-rectangular, termen straight, strongly oblique; white, with fuscous markings; a very slender sub-basal transverse line, angled in middle; a broad outwardly oblique line from $\frac{1}{6}$ costa, bent above mid-disc, thence narrow and interrupted to anal vein at $\frac{1}{4}$, from which a bar proceeds to $\frac{1}{3}$ dorsum; two dots in median area precede this line; a broad line from $\frac{2}{3}$ costa, gradually becoming broader to mid-dorsum, nearly straight, its anterior edge crenulate; a slightly wavy straight subterminal line; a narrow post-median spot outlined by fuscous resting on anterior edge of postmedian line; a fine interrupted terminal line; cilia white, with broad fuscous bars. Hindwings with termen rounded; white; towards base sometimes with pale red hairs on veins; terminal edge and cilia as forewings.

North Queensland: Cape York; Cairns; Ingham. My material consists of one of each sex from Ingham (E. J. Dumigan), a female from Cairns (Miss Dodd), and another female from Cape York (W. B. Barnard). The only male example is my type.

Fam. ANTHELIDAE.

Anthela euryphrica n. sp.

εὐρυφρικος, broadly rippled—

♂♀ ·38-46 mm. Head and palpi brown. Antennæ white; pectinations fuscous, in male 12, in female $1\frac{1}{2}$. Thorax and abdomen ochreous-fuscous; pectus ochreous. Legs ochreous; tarsi fuscous, with white rings. Forewings triangular, costa straight, apex rectangular, termen rounded, not oblique; dark fuscous, with pale ochreous transverse rippled lines, more whitish in female; sub-basal from $\frac{1}{6}$ costa to $\frac{1}{4}$ dorsum, curved, dentate; median very slender, finely crenulate; postmedian from $\frac{3}{4}$ costa to before tornus, broad, slightly curved, its inner surface crenulate; a crenulate terminal line, sometimes very fine and submarginal; snow-white subcostal discal spots at $\frac{1}{4}$ and middle; cilia pale ochreous. Hindwings with termen rounded; colour as forewings; without sub-basal line and discal spots; a fine and nearly straight median line; postmedian approximated, rather broader, straight. Underside similar, but with snow-white median spots at $\frac{1}{4}$ and middle.

Closely allied to *A. denticulata*, with which it agrees in pattern of forewings, but differs in its ochreous colour and especially in the hindwings.

New South Wales: Scone. A large number of larvæ feeding on Barley Grass (*Bromus arenaria*) were collected in August by Mr. H. T. Nicholas. He describes them as very hairy, brown with blue or reddish spots or markings, head tan colour, with cream markings. They pupated in cocoons about one inch beneath the surface. Twenty-three moths emerged in April and May. A large number of larvæ were killed by dipterous parasites.

Anthela callileuca Turn.

I have received from Mr. W. B. Barnard tree examples taken at Jandowae, near Dalby, Queensland, in which a broad straight fuscous line, dentate on its posterior edge, runs from costa before apex to dorsum before tornus in forewings, with a similar but finer and interrupted line on hindwings. This conspicuous form is only a variety or possibly a local race. Traces of a similar line may be detected in the typical form.

Fam. LASIOCAMPIDAE.

Crexa macqueeni n. sp.

♂ ·28-30 mm. ♀ ·40-41 mm. Head whitish, with central fuscous spot. Palpi whitish, external surface partly fuscous. Antennæ fuscous; pectinations in male 12, in female 2. Thorax fuscous, mixed with whitish hairs. Abdomen reddish-brown; tuft in male fuscous; in female tuft and spots on apices of segments white. Legs fuscous mixed, and tarsi ringed, with white. Forewings elongate-triangular, costa straight to near apex, apex rounded, termen longer than dorsum, gently rounded, oblique; dark-grey; in male fuscous-brown towards base; veins near base reddish-brown; a sub-basal whitish line, more distinct in female; a reddish-brown median subcostal discal spot, edged anteriorly and posteriorly by a fuscous dot; beyond this a whitish suffusion more marked in female; a short white externally oblique streak from $\frac{2}{3}$ costa, giving rise to a finely dentate line to dorsum before tornus; a subterminal series of fuscous spots edged with whitish; cilia grey. Hindwings with termen rounded; in male reddish-brown, suffused with fuscous towards costa; in female grey with a whitish median transverse line; cilia white.

The forewings are similar in both sexes, but not the hindwings. The male is similar in colour to *C. macroptila* Turn., but unlike that species the hindwings are of normal shape. I dedicate this interesting species to Mr. J. Macqueen, who has made many interesting discoveries in the fauna of his locality.

Queensland: Milmerran, in December, January, and March; four specimens bred by Mr. J. Macqueen.

Gen. *Eremanepsia* nov.

ἐρημανεψιος, a desert cousin—

Eyes smooth, large, rounded. Palpi moderate, porrect, reaching slightly beyond froms. Forewings with 2 from $\frac{1}{3}$, 3 from before angle, 4 and 5 connate from angle, 6 from upper angle, connate with 8, 9, which are stalked, 11 from $\frac{2}{3}$. Hindwings with cell $\frac{1}{3}$, 2 from middle, 3 from angle, connate with 4, 5, which are stalked, 6 from upper angle, 7 from shortly before angle, no subcostal cell, 12 anastomosing to middle of cell, a forked pseudoneurium from its base.

Allied to *Eremonoma*.

Eremanepsia agrapta n. sp.

ἀγραπτος, unmarked—

♂ ·20 mm. Head, palpi, and thorax dull reddish. Antennæ reddish; pectinations in male 4. Abdomen pale reddish; beneath whitish-grey. Posterior legs whitish-grey. Forewings triangular, costa straight, apex obtusely pointed, termen slightly rounded, moderately oblique; dull reddish; cilia dull reddish. Hindwings with termen rounded; pale reddish; cilia pale reddish.

Central Australia: Tennant's Creek (Spencer-Gillies Expedition); one specimen. Type in Coll, Lyell.

Digglesia diamphidia n. sp.

διαμφιδιος, different—

♂ ·42 mm. Head whitish-ochreous; face fuscous. Palpi moderately long (2¼), exceeding frontal tuft, densely clothed with long hairs; reddish-fuscous. Antennæ short; fuscous; in male bent beyond middle, pectinations 6 at base, gradually shortening to apex. Thorax reddish-fuscous; a submarginal transverse anterior line and median area whitish-ochreous. Abdomen fuscous-reddish; apices of segments beneath whitish-ochreous. Legs fuscous-reddish; tarsi fuscous with whitish-ochreous rings. Forewings narrow towards base, dilated posteriorly, costa sinuate, apex round-pointed, termen rounded, oblique; whitish, with fuscous markings; fine reddish streaks on all veins, becoming broader shortly before termen; a dentate line inwardly oblique from ⅓ costa, angled outwards above dorsum, ending on ¼; a similar line from ⅔ costa to mid-dorsum; a well-marked but irregularly bent subterminal line; a broad terminal line interrupted by streaks on veins; some fuscous suffusion containing a whitish median dot between first and second lines; cilia fuscous. Hindwings with termen strongly rounded; fuscous-reddish; cilia fuscous.

Very distinct; but the pattern of the forewings shows some resemblance to *D. ecnoma* Turn., from West Australia. The palpi are short for this genus.

Queensland: Bunya Mountains, in November; one specimen received from Mr. W. B. Barnard, who has the type.

Fam. LIMACODIDAE.

Parasa symphonistis n. sp.

συμφωνιστις, harmonious—

♂ ·30-32 mm. Head and palpi brown. Antennæ whitish-ochreous; pectinations in male 6, ceasing rather abruptly at ½. Thorax fuscous-brown with white-tipped hairs. Abdomen grey-brown or fuscous-brown. Legs brown; tarsi whitish-ochreous with fuscous-brown rings. Forewings triangular, costa straight, apex rounded, termen rounded slightly oblique; pale purple-grey, disc sometimes fuscous-reddish except towards base and termen; a strong fuscous streak from ¼ dorsum, externally oblique, sometimes short, sometimes dentate or broken and extending to near $\frac{1}{3}$ costa; a rounded dark line from $\frac{4}{5}$ costa to tornus, sometimes lost in central dark suffusion; preceded by a variable median cluster of three fuscous dots; an interrupted crenulate grey subterminal line; cilia grey. Hindwings with termen rounded; pale reddish; cilia grey.

Queensland: Milmerran, in November, December, and January; three specimens received from Mr. J. Macqueen.

Susica fasciata. Wlk.

Through the kindness of Mr. E. J. Dumigan, I have received two remarkably fine specimens of this species of a form with brownwhitish thorax and dorsal blotches on hindwings. They emerged from subterranean cocoons obtained by the pupils of Mr. Bartlett on Mount Tambourine, while digging under a "Wheel of Fire" tree (*Stenocarpus sinuatus. Proteaceae*).

Fam. COSSIDÆ.

Xyleutes eremonoma Turn.

Trans. Roy. Soc. S.A. 1906, p. 139.

Xyleutes amphiplecta Turn.

Trans. Roy. Soc. S.A. 1932, p. 195.

I have received examples of both these species from Mr. A. P. Dodd, bred from larvæ feeding in the stems of *Bassia quiquecuspis* in Goondiwindi. The females of both species are remarkable in their very elongate swollen abdomens and abbreviated, though perfectly formed, wings. They can hardly be capable of flight.

Xyleutes spilota n. sp.

σπιλοτος, spotted—

♀ ·25 mm. Head white. Palpi fuscous; apices white. Antennæ white, sprinkled with fuscous. Thorax white; two longitudinal lines and some irroration blackish. Abdomen white, sprinkled with fuscous; apices of segments fuscous. Legs dark fuscous. Forewings rather narrow, costa nearly straight, apex rounded, termen obliquely rounded; white; numerous short strigulæ and some larger spots dark fuscous, with steel-blue reflections; strigulæ most numerous in dorsal area; an elongate oblong subcostal spot at $\frac{1}{3}$; three partly confluent costal and subcostal spots at $\frac{2}{3}$; veins marked by fine ochreous lines; a dark fuscous terminal line; cilia white with dark fuscous bars. Hindwings with costa sinuate, apex round-pointed, termen nearly straight; whitish with fuscous strigulæ, which are confluent over central area, cilia as forewings.

New South Wales: Brewarrina; one specimen received from Mr. W. W. Froggatt.

Xyleutes riparia n. sp.

riparius, frequenting river-banks—

♂ ·64-70 mm. ♀ 82 mm. Head fuscous; face mostly or wholly ochreous-brown. Palpi blackish; lower surface except at apex whitish-ochreous. Antennæ fuscous; dorsal surface of shaft whitish; in male bipectinate to about middle, thence serrate, pectinations 5. Thorax grey-whitish; a strongly curved submarginal anterior fuscous line;

three pairs of fuscous dots, with a fourth pair on tegulæ. Abdomen blackish, bases of segments whitish, apices ochreous; first two segments grey-whitish; tuft fuscous. Legs fuscous; tibiæ white-ringed. Forewings elongate, suboblong, in female broader, costa slightly arched, apex round-pointed, termen slightly rounded, slightly oblique; whitish with numerous coarse blackish strigulæ, leaving two oblique white fasciæ; first from beyond midcosta to before mid-dorsum, where it turns inwards to base of wing; second from $\frac{5}{6}$ costa to dorsum before tornus; in female these fasciæ are reduced to large spots or blotches; costa coarsely strigulated with blackish; terminal area blackish except for streaks on veins and an irregular line before termen; cilia whitish. Hindwings with termen sinuate; dark fuscous, in female with coarse pale strigulæ; a series of whitish spots close to termen.

Queensland: Stanthorpe, in November and January; three specimens received from Mr. W. B. Barnard, who has bred a series. Mr. Barnard found the larvæ boring the lower part of the stems of *Leptospermum abnorme*, which frequents the banks of rivers and creeks, tunnelling always upwards for a distance of seven inches or more. Before pupating each larva perforates the inner bark, leaving the outer bark intact, so that the place of future emergence may sometimes be detected by running the fingers over the surface and pressing on it. The presence of the larvæ is often betrayed by the ejecta beneath the stem attacked. They are not injured by the submergence of the stems in flood waters. They pupate in the spring and emerge from November to January. Those of various ages are found in the same tree, and after their feeding habits had been ascertained were found to be not uncommon.

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Contribution to the Queensland Flora, No. 5.

By C. T. WHITE, Government Botanist.

(*Read before the Royal Society of Queensland, 26th August,* 1935.)

Since the publication of the previous contribution (these Proceedings, Vol. XLI., pp. 139-143, 1929) some important collections of Queensland plants have come into my hands for determination. Outstanding among these is the collection made by Mr. L. J. Brass in North Queensland in the early months of 1932. By an arrangement with the Arnold Arboretum of Harvard University, U.S.A., Mr. Brass spent between three and four months in North Queensland before leaving on an extensive collecting and photographing trip to the Solomon Islands. Among the material collected and here described is an apparently undescribed genus of *Hernandiaceae,* and members of the genera *Coronanthera* (*Gesneraceæ*) New Caledonia—and *Dimorphocalyx* (*Euphorbiaceæ*) —Malaya—previously unrecorded as Australian. A particularly interesting find was *Ostrearia* (*Hamamelidaceae*), of which flowers were previously unknown. My best thanks are due to members of my staff and botanists in the other States and abroad for much help received, which has enabled me to present the present paper. Due acknowledgement has been made under the different plants concerned.

Order DILLENIACEAE.

Hibbertia sericea (R. Br.) Benth. Fl. Austr. I. 26, 1863.

Mount Barney, S.E. Queensland, alt. 4,000 ft., in rocky crevices, rare. *C. T. White* (flowering specimens) 7852, 27/8/1931. (shrub or subshrub, abt. 1 ft. high, stems procumbent or with ascending branches; fls. yellow.) Mount Ernest, S.E. Queensland, alt. 2,000-3,000 ft., in rocky crevices, very common. *C. T. White,* No. 8591 (flowering specimens), 10/10/1932. (shrub or subshrub of rather dense growth, flowers yellow.) Mt. Lindesay, alt. over 3,000 ft. Rev. N. Michael, No. 2223, 14/7/1935. Not previously recorded for Queensland.

Hibbertia stirlingii sp. nov.

Fruiticulus parvus, virgatus; ramulis foliisque plus vel minus dense stellato-pubescentibus (f. stelligera) vel squamulosis (f. squamulosa). Folia linearia apice obtusa vel minute apiculata, basem versus leviter angustata, 1·5-2 cm. longa, margine valde recurva; costa media supra excavata subtus valde elevata. Pedunculi 5-8 mm. longi (f. stelligera) vel ad 2 cm. longi (f. squamulosa) dense stellato-tomentosi; bracteis ovatis 2 mm. longis. Sepala subrotunda, extus densissime lepidota intus glabra, margine ciliata, 2 exteriora, 2·5 mm. longa, 3 interiora 5 mm. longa. Petala obovata 6 mm. longa. Stamina numerosa 2 mm. longa. Carpella 2 lepidota, 2-ovulata; stylis glabris 3 mm. longis.

(*a*) f. stelligera:

Ravenshoe, alt. 3,000 ft., on Eucalyptus forest slopes. L. J. Brass, No. 1888 (flowering specimens); Jan. 1 (small shrub). Range road, Miss Wheatley, No. 117 (flowering specimens); August 8, 1934.

(*b*) f. squamulosa.

Herberton, J. Stirling (*type of the species*); (flowering specimens), July, 1904. Stannary Hills, Dr. T. L. Bancroft (flowering specimens), June, 1908.

The two collections of the *forma squamulosa* were found in the Queensland Herbarium in the *H. lepidota* R. Br. folder, but I think the closest affinities of the new species lie with *H. scabra* R. Br., which differs in having longer leaves, longer pedicels, acute, not obtuse, sepals, tomentose, not lepidote, on the outside, and tomentose, not lepidote, carpels.

It is intermediate in many ways between the two species. *H. lepidota* R. Br. is distinguished by its very dense, not scattered, clothing of scales on stems and leaves, the leaves being flat or concave with the margins not at all recurved, the peduncles rather shorter, and the sepals subacute. It was recorded for Northcote (leg. R. C. Burton) by the late F. M. Bailey. I have not seen these specimens, but Mr. Brass has collected it in two localities in North Queensland, e.g., Settlement Creek, near Gulf of Carpentaria, No. 297 (flowering specimens), Feb., 1923 (shrub 3-5 ft.); and Newcastle Range, between Einasleigh and Forsayth, No. 1762 (flowering specimens), Feb., 1928 (small shrub on sandstone).

H. scabra R. Br. I have not yet seen from a definite Queensland locality.

Order GUTTIFERAE.

Garcinia brassii sp. nov.

Arbor parva; ramulis robustis, juvenilibus quadrangulatis, internodiis 1-1·5 cm. longis; stipulis crasse coriaceis, ovatis, intus concavis 2 mm. longis. Folia petiolata subcarnosa (Brass) in sicco rigide coriacea, obovata, margine recurva, apice obtusa vel emarginata, basi cuneata; petiolo 0·5-1 cm. longo; lamina 3-8 cm. longa, 1·5-4 cm. lata; costa media notata, supra depressa, subtus elevata; nervis lateralibus valde elevatis, subparallelis, utrinque 14-18, prope marginem nervo marginali conjunctis. Inflorescentia terminalis. Flores ignoti; sepalis (sub-fructu) rotundatis, 5 mm. diam. Fructus depresso-globosus, pallido-virens, ca. 5 cm. diam., 4 cm. altus, stigmate granuloso 4-lobato coronatus; seminibus irregulariter ellipsoideis vel globosis, in sectione transverso irregulariter triangularibus, dorso convexis, lateribus applanatis.

Thornton Peak, in low scrub at the summit, L. J. Brass, No. 2277 (fruits) March 14; (small tree of various habit, but commonly with thick, erect, dark trunk, about 7-8 ft. high, ending abruptly in a dense flat crown of small erect branches; sap yellow; leaves thick and rather fleshy, the margins recurved; petioles reddish; fruit terminal, depressed-globose, pale green, acidulous).

This makes the fifth species of Garcinia to be found in North-eastern Australia. Among previously described Australian species it most resembles *G. Warrenii* F. v. Muell., which is distinguished by larger leaves, with a more pointed apex, and smaller, not depressed, fruits.

Order Pittosporaceae.

Pittosoporum O'Reillyanum sp. nov.

Frutex vel arbor parva gracillima; ramulis spinis numerosis armatis, junioribus hirsutis, intermediis leviter muricatis, adultis glabris cortice albo obtectis. Folia juniora subtus pilis longis paucis obsita, adultis glabra, ovato-lanceolata 0·5-2 cm. longa, 2-5 mm. lata; venis suboscuris; petiolis 0·5-1·5 mm. longis. Flores singulares axillares vel terminales, pedicello pubescenti 1·5-2 mm. longo. Calyx vix 2 mm. longus, alte 5-lobatus. Corallæ tubus 6 mm. longus; lobis late linearibus, 3 mm. longis. Anthera breviter exserta; filamentis liguliformibus. Ovarium hirsutum. Capsula 7-8 mm. diam.; seminibus paucis magnis rubris; angularibus dorso convexis.

Mount Hobwee, Lamington National Park, near New South Wales-Queensland border, alt. 4,000 ft., common in rain-forest. C. T. White, 6173 (type; flowering specimens), Sept. 1, 1929; (small tree, with a very slender stem, usually weighted with a dense growth of mosses and liverworts). Roberts Plateau, Lamington National Park, alt. 3,500-4,000 ft.; (fruiting specimens); Mrs. Frieda Cobb Blanchard, May, 1928; C. T. White, No. 6064, Feb., 1929; T. O'Reilly, May, 1929.

Very dissimilar to previously described Australian species, and more closely resembling some of the very small-leaved New Zealand species.

Named in honour of my friend, Mr. Thos. O'Reilly, who, while resident in the park, freely gave to visiting naturalists all possible help and guidance in the pursuit of their studies.

Order Caryophyllaceae.

**Sagina apetala* Linn. Mant II., 559.

Toowoomba, H. A. Longman. Bet. Ballandean and Wallangarra, C. T. White, 9330, 13/10/33.

The Toowoomba specimens were referred by F. M. Bailey (*Queensland Agricultural Journal*, XXV. (1910), 234) to *S. procumbens* L.

Order Portulacaceae.

Portulaca digyna F. v. M. Fragm. Phytogr. Austr. 1, 171 (1859).

Glenhallam, near Boulia, S. H. Teece, March, 1934.

As far as I can ascertain, these are actually the first specimens of this *Portulaca* collected in Queensland. F. M. Bailey (Queensland Flora, 1, 94) recorded it from "Northern interior and Stanthorpe." There were no specimens from Western Queensland in the Queensland Herbarium, and the Stanthorpe specimens, though fragmentary, I have little hesitation in referring to the very widely-spread *P. bicolor* F. v. M.

Order Malvaceae.

Sida Dallachyi sp. nov.

Suffrutex vel herba perennis basi tandem lignescens; partibus omnibus dense et molliter stellato-pubescentibus. Caules erecti; ramis paucis strictis. Folia petiolata, anguste ovato-lanceolata, basi in foliis latioribus subcordata, in foliis angustioribus subacuta, apice subacuta, margine serrata, supra pallido-viridi, subtus pallidiore ("argenteo-grisea"—Brass); nervis praecipuis supra leviter impressis, subtus elevatis; petiolo

0·5-2 cm. longo, lamina 3-11 cm. longa, 0·5-4 cm. lata; stipulis subulatis 4 mm. longis. Pedunculus tenuis, uniflorus 1·5-3 cm. longus, supra medium articulatus. Calyx ca. 8 cm. diam., turbinato—campanulatus, pentagonus valde 10-costatus, in dimidio superiore in dentos acutos triangulares divisus. Petala flava, ca. 1 cm. longa. Carpella matura calyce fere duplo breviora, mutica, ca. 7, lateribus et dorsi, transverse rugosa, bivalvia plerumque monosperma.

Rockingham Bay, J. Dallachy (Herb. Melbourne—flg. and ftg. specimens), 24 VI. 1866, (herb at river). Mount Molloy, alt. 1,200 ft., in rocky places, L. J. Brass, No. 2443 (type—flowers and immature fruits); 11/4/1932; (2-3 ft. high, upper surface of leaves very pale green, lower silver-grey; flowers yellow).

Amongst previously described Australian species most closely allied to *S. mutica* Domin., *S. cordifolia* L. var. *mutica* Benth.), which differs in having very much smaller leaves and very short pedicels (shorter than the calyx).

I am much indebted to Mr. S. T. Blake for kindly comparing these specimens with the unnamed ones of Dallachy's at the National Herbarium, Melbourne, and to Mr. F. J. Rae, Government Botanist, Melbourne, for their subsequent loan so that a full description could be drawn up.

Order Tiliaceae.

Grewia papuana Burret in Notizb. Bot. Gar. u. Mus., Berlin, IX., 672 (1926).

Mowbray River, in rain-forests, L. J. Brass, No. 2011; (flowers and young fruits); Jan. 25; (small slender tree or large bush; leaves glossy above, paler beneath; flowers yellowish green, secreting a large quantity of nectar, which often sticks the points of the perianth lobes together and prevents the proper opening of the flowers).

Only previously known from Northern New Guinea. The specimens have kindly been compared with the type material at Berlin by Dr. Burrett, who states that it is quite the same as his plant.

Triumfetta suffruticosa Bl. Bijdr. 113.

Palm Island, North-east Queensland, W. A. Somerville, May, 1926.

Determination at Royal Botanic Gardens, Kew (Eng.), by W. D. Francis. Not previously recorded for Queensland.

Order Rutaceae.

Eriostemon ambiens F. v. Muell. Fragm. Phytogr. Austr. VI. 166 (1868).

Wyberba, Southern Queensland. Mrs. Gunn; (flowering specimens), 9/9/1932.

Eriostemon salicifolius Sm. in Rees. Cyclop. XIII, No. 1.

Pyramid Mountain, abt. 30 miles from Stanthorpe. H. Jarvis, 6/11/1931.

A definite record for a plant previously recorded for Queensland without specific locality.

Melicope sessiliflora sp. nov.

Arbor parva vel frutex elatus; partibus novellis stellato-tomentosis mox glabris. Folia opposita, petiolata, unifoliolata, in sicco chartacea vel subcoriacea, supra subnitida, subtus pallidiora, opaca et dense atro-punctata, elliptica vel elliptico-lanceolata, basi obtusa vel subacuta, apice obtusa vel obtuse acuminata; nervis lateralibus subparallelis, utrinque 25, in sicco nervis et venis utrinque prominulis; petiolo 1-1·5 cm. longo; lamina 8-16 cm. longa, 3-5·5 cm. lata. Flores albi sessiles in fasciculos paucifloros axillares vel laterales dispositi. Sepala 4, imbricata late ovata, 2 mm. diam., extus stellato-tomentosa. Petala 4 linearia, concava, ad apicem in alabastro inflexa, extus dense stellato-tomentosa, intus glabra, 7 mm. longa. Stamina 8, omnia fertilia, alterna breviora; filamentis applanatis, brevioribus glabris, longioribus intus carinatus et apicem versus verrucoso-ciliatis. Discus annularis 8-lobatus, Gynoecium glabrum; ovario in 4 carpella distincta diviso; styli ramis ad apicem conjunctis.

Mossman River Gorge, in rain-forest, L. J. Brass, No. 2108; (flowering specimens and one unripe fruit); Feb. 9; (tall bush or small tree with stiff brittle leaves, flowers white).

Among previously described Australian species seems to have the closest affinity with *M. Fareana* F. v. Mueller, which differs in having the leaflets cuneate at the base and the flowers on rather long slender pedicels.

The material of the new species to hand is rather scrappy. Only a few flowers were available for dissection. There was one-half or less than half matured fruit and this seems to be surrounded by persistent sepals and persistent or subpersistent petals, a character it shares with *M. Fareana* F. v. Muell.

Order BURSERACEAE.

Canarium australianum F. v. Mueller, Fragm, Phytogr. Austr., III., 15, 1862.

Mossman River, in riverine rain-forest, L. J. Brass, No. 2044; (flowering specimens), Feb. 4; (stiff-branched tree up to 60 ft. high; leaves very stiff, upper surface shining, lower greyish; flowers white). Mowbray River, L. J. Brass, in rain-forests, No. 2005; (flowering and fruiting specimens), Jan. 23; (small, slender-stemmed tree up to 18 ft.; leaves clustered at ends of branches).

These two specimens are recorded as—No. 2044 represents the typical form with the lower surface of the leaves in the adult tree clothed with a dense tomentum and the panicle branches, calyces, and young petals densely pilose; while No. 2005 represents a very distinctive form. I had drawn up a description of this latter as a new species, but on looking through the large series of specimens in the Queensland Herbarium concluded that though very distinctive at first sight it could not be separated specifically. It is characterised by being almost entirely glabrous, only the young parts being pilose, this referring to the panicle branches and calyces as well as to the leaves. The leaves on the whole are larger with more numerous leaflets, and the lateral veins are fewer and wider apart. We have specimens of what is apparently the same species in leaf only, determined by Mueller as *Santiria lævigata* Blume, collected at Harvey's Creek, Russell River, by W. A. Sayer in 1887, so evidently Mueller did not connect it with his *C. australianum*.

I have refrained from naming this form specifically, not only on account of the known variability of members of the genus, but also from the fact that an intermediate form occurs in which the leaves of adult trees are quite glabrous, but the panicle branches, calyces, and young petals have the densely pilose character of the normal form. This intermediate form is represented in the Queensland Herbarium from Townsville (collected by the Rev. N. Micheal, No. 1360, and by C. T. White, sine no. February, 1922; from Mount Molloy, Forest Officer Carlin, and Irvinebank, F. Bennett). Another point that has restrained me from naming it as a species is the fact that No. 2005 has been taken from a young tree, and so far as I have observed in the field the leaves on the young trees of *C. australianum* are much larger than those of the adult tree, and perfectly glabrous on both the upper and lower surfaces.

Order Rhamnaceae.

Cryptandra lanosiflora F.v.M. Fragm. Phytogr. Austr., III., 65 (1862).

Slopes of Mount Jibbenbar, bet. 2,000 and 3,000 ft. alt. L. C. Ball, July, 1919.

Not previously recorded for Queensland.

Order Sapindaceae.

Arytera subnitida sp. nov.

Arbor parva, partibus junioribus dense fusco-tomentosis. Folia 4-6-foliolata; rachi 8-18 cm. longo tomentoso basi tumido; foliolis lanceolatis utrinque costa media excepta glabris valde reticulatis apice obtusiuscule acuminatis vel subobtusis basi cuneatis, in sicco papyraceis supra opacis subtus nitidis pallidioribus, in axillis nervorum præcipuorum valde foveolatis laminis 8-15 cm. longis, 2·5-5 cm. latis; petiolulis ca. 5 mm. longis dense tomentosis basi leviter tumidis. Thyrsi paniculati vel racemosi folia subœquantes; ramis tomentosis cincinnos numerosos breviter (2-5 mm.) pedunculatos 2-3-floros gerentibus; floribus pedicellatis, pedicellis ad 3 mm. longis pilis stramineis paucis obsitis. Calyx late cupularis 5-dentatus 2·5 mm. diam. extus pilis paucis adspersus, lobis ovatis. Petala calycis lobos aequantes vel vix superantes. 2—squamata, squamis magnis petala fere œquantibus margine pilis longis albis obsitis. Discus carnosus, leviter lobatus. Stamina 8, antheris 1 mm. longis, filamentis 0·5 mm. longis, basi pubescentibus. Ovarium triloculare, in parte superiore pilis stramineis paucis obsitum, stylo dense pubescenti.

Daintree River in riverine rain-forest, L. J. Brass, No. 2345; (flowering specimens); March 19; (small tree with close grey bark, lower surface of leaves smooth and shining).

Among previously described Australian species is most closely allied to *A. foveolata* F. v. M., which differs in having rather smaller leaflets with stronger primary veins and a much more branched panicle.

Mischocarpus montanus sp. nov.

Arbor parva compacta, 2-3 m. alta; partibus junioribus tomentosis; ramulis purpureis. Folia abrupte pinnata, 2-4 foliolata, rachi purpureo 2-4 cm.; foliolis ellipticis vel elliptico-lanceolatis, apice subacutis vel obtusis basi cuneatis vel subobtusis æquilateris integris, margine subrevolutis, coriaceis utrinque glabris et valde reticulatis; costa media supra excavata subtus valde elevata purpurea; nervis lateralibus utrinque 10-12; lamina 4-6 cm. longa, 2-2·5 cm. lata; petiolulo 8 mm. longo purpureo basi tumido. Paniculæ axillares vel subterminales ad 12 cm. longae et 8 cm. latæ; ramulis tenuiter tomentosis; pedicellis 2·5 mm. longis tenuiter pubescentibus. Calyx 1·5 mm. diam. tenuiter pubescens, lobis late triangularibus. Petala 1 mm. longa, margine pilis longis albis adspersa; squamis albo-pilosis sed vix cristatis. Discus cupularis crassus glaber. Stamina 8, 2 mm. longa; filamentis tenuis, albopilosis. Ovarium tomentosum parvum stipitatum, stipite crasso.

Thornton Peak, alt. 4,000-4,500 ft.; in low scrubs near the summit, L. J. Brass; No. 2293; (flowering specimens); March 14; (compact tree 6-8 ft. high; branches, petioles and leaf midribs purple; leaves stiff, curved, and with margins recurved; flowers white).

In general facies the species somewhat resembles *M. anodonta* (F. v. M.) Radlk., moderately common in some parts of Queensland, in which, however, the leaves are much longer with the margins flat; the flowers apetalous and the stamens glabrous.

Order Leguminosae.

Acacia Rothii F. M. Bail., in "Queensland Agricultural Journal," VI. 39 (1900).

Flower heads on peduncles of 6-8 mm.; arranged in axillary racemes; racemes single in the upper phyllode axils, up to 12 cm. long, or more. Calyx lobes 5, pubescent, spathulate, free almost to the base, 1 mm. long, petals ovate, about the same length as the calyx lobes.

Cape York Peninsula. D. F. Thomson, No. 5.

Flowers not previously described.

Bauhinia malabarica Roxb. Hort. Beng. 31 (1814) (nomen nudum). Fl. Ind. ed. 2, Vol. 2, p. 321 (1832). *B. Gilesii,* F. M. Bail, and F. V. Muell. in Wing's Southern Science Record, Vol. 2, p. 151 (1882). *B. Hawkesiana,* F. M. Bail, in Queens. Agric. Journ., Vol. XV., 897 (1905).

Northern Territory: In the vicinity of Port Darwin, Alfred Giles.

Queensland: Coen, Cape York Penins. Mrs. R. W. Garraway.

Though the material is rather scrappy in both cases, I have little hesitation in referring *B. Hawkesiana* F. M. Bail. to the earlier described *B. Gilesii* F. M. Bail. and F. V. Muell., and very much doubt if either are really distinct from the widely distributed *B. malabarica* Roxb.

**Bauhinia monandra* Kurz. in Journ. As. Soc. Beng. 42 (2) 73.

Mowbray River, in riverine rain-forests; L. J. Brass, No. 2023 (flg. specimens), 27/1/32 (tree, about 15 feet, branching a few inches above the ground; fls. pale pink, mottled with red).

This tree is much grown in North Queensland gardens, and is evidently now quite established as a naturalised alien in the above locality.

**Crotalaria acicularis* Ham. in Wall. Cat. No. 5390, 1832 (nomen nudum); Benth. in Hook. Lond. Journ. Bot. 2, 476 (1843).

D'Aguilar. A very common weed on alluvial flats. Mrs. J. M. Newman. 16/3/1934.

A native of Bengal, Malayan Archipelago, and Philippine Islands, quite naturalised in the above locality. Determination verified at Royal Botanic Gardens, Kew, England.

Daviesia latifolia R. Br. in Ait. Hort. Kew (2nd ed.), III., 20 (1811).

Lyra (between Wallangarra and Stanthorpe). W. R. Petrie.

Not previously recorded for Queensland; the specimens are in leaf only, but I have little doubt as to the identification.

Milletia pilipes F. M. Bailey. Second Add., Third Suppl. Synop. Queensland Flora in Catalogue of Queensland Plants, p. 108 (1890).

Mossman River Gorge, in rain-forest. L. J. Brass, No. 2123 (pods); 9/2/32. (Large liane.)

Pods 20 cm. or more long, densely covered with a soft rusty-brown pubescence, mostly 4-5-seeded and rather deeply constricted between the seeds.

An interesting plant only previously known from the type gathering. Though the type is extremely fragmentary, I think there is little doubt of the above specimens being correctly matched. Pods were previously unknown.

Pultenaea daphnoides Wendl. Bot. Beob. 49 (1798).

Mount Ernest, S.E. Queensland, alt. 2,500 ft. C. T. White, 8577 (flg. specimens); 10/10/32. (Upright shrub, 0·5 m. high, standard yellow, wings and keel dark vinous red). S. T. Blake, 4323. (Virgate shrub, 2-4 ft., petals yellow, keel deep red, standard with a red mark.)

Vigna canescens sp. nov.

Herba volubilis; radice tuberosa; caulibus tenuis volubilis canescentibus; stipulis ovato-lanceolatis valde nervosis extus strigoso-canescentibus, intus glabris, demum reflexis, 2·5 mm. longis. Foliolae (in specimine nostro) lineari-lanceolatae, ca. 5 cm. longae, 0·5 cm. latae, utrinque pilis albis inspersae, subtus prominule nervosae; stipellis late lanceolatis; petiolo communi ca. 3 cm. longo, albo-strigoso; rhachi inter foliolis 0·5-0·6 cm. longa, albo-strigosa. Pedunculi axillares, uniflori, 1·5-1·7 cm. longi albo-strigosi; pedicellis 2·5 mm. longis; bracteis persistentibus late ellipticis extus dense canescentibus intus glabris. Calyx valde nervosus, extus canescens, intus glaber, 0·7 cm. longus; tubo campanulato, lobis ovatis tubum aequantibus, 2 superioribus connatis, lobo inferiori paullo longiori. Vexillum late orbiculatum, 2 cm. diam. Alae ca. 2 cm. longae. Carina alas subaequans superne valde incurva. Filamentum vexillare a basi liberum. Stylus glaber. Ovarium dense hirsutum. Legumen non vidum (glabrum-teste Thomson).

Cape York Penin., Dr. and Mrs. D. F. Thomson. No. 43.

Closely allied to *V. vexillata* Benth., but differs in several characters. The leaves in our specimen are linear-lanceolate, but a drawing by Mrs. Thomson accompanying the specimens shows them to vary from this to almost ovate. *V. vexillata* Benth. is a stouter plant, the pubescence is dark rufous in colour, the peduncles mostly two or more flowered, the bracts deciduous, the calyx lobes longer, narrower, more acute, and the style bearded along the inner face in the upper parts. Dr. Thomson writes:—"I am sending herewith photographs of two sketches of No. 43 (*Vigna canescens*) and No. 44 (*Vigna vexillata*). These sketches were made by my wife from fresh material in the field. The natives, who use both for food, distinguish them, and they (and I, too) could separate the plants on general appearance, and roots also on general appearance and taste, apart from the foliage. The pod of No. 44 (*Vigna vexillata*) is hirsute, and of No. 43 (*Vigna canescens*) glabrous."

Order CUNONIACEAE.

Ackama australiensis n. comb.

Betchea australiensis Schlechter in Engl. Bot. Jahrb. LII., 150 (1914).

Ackama quadrivalvis White and Francis in Bot. Bull. XXII., Dept. Agric., Brisbane, 14 (1920).

Rockingham Bay, J. Dallachy (type); Glenallyn, via Malanda, H. C. Hayes (large tree local name Pencillia); Atherton Tableland, J. M. Fraser (type of *A. quadrivalvis* White and Francis); Gadgarra, S. F. Kajewski No. 1805 (specimens in advanced fruit), 4/6/29 (large tree common in rain forest, Daintree River); Ravenshoe, Forest Overseer Manuell. Daintree River, in rain-forests, L. J. Brass, No. 2232 (flowering shoots and detached fruiting panicles); March 2 (tree 60-80 ft. high; bark grey, slightly fissured, $\frac{5}{8}$ inch thick on a tree 15 inches in diameter; a thin red layer immediately under the outer bark, dark-brown further in; leaves foveolate, paler on the under surface; stipules fugacious; flowers white, sweetly scented).

If we accept Schlechter's view of the genus *Ackama,* it is at present confined to four species—two, or perhaps three, in Australia, and one in New Zealand. As regards the North Queensland plant named by Schlechter as *Betchea australiensis,* and later by White and Francis as *Ackama quadrivalvis,* I may say it does not appear to me to be more than specifically distinct from *A. paniculata* (F.v.M.) Engl., of Southern Queensland and Northern New South Wales. The North Queensland plant was first collected at Rockingham Bay by Dallachy and distributed by Mueller under the name of *Ackama Muelleri* Benth. The presence of a 3-4-celled ovary in the Rockingham Bay plant was drawn attention to by Pulle (in Lorentz Nova Guinea, VIII., 640), but he did not even raise it to varietal rank. *A. australiensis* shows some slight differences from *A. paniculata* Engl. (*A. Muelleri* Benth.). The leaves on the whole are less serrate, the panicle branches thicker, and the capsules smaller and 4- (sometimes 3- or 5-) celled. In his noting under *Betchea australiensis* Schlechter l.c. says that *Ackama* has only two carpels and in the fruit in each only one, long-hairy, large seed. He had, however, no fruiting specimens of the North Queensland plant before him. I have compared the seeds of *A. australiensis* (Schlechter) C. T. White and *A. paniculata* (F.v.M.) Engl, and can see no essential differences. Whether the other species of *Betchea* listed by Schlechter in his account of the genus in Engler's Botanische Jahrbucher Band 52, pp. 146-151, are separable from *Ackama* or not I would not say without an examination of the material.

Ceratopetalum succirubrum sp. nov. *C. Virchowii* C. T. White. Aus. Forestry Journ., XII., 19 (1929), non F. v. Mueller.

Arbor magna 30 m. alta; trunco 1 m. diam. Folia opposita 2-3 (plerumque 3)-foliolata; petiolo communi 1-2·5 cm. longo; foliolis coriaceis lanceolatis apice leviter acutis vel subobtusis, basi cuneatis, utrinque reticulatis, margine in parte superiore valde crenulato-serratis, laminis 5-12 cm. longis, 1·5-4 cm. latis; petiolulis 0·7-1·3 cm. longis. Paniculae terminales vel subterminales multiflorae; remulis pedicellisque tomentosis; pedicellis 2 mm. longis. Calycis tubus late turbinatus, parce tomentosus, 1 mm. diam.; lobis 4 utrinque parcissime tomentosis, post anthesin auctis. Stamina 8, filamentis 1·5 mm. longis, complanatis basem versus leviter dilatatis, connectivi apiculo prominenti leviter recurvo. Discus subcarnosus, annulatus, lobatus. Ovarium tomentosum, styli glabri.

Gadgarra, Atherton Tableland, J. L. Tardent sine no (type-flowering specimens). Received 14/12/28, several duplicates of Mr. Tardent's specimens were distributed from the Queensland Herbarium as *C. Virchowii* F.v.M., C. T. White, No. 1571 (leaves only available); 20/3/32 (large tree, local name, "Blood-in-the-Bark"); Danbulla, Atherton Tableland (D. Fraser, No. 14, leaves only). Forest Reserve R. 310, Gadgarra; R. B. Dreghorn (leaves only available), 25/10/1934.

Closely allied to *C. Virchowii* F.v.M., but differing as follows:—

Leaflets distinctly acuminate, acumen often long, margin very slightly crenate; flowers 5-merous .. .. *C. Virchowii*

Leaflets slightly acute or obtuse, margins markedly crenulate-serrate in the upper part; flowers 4-merous .. .. *C. succirubrum*

I had previously identified "Blood-in-the-Bark," a common tree in North Queensland, as *C. Virchowii*, and recently I received specimens of a tree commonly called "Dogwood" in the North Queensland scrubs from Forest Overseer R. B. Dreghorn. These were also determined as *C. Virchowii* F.v.M., but Mr. Dreghorn states that the two trees are very distinct in the field. He writes:—

"(1) 'Dogwood' favours the poor soils, and I have not noticed this tree on any but the grey soil in more or less stunted scrub or rain-forest, whilst 'Blood-in-the-Bark' favours richer soils and heavy scrubs. (2) The 'Dogwood' crown is fairly heavy, whilst 'Blood-in-the-Bark' has a very light crown. (3) At date 26/10/34 'Dogwood' is flowering heavily, whilst 'Blood-in-the-Bark' is not flowering. (4) The wood of 'Dogwood' is much heavier than that of 'Blood-in-the-Bark,' of which there is a constant demand for timber purposes, mostly for plywood. (5) Less 'blood' exudes from the bark when cut from 'Dogwood' than from 'Blood-in-the Bark.' "

Critical examination of the herbarium specimens bears out Mr. Dreghorn's opinion that the two trees are quite distinct.

Satin Sycamore is the official name for the timber of *C. succirubrum* adopted by the Queensland Forest Service, and writing of it Mr. E. H. F. Swain, in his "Timbers and Forest Products of Queensland," says:—

"Satin Sycamore is a wood of unusual appearance, and capable of special application in cabinet work. It is tough and strong, and takes glue and stain well. It is not durable in the ground. The log cuts up very faultily. To get first-class wide boards entails getting a large proportion of second class. It is inclined to twist in drying, and requires careful seasoning in stripped stacks under cover.

"Satin Sycamore is used in North Queensland as a general building hardwood for the framing, flooring, and lining of houses. It is also used on occasions for external sheeting, but its use for this purpose is not recommended where more durable timbers are available. It makes a very handsome polished floor, especially when back-sawn. It is now being successfully used as a furniture wood."

Order Hamamelidaceae.

Ostrearia australiana Baill. in Adansonia X., 131 (1871).

Mossman River Gorge, in rain-forests, L. J. Brass, No. 2140 (flower buds); 11th February, 1932. (Small tree with weak spreading branches; leaves aromatic, glossy above, greyish on the underside; inflorescence pendulous under the leaves.)

A very interesting find; the genus was previously only known from fruiting material and its systematic position was doubtful. The following additional particulars to those previously known are now published:—

Flowers hermaphrodite, borne in spikes terminal or in the upper axils, the few lowermost flowers distant, upper ones more or less crowded; bracts subtending the few lowermost flowers often leaf-like, those under the upper one narrow-linear. Calyx valvate. Petals 6. Stamens 6, subsessile. Ovary 2-celled, semi-inferior, loculi 1-ovulate.

The plant was originally collected at Rockingham Bay by Dallachy. As no specimens of the plant were available for comparison in the National Herbarium, Melbourne, where most of Dallachy's specimens are to be found, a sheet of Brass' gathering was forwarded to the Royal Botanic Gardens, Kew, where it was known specimens of *O. australiana* Baill. were represented. The specimen was very kindly examined by Dr. Hutchinson, who reported that it agreed perfectly with *O. australiana* Baill., and that in his opinion it seemed to be a distinct genus and most nearly related to *Dicoryphe* from Madagascar.

Order Myrtaceae.

Backhousia Hughesii sp. nov.

Arbor magna, cortice subfibroso, ligno duro, ramulis novellis angularibus. Folia petiolata, elliptica apice leviter et obtuse accuminata vel emarginata, basi acuta, supra subnitida subtus pallidiora et opaca; petiolo ad 5 mm. longo; lamina 3·5-5 cm. longa, 2-3 cm. lata; nervis lateralibus in sicco prominulis 12-15 in utroque latere. Flores albi parvi in cymas paniculatas multifloras terminales dispositi; bracteis paucis foliatis ad 1 cm. longis et 3 mm. latis; ramis et pedicellis glabris vel leviter pubescentibus, pedicellis gracilis 1·5 cm. longis, e pedunculis communis 2-7 floris orientibus. Calycis tubum late turbinatum; lobis suborbicularibus, majoribus 2·5 mm. diam. Petala oblonga vel suborbicularia in sicco membranacea calycis lobos aequantia vel vix superantia. Stamina numerosa; filamentis 4 mm. longis. Ovarium 2-loculatum, semisuperum.

Daintree River, Apicos Hughes, who remarks:—

> "The trees grow exclusively on the hills in dense scrub, coming out of the ground with round barrel and round surface roots, but no flanges. To test its lasting qualities I felled a tree and let it lie ten years in the scrub, and when milled it showed no sign of rot and was only discoloured in about ½ inch. The timber is very hard but works well with saw and carpenter's tools. A peculiarity of it is that if during its growth the tree is bruised or damaged it bleeds a grey-looking sap, which forms into a grey cement as per sample enclosed, and is found often under the sap wood and bark.

R.S.—C.

"The local name here is Grey Teak or Stone Wood, and it is being used extensively in building and bridge timbers. I would be glad to know the botanical name or any information you may have about it, as I have not found it in any other locality than Daintree River."

Among previously described species most closely allied to *B. Bancroftii* Bail., which differs in having the young shoots, pedicels, and calyx tube pubescent, the leaves very much longer, 5-13 cm. long and 2·5-5·5 cm. broad, the flowers and fruit much larger, and less numerous on shorter, stouter pedicels.

Callistemon rigidus R. Br. in Bot. Reg. Tab. 393 (1819).

Wyberba, between Stanthorpe and Wallangarra, in swampy country or in seepages among granite hills. C. T. White, No. 9336 (ftg. specimens); 13/10/33. (Shrub, mostly with a single stem 2 m. high.) Lyra, between Stanthorpe and Wallangarra, W. R. Petrie.

Both Wyberba and Lyra are several miles within Queensland territory. The species has a wide range in New South Wales, and has been recorded from Wallangarra (New South Wales-Queensland border).

Eucalyptus oreades R. T. Baker, in Proc. Linn. Soc., New South Wales, XXIV., 596, t. XLIII. (1900).

Springbrook, S.E. Queensland, alt. 3,000 ft. C. T. White, 6233 (young buds and nearly ripe seed capsules); 20/9/1929. (Medium-sized tree with persistent, rather "box"-like bark at base, leaves coriaceous, glossy green. Coppice shoots glaucous white, the leaves dull glaucous green, young ones (" gum-tips," a rich wine colour).

Not previously recorded for Queensland. I am indebted for the determination to Mr. W. F. Blakely (National Herbarium), Sydney.

Eugenia sordida F. M. Bailey in Bull. 18 (Bot. Bull. V.), Dept. Agric., Brisbane, 15 (1892). *E. macoorai* F. M. Bailey l.c.

Bellenden Ker, alt. 4,700 ft.; F. M. Bailey (type); Bellenden Ker, near the summit of the south peak, F. M. Bailey (type of *E. macoorai*). Bellenden Ker, C. T. White (old flowers), January, 1923. Eungella Range, W. D. Francis (rather old flowering specimens), October, 1922 (low, densely branched, spreading shrub, growing in creeks near the mountain side); Gadgarra, T. Fuller; Freshwater Creek, near Cairns, W. D. Francis (old flowers), June, 1928 (straggling tree on banks of the creek); slopes of Mount Demi, alt. 2,500 ft., L. J. Brass, No. 2094 (fruits); 6th February (tall shrub, leaves coriaceous, paler on under side; solitary terminal globose fruits, $1\frac{1}{4}$ inch diam.).

After examining the types of *E. sordida* F. M. Bailey and *E. macoorai* F. M. Bailey, I am convinced that both represent the same species. The fruit was previously undescribed; the solitary specimen collected by Brass is globose, 3·5 cm. diam., and crowned by the wide persistent rim of the calyx, which forms a fine ring about 2 cm. diam.

Micromyrtus hexamera Maid and Betche in Proc. Linn. Soc., N.S.W., XXVI., 82 (1901).

Charlotte Plains, 30 miles west of Cunnamulla, W. A. L. Ivory, No. 1, September, 1894.

Not previously recorded for Queensland. (Determination by S. L. Everist, Botanic Museum and Herbarium, Brisbane.)

Rhodomyrtus recurva sp. nov.

Frutex glaber vel arbor parva; ramulis robustis. Folia lanceolata, pennivenia in sicco subchartacea, apice subacuminata, basi cuneata; nervis lateralibus subtus prominulis ca. 22 in utroque latere; vena intramarginali ca. 1 mm. a margine remota; margine recurva; petiolo 1 cm. longo, in sicco nigrescenti; lamina ad 18 cm. longa et 6·5 cm. lata. Flores in cymas axillares dispositi; cymis brevis petiolis vix duplo longioribus. Calycis tubus breviter cylindricus, 3 mm. longus; limbo irregulariter 5-lobato; lobis majoribus 3 mm. diam. Petala suborbicularia, stamina numerosa petala haud superantia.

Mossman River, in rain-forest, No. 2127 (flowering specimens); 2nd February. (Tall bush or small tree with close pale-grey bark; leaves thick, rather fleshy and brittle, margins recurved.)

The present species has its closest affinities with *R. macrocarpa* Benth., which differs in having larger leaves on longer petioles, lacking an intramarginal vein, and in the young parts and inflorescence being hoary-tomentose. *R. cymiflora* F.v.M. differs in being much smaller in all its parts and in having much more elongate slender loosely arranged cymes.

Order ARALIACEAE.

Polyscias mollis (Benth.) Harms in Engl. Prantl. Nat. Pflanzenfam. III. (8), 45 (1894).

Slender, erect, sparsely branched rain-forest tree, 5 m. high, upper part of stem pithy, marked with large leaf-scars, and armed with stout sharp prickles (Brass). Leaves simply pinnate, rhachis, including the petiole, about 60 cm. long, tomentose, petiole itself about 25 cm. long, clothed on the inner side with rather numerous prickles, the prickles gradually disappearing from the upper part of the rhachis; leaflets 7-8 pairs and a terminal odd one, glabrous above, densely velvety pubescent beneath, lowermost pair ovate, 10 cm. long, 6·5 cm. wide, intermediate ones oblong-lanceolate, averaging about 15 cm. long and 5 cm. broad, oblique and acute or subacute at the base, petiolules mostly about 1 cm. long, tomentose, terminal leaflet lanceolate aequilateral at the base, apex in all leaflets except commonly the lowermost pair acuminate-caudate, the acumen itself up to 2 cm. long. Panicle terminal, thrice branched, 45 cm. long and rather more in diameter, all parts reddish purple (Brass); branches tomentose, lateral branches 20-30 cm. long, bearing numerous umbels, on peduncles of 2·5-5 cm. Umbels 10-12 flowered, pedicels 6-8 mm. long. Flowers not seen. Fruits compressed, globose, 4 mm. diam., carpels strongly ribbed.

Daintree River, in rain-forest, L. J. Brass, No. 2343 (fruiting specimens); 19th March, 1932. (Slender, erect, sparsely branched tree, 15 ft. high, upper stem pithy, marked with large leaf scars and armed with stout sharp prickles; inflorescence a terminal thrice branched panicle 18 in. long and rather more in diameter; all parts reddish-purple; fruits ribbed and very much compressed.)

A description of the above species drawn up from Brass' No. 2343 is offered herewith as Bentham's original description of *Panax mollis* in the Flora Australiensis III., 382 (1866) is exceedingly meagre; it is supplemented by a note on the aculeate nature of the stem by Mueller in Fragmenta Phytographiae Australiae VII., 96 (1870). The species was apparently only previously known from the type locality—Rockingham Bay. The dried specimens are markedly aromatic, with a celery-like scent.

Polyscias purpureus sp. nov.

Frutex glaber 2-3 m. altus. Folia simpliciter imparripinnata 7-9 foliolata rachi cum petiolo ca. 35 cm., petiolo ipso 17 cm., basem versus subdense lenticellato, basi in vaginam semiamplexicaulem dilatato; foliolis lanceolatis apice longe acutis vel subacuminatis subcarnosis (Brass) in sicco papyraceis vel subcoriaceis; nervis praecipuis subtus elevatis venis et venulis sub lente prominulis; margine crenulatis dentibus paucis praeditis; laminis ad 23 cm. longis et 8 cm. latis; petiolulis ad 1·5 cm. Paniculae ca. 25 cm. diam.; ramis praecipuis 15-18 cm. lenticellatis; ramis secundariis subverticellatis 1·5-3·5 cm.; ramis ultimis vel pedunculis 1-2 cm. longis 8-12 floris; pedicellis tenuibus 3-5 mm. Calyx urceolatus; limbo truncato. Petala 5, ovato-lanceolata, 2 mm. longa; stamina 5, filamentis 1 mm., antheris versatilibus 1 mm. longis. Fructus compressus 3 mm. diam., stylis 2 valde recurvis.

Mossman River Gorge, in rain-forest. L. J. Brass, No. 2072 (type: flowering and fruiting specimens); 5th February (sparingly branched shrub 6-8 ft., rather fleshy pale-green leaves, all parts of inflorescence purple). Mowbray River, in rain-forest. L. J. Brass, No. 1982 (flowering specimens); 21st January (large shrub, inflorescence purple). Ranges near Trinity Bay, F. M. Bailey (small tree). Bellenden-Ker, H. Newport (Meston's Bellenden-Ker Exped., 1904), determined and recorded by F. M. Bailey as *Panax Murrayi* F.v.M. Kuranda, C. T. White, No. 1532 (fruiting specimens) 28/2/1922.

Among previously described Australian species intermediate between *P. Murrayi* (F.v.M.) Harms and *P. Macgillivrayi* (Benth.) Harms. The former differs in having much more numerous leaflets (from 13-20 pairs) and a much larger differently branched inflorescence. The latter, according to a tracing of the type made for me at the Royal Botanic Gardens, Kew, by Mr. W. D. Francis, has more oblong or elliptic leaflets, and a very much larger, rather differently branched panicle, the primary branches being 25 cm. or more long.

Order Rubiaceae.

Ixora triflora R. Br. ex Benth. Fl. Austr. III. 416 (1866).

Mt. Demi, alt. 2,000 ft., on mountain slopes, L. J. Brass, No. 2080; (flowering specimens); Feb. 6. (Shrub, about 4 ft. high, leaves thin and soft, paler on the underside; flowers white in terminal pairs, between very pale green bracts.)

This interesting plant was previously only known from one or two coastal localities. The present specimens differ from these in that the leaf-like bracts subtending the flowers are ovate-lanceolate, and sharply pointed, not orbicular in shape. Otherwise the leaves and flowers agree. A note on *Ixora triflora* R.Br. and its confusion with *Diplospora ixoroides* F. v. M. was published by Spencer Moore in the "Journal of Botany," LXIV. 215, 1926.

Randia Audasii sp. nov.

Arbor parva, 3-4 m. alta, glabra, ramulis novellis, compressis. Stipulae late ovatae 2 mm. longae. Folia brevipetiolata, in sicco papyracea vel crasse membranacea, atrocastanea, ovato-lanceolata, basi obtusa vel subacuta, apice obtusa, subacuminata; petiolo 5 mm. longo; lamina 10-13 cm. longa, 3-5 cm. lata; nervis lateralibus utrinque 7-8, supra impressis, subtus leviter elevatis. Inflorescentia terminalis 2-4-flora; bracteis late ovatis, 2-3 mm. longis; pedunculo 5-7 mm. longo; pedicellis ca. 1 cm. longis. Calyx alte cupularis, 1 cm. longus; limbo breviter 5-dentato. Corolla albo-cremea; tubo 4 cm. longo, extus glabro, intus dense piloso; lobis 5-elliptico-oblongis 2·5-3 cm. longis, 1-1·5 cm. latis. Stamina in fauce inserta; filamentis 1 mm. longis; antheris linearibus 1 cm. longis. Stylus glaber, stigmate valde incrassato, bilamellato.

Mowbray River, alt. 1,000 ft., on rain-forest borders, L. J. Brass, No. 1956; (type; flowering specimens); Jan. 19. (Tree 10-12 ft. high, large creamy white honey-suckle scented flowers). Endeavour River, Miss Lovell.

This is evidently a striking plant in the field; it does not show marked affinities with any previously described Australian species. Miss Lovell's specimens were examined by Mr. W. D. Francis while at the Royal Botanic Gardens, Kew, and he reported that they could not be matched with any species of Randia or Gardenia in the herbarium there.

I take the opportunity of dedicating this plant to my friend, Mr. James W. Audas, Curator of the National Herbarium, Melbourne, who has rendered me valuable assistance in my studies on North Queensland plants.

Wendlandia inclusa sp. nov.

Frutex altus dense pubens; ramulis subrobustis. Stipulæ lanceolatae 6 mm. longae mox deciduae. Folia lanceolata vel ovtao-lanceolata, supra atro-viridia subtus canescentia, in sicco crasse papyracea, apice acuta vel subacuminata, basi acuta in petiolum angustata; lamina 10-15 cm. longa, 4-6 cm. lata; petiolo 1-3·5 cm. longo, petiolis oppositis interdum valde inæqualibus. Inflorescentiæ terminales, cymosæ, paucifloræ, foliis multo breviores. Flores rosei, pro genere magni. Calycis tubus late campanulatus 3-4 mm. longus; limbus 5-partitus; lobis subæqualibus tubo longioribus lanceolatis persistentibus. Corollæ tubus breviter infundibularis calycis lobos æquans, extus dense pilosus, intus glaber; limbo 5-partito; lobis oblongis tubum subæquantibus, basi appendidculatis et faucem includentibus, in sicco venosis. Stamina 5 inclusa ad basem corallæ inserta; filamentis brevis applanatis, antheris magnis elongatis corollæ tubum æquantibus. Ovarium inferum, 2-loculare; stylus filiformis pubescens tubum corollæ æquans; stigma clavellatum; ovula in loculis numerosa, in placentis elongatis crassis inserta. Capsula oblonga, crustacea; seminibus subangularibus, testa reticulata.

Daintree River, in rain-forest gullies, L. J. Brass, No. 2,327 (flowering and fruiting specimens); March 13 (tall pubescent shrub, upper side of leaves very dark green, lower grey with very pale, almost white, hairs on the nerves).

The present plant is so different in appearance to other members of the genus known to me that I drew up a description of it as a new genus, but after going carefully into the matter consider it cannot be separated generically from Wendlandia. The chief features are the comparatively large flowers in a definite cymose inflorescence; the corolla lobes with a raised appendage at the base more or less closing the throat and the included stamens inserted at the very base of the corolla tube.

Order COMPOSITAE.

Blumea pubigera (L.) Merr. in Philipp. Journal Science, XIV. 250 (1919). *B. chinensis* DC. Prodr. 5.444 (1836), non *Conyza chinensis* L. *Conyza elata* F. M. Bailey, Bot. Bull. VIII., Dept. Agric. Brisbane, 78 (1893).

Russell River, F. M. Bailey (Bellenden Ker Exped., 1889); Barron River, *E. Cowley;* Stony Creek, near Cairns, *E. Cowley;* Johnstone River, *Rev. N. Michael*; between Cairns and Herberton, *C. J. Wild.*

I have no hesitation in referring *Conyza elata,* F. M. Bailey, to the common *Blumea pubigera* (L.) Merr., widely distributed through India, the Philippines, Malay Archipelago, and New Guinea.

Brachycome discolor C. Stuart in Benth. Fl. Austr. III. 520 (1866).

Wyberba, near Queensland-New South Wales border; among rocks in granite hills. C. T. White, No. 9378 (flowering specimens), Oct. 13, 1933 (leaves dull green above, purple beneath, fls. mauve).

This plant was previously admitted into the Queensland flora by both Mueller and Bailey, but no Queensland specimens were previously found in either the National Herbarium, Melbourne, or the Queensland Herbarium, Brisbane.

**Conyza chilensis Spreng,* Nov. Prov. p. 14 (1818).

Toowoomba, Darling Downs. A common weed in grassland, on red basaltic soil; C. T. White, 6644, 27/2/1930. Toowoomba, common weed on roadside; S. T. Blake, 5135, 10/2/34.

A native of South America. Determination by W. D. Francis at Royal Botanic Gardens, Kew.

**Eleutheranthera ruderalis* Schultz. Bip.

Townsville; a very common weed about the town. C. T. White, 8956, 26/3/33. Bartle Frere. Dr. H. Flecker, No. 547 [2/6/35].

A native of Tropical America. A specimen was forwarded to the Royal Botanic Gardens, Kew, England, where it was kindly determined for me by Mr. V. S. Summerhayes.

**Microlonchus salmanticus* D.C. Prodr. VI. 563 (1837). *Centaurea salmantica* L. Sp. Pl. 918.

Greenmount, Darling Downs. H. Mansbridge, Nov., 1931.

A native of the Mediterranean region not previously recorded as a naturalised alien.

Olearia argophylla F. v. M. var. *grandiflora* n. var. *O. oliganthema* White and Francis, Proc. Roy. Soc. Q. XXXV. 72; 1923 non F. v. Muell.

Excellit capitulis majoribus, involucra 1 cm. diam. bracteis numerosis pilis longis dense vestitis, flosculis longioribus cum æchænia 1·2 cm. longis.

Differs from the type in the flowers being much larger (involucre 0·5 cm. diam. in the type, 1 cm. diam. in var. *grandiflora*), the involucral bracts also are more numerous and more hairy than in type, the individual florets are larger (0·8 cm. long in the type, including the achene, and 1.2 cm. long in the var. *grandiflora*).

Macpherson Range, near Emu Vale, 70 miles south-west from Brisbane. C. P. Saunders, No. 88; W. D. Francis (flowering specimens), Nov., 1920; Roberts Plateau, Lamington National Park, alt. 1,000 m., C. T. White, No. 6032 28/5/1929; (leaves only) small spreading tree or large shrub, 4 m. high, leaves dull dark green above, silvery white beneath.

The Macpherson Range specimens were recorded by White and Francis l. c. as *O. oliganthema* F.v.M., but on a closer examination of the material I am convinced they more closely conform to *O. argophylla* F. v. M., though differing from the common New South Wales and Victorian form in the features indicated above.

Olearia stellulata D. C. Prod. V. 272, var. *lirata*, Benth. Fl. Austr. 1. 473, 1866.

Springbrook, alt. 3,000 ft., W. Rudder; (flowering specimens); 6/9/1929. Upper Tallebudgera, C. T. White, 12/1917.

These specimens seem to agree with Bentham's variety, though they represent rather a robust form. The Springbrook plant has leaves, including the 1 cm. long petiole, up to 16·5 cm. (6½ inches) long; the blades on flowering shoots are 7-8 times as long as broad, broader on sterile ones. The Upper Tallebudgera specimens bear only very old flowering branches; they have slightly broader leaves, more bullate above, but obviously representing the same plant. No altitudinal record is given on the latter specimens, but they were probably gathered on the track from Upper Tallebudgera to Springbrook, as I visited Springbrook by that route in December, 1917.

The variety not previously recorded for Queensland.

**Schkuhria isopappa* Benth. Pl. Hartweg. 205.

Wyaralong, Boonah. Rev. N. Michael, No. 1967; (flg. specimens); 28/12/33.

A native of Colombia, South America. For the specific determination I am indebted to Mr. V. S. Summerhayes, Royal Botanic Gardens, Kew (Eng.).

As this was rather an unusual introduction, I asked Mr. Michael for any particulars he could forward. In reply he wrote:—

> "Very many thanks for your letter and the interesting information relating to my No. 1967 *Schkuhria isopappa* Bentham. I showed your letter to Mr. Colin Philp, who owns Wyaralong homestead some 8 or 10 miles out from here. He is unable to throw any light on it, except to say that he has noticed it only within recent times—a few years. I found it to be growing abundantly in the home paddocks.
>
> "I had an idea that it might have been introduced in the numerous packing cases which have for many years made their appearance on his property from overseas. His whole back yard and sheds are choked with many varieties of cars, trucks, and agricultural and log-hauling machinery. It had occurred to me some stray wind-blown pappi or achenes could quite easily come over in some of the huge machinery cases which have from time to time littered his yard.

"Then, another problem arises. Since collecting these specimens at Wyaralong, I have seen this same plant growing more or less abundantly along the road following Teviot Brook towards Mr. Sandy Mackay's place, 'The Ranch,' near the head of the Teviot Brook, at the foot of Wilson's Peak. A most delightful spot where we often go to spend a day. Now, the Ranch is about 21 miles in the opposite direction from here; Wyaralong is 8-10 miles on the road to Beaudesert—a crow's flight distance of some 30 miles. I have another theory that this plant comes originally from the Wilson's Peak area, as the Teviot Brook waters the whole country, and wanders about from there through Wyaralong for at least 40 miles. Mr. Philp has more than 10 miles of it running through his property. I have an idea that an examination of the country, at the proper time, will show that this stream has distributed our new botanical stranger, which will no doubt be found in the Albert River areas, which take in the Teviot before Beaudesert."

Spilanthes Acmella (L.) Murr. Syst. 610 (1774).

Kamerunga, Barron River, North Queensland; E. Cowley, Aug., (1891.)

This widely distributed tropical species does not appear to have previously been recorded for Queensland. Determination at Royal Botanic Gardens, Kew (Eng.), by W. D. Francis.

Vittadinia tenuissima J. M. Black, Fl. Sth. Aus. p. 595. (1929.)

Ramsay, Darling Downs, Mrs. John Ramsay; Toowoomba, Darling Downs, C. T. White.

Previous to these records the inclusion of this species in the "Queensland Flora" rested on doubtful material from the Burnett River, collected by Mueller, and from specimens from Tambourine Mountain, collected by Domin, which, however, he states are not typical.

Order Sapotaceae.

Lucuma sessiliflora sp. nov.

Arbor parva, ramulis novellis angularibus dense ferrugineo-hirsutis. Folia petiolata, juniora utrinque pilis ferrugineis sericeis plus vel minus dense obsita, vetustiora glabra, chartacea, in sicco utrinque sub lente minute et distincte reticulata, supra viridia, opaca, subtus fulva, subnitida, elliptica vel ovato-lanceolata; nervis secundariis utrinque 5-6; petiolis1-1·5 cm. longis; laminis 6·5-8 cm. longis, 3-4 cm. latis. Flores sessiles, solitarii axillares. Sepala 5, utrinque hirsuta 2 exteriora late ovata subacuta 6 mm. longa, 4 mm. lata, 3 interiora, paulo longiora (marginibus extus glabris). Corolla glabra, 1 cm. longa; lobis 2 mm. longis, rotundis. Antherae late ovatae, 1 mm. longae, subsessiles; staminodia paulo altius inserta, ligulata, 1·75 mm. longa, 0·75 mm. lata. Ovarium cylindricum, hirsutum; stylo glabro, incluso; stigmate capitato.

Mount Demi, alt. 3,000 ft., in light rain-forest, L. J. Brass, No. 2088; (flowering specimens); Feb. 6; (small tree, on summit of mountain).

Among previously described Australian species has very close affinities with *L. Unmackiana* F. M. Bail, which has usually shorter leaves, broader in comparison, more inclined to obovate in shape, the lateral nerves closer together and more prominent underneath, but the reticulations on both surfaces much less distinct and, according to the description, a 4-merous flower. When fruits are collected other differences will probably be shown. *L. sericea* (R. Br.) F. v. M. has usually smaller leaves, smaller pedicellate flowers clustered in the axils, and a pubescent corolla.

Order SYMPLOCACEAE.

Symplocos Bauerleni R. T. Baker in Proc. Linn. Soc. N.S.W. XXVII., 594, Pl. XXVIII. (1902).

Springbrook, alt. 1,000 m.; W. Rudder, 6/9/1929; (small tree, glossy green leaves, numerous white flowers, very ornamental).

Not previously recorded for Queenlsand.

Symplocos cyanocarpa sp. nov.

Frutex glaber 1-1·5 m. altus; ramulis junioribus angularibus. Folia lanceolata, in sicco chartacea, apice longe acuta vel subacuminata, basi in petiolum brevem attenuata, margine leviter recurva undulata dentibus parvis paucis praedita; costa media supra impressa subtus valde elevata; nervis lateralibus utrinque 10-12, subtus distinctis; petiolo 3 mm. longo robusto; laminis 11-23.5 cm. longis, 2·5-5·5 cm. latis. Inflorescentiae sessilies in fasciculos axillares paucifloros dispositae; bracteis exterioribus late ovatis glabris vel glabrescentibus, interioribus ovatis pilis fulvis longis obsitis. Flores ignoti. Fructus sessilis atro-cyaneus (Brass) sybcylindricus 2 cm. longus, 5 mm. diam., basi brevissime stipitatus, apicem versus tenuiter pubescens, lobis calycinis pubescentibus coronatus.

Mossman River, in rain-forest, No. 2050; (fruiting specimens); Feb. 4. (Shrub 3-4 ft. high, leaves paler on the underside, serrulate, margins recurved; ripe fruits dark blue in colour.)

Among previously described Australian species most closely allied to *S. Hayesii* White and Francis, which differs in having the branchlets clothed with long spreading hairs, the leaves more markedly dentate and obtuse, not narrowed or cuneate at the base.

Order OLEACEAE.

Linociera coriacea sp. nov.

Arbor parva, ramulis robustis, glabris, subteretibus. Folia ampla, petiolata coriacea, lanceolata-oblonga, basi obtusa, apice gradatim acuminata; nervis praecipuis supra impressis subtus elevatis; lamina 17-30 cm. longa, 5-8 cm. lata; petiolo valido ad 1 cm. longo. Flores in racemos, 2-4 cm. longos, glaberrimos, axillares dispositi; bracteis ovato-lanceolatis 2 mm. longis; pedicillis gracilibus ad 1 cm. longis. Calyx alte 4-fidus; lobis anguste ovato-lanceolatis, 4 mm. longis. Petala 4 ovata, 6 mm. longa, alba vel rosea, margine incurva. Stamina 4, 3 mm. longa; filamento applanato; anthera magna 2 mm. longa. Ovarium subquadrangulatum; stigmate subcapitato.

Mossman River Gorge, in rain-forest, L. J. Brass, No. 2062; (flowering specimens); February 4; (small tree; leaves coriaceous, paler on under side; flowers pale pink, pendulous below the branches); L. J. Brass, No. 2125; (type; flowering specimens); Feb. 9; (tall bush or small tree, leaves coriaceous and prominently veined; flowers white).

Among previously described Australian species the present one is most nearly related to *L. axillaris* F. v. M. The differences are as follows:—

Leaves 9-13 cm. long, 3-4 cm. broad; apex acute, base cuneate; stamens 2 .. .. *L. axillaris.*

Leaves 17-30 cm. long, 5-8 cm. broad; apex acuminate, base obtuse; stamens 4 .. .. *L. coriacea.*

I had some difficulty in placing this plant in its correct family, so sent specimens to the Director of the Royal Botanic Gardens, Kew, and received a reply from Mr. J. S. L. Gilmour, Assistant Director, to the effect that they had been unable to match the two specimens, and they seemed to be either a new species (rather aberrant) of Linociera (Oleaceæ) or possibly a new genus allied to this. He further stated, however, that in the absence of fruit they did not feel prepared to make a definite pronouncement.

My best thanks are due to the Kew authorities for the trouble taken. After drawing up the description I feel fairly certain that the plant cannot be separated from *Linociera.*

Order Apocynaceae.

Alyxia orophila Domin. in Bibl. Bot. XXII. (Heft. 89^6), 1077. (1928).

Thornton Peak, alt. 4,000-4,500 ft.; L. J. Brass, No. 2279 (fruiting specimens); March 14; (small stunted tree with thick branches; leaves rigid and curved, the apex hooked, glossy on both sides, paler underneath, channelled, the margins much recurved, fruit smooth, orange-yellow, simple, or divided into 2 or 3 articles).

A rather distinctive form that I had at first placed under the polymorphic *A. ruscifolia* R. Br., but on further consideration changed to *A. orophila* Domin, which seems to differ principally from *A. ruscifolia* R. Br. in having single or few-flowered axillary, not several to many-flowered terminal inflorescences. The present plant differs from the type in that the young branches are perfectly smooth, not asperulous, and the veins not at all or scarcely perceptible on the under surface of the leaves. I have refrained from giving it a varietal name in view of the extremely variable character of the more widely distributed *A. ruscifolia* R. Br., a feature *A. orophila* Domin will probably be found to share.

**Rauwolfia canescens Linn.* Sp. Pl. Ed. II. 303.

North Rockhampton. Miss O. M. Court, No. 28; (fruits); May, 1925. (bushy tree, growing on banks and in dry beds of creeks just outside North Rockhampton.) North Rockhampton, Miss M. Standish; (flowers); Feb., 1933. (Recently made its appearance on a property.)

I am indebted for the determination of the above plant to Mr. V. S. Summerhayes (Royal Botanic Gardens, Kew, England), and in a letter from the Director (Sir Arthur W. Hill) the plant is described as a native of Tropical America, now a naturalised weed in South India, though there is no evidence to show it has become a bad pest anywhere.

Parsonsia lenticellata sp. nov.

Suffrutex scandens, ramulis subrobustis, valde lenticellatis, tomentosis. Folia opposita, glabra subcoriacea lanceolata vel anguste ovato-lanceolata, supra leviter scaberula, subtus opaca, apice gradatim angustata, basi obtusa, margine revoluta; petiolo ca. 1 mm. longo; lamina 5-9 cm. longa, 0·5-1·3 cm. lata. Inflorescentiae axillares densiflorae, ca. 1·5 cm. diam.; pedunculo 5-6 mm. longo; cymae ramulis secundariis brevissimis tomentosis. Pedicellus 2-3 mm. longus, furugineo-tomentosus.

Bracteae ca. 1 mm. longae. Calycis lobi lineari-lanceolati, recurvi, extus puberuli 2·5 mm. longi, vix 1 mm. lati. Corolla 5 mm. longa, extus minute puberula, intus fauce deorsum setosa. Antherae acutae, 2·5 mm. longae; filamentis tenuis 1 mm. longis, intus albo-hirsutis. Pistillum glabrum; ovario subgloboso; squamis disci oblongis subcarnosis.

Mowbray River, L. J. Brass, No. 2020 (flowering specimens); January 27; (small savannah climber).

Among previously described Australian species most closely allied to *P. lanceolata* R. Br., which differs in having much broader, obtuse, or shortly acuminate leaves, and a smaller inflorescence, with smaller flowers, with straight, not recurved, calyx lobes.

Order Asclepiadaceæ.

Tylophora colorata sp. nov.

Fruticulus volubilis parum ramosus; partibus junioribus tomentosis; ramis flexuosis, laxe foliatis, internodiis 4-9 cm. longis. Folia anguste ovata, apice acuta vel subacuminata, basi obtusa, supra glabra, subtus pallidiora glabra, costa media et nervis praecipuis basem versus excepta; nervis lateralibus ca. 6 in utroque latere; petiolo 1-1·5 cm. longo; lamina 5-6 cm. longa, 2-2·5 cm. lata. Cymae axillares effusae, pauciflorae 3-4 cm. longae ramis gracilibus. Flores purpurei; pedicellis tenuibus ad 1 cm. longis. Calyx parvus, 2·5 mm. diam., lobis ovato-triangularibus, acutis. Corolla purpurea fere ad basem 5-fida; lobis 4 mm. longis, 1·5 mm. latis, obtusis. Coronae squamae carnosae, antherae quadratae; appendice hyalina reniformi minute apiculata; pollinia parva ellipsoidea. Folliculi immaturi fusiformi, 7 cm. longi, 1 cm. lati.

Mt. Demi, alt. 2,000 ft., in rain-forest, L. J. Brass, No. 2092; (flowers and nearly mature follicles); February 6, 1932; (small twining plant, young parts, petioles, main leaf nerves and flowers and fruit purple).

Among previously described Australian species nearest to *T. barbata* R. Br., which possesses smaller leaves, subacute at the base, and smaller flowers usually in simple umbels, and has the corolla lobes slightly hairy inside.

Order Loganiaceæ.

Fagraea Rosemstromii sp. nov.

Arbor (Rosenstrom) vel frutex subscandens (Brass); ramulis robustis. Folia glabra "carnosa supra nitida subtus pallidiora et opaca" (Brass) in sicco coriacea subtus pallidiora sed utrinque opaca, petiolata; petiolo 2-3 cm. longo ad basin, leviter incrassato et dilatato atque utrinque glandula stipuliformi parva aucto; lamina late lanceolata, apice acuta vel subrotunda et subacuminata, basi cuneata, 10-15 cm. longa, 5-6 cm. lata; costa media notata; nervis lateralibus inconspicuis. Flores ochroleuci vel sulphurei, fragrantes, in apicem ramulorum in cymam collecti. Cymae magnae 2-plo divisae, ramis robustis; bracteis ovatis coriaceis supra concavis 6-8 mm. longis. Calyx basem versus in pedicellum angustatus, cum pedicello 3 cm. longus; lobis brevis rotundis. Corollae tubus 7-10 cm. longus in parte inferiore cylindraceus, superne ampliatus, rectus; lobis 5 rotundatis, oblongis, 2-2·5 cm. longis, 1 cm. latis. Genitalia non vel vix exserta; stigmate 2-lobo, lobis ovatis 3 mm. longis.

Mossman River, Gus. Rosenstrom, No. 7; (mango-like tree, flowers very fragrant). Mossman River Gorge, in rain-forest, L. J. Brass, No. 2054; (flowering specimens); February 5. (A very large, fleshy, almost arborescent rambler growing on the river bank; soft, brown, scaly bark; leaves thick, fleshy and obscurely nerved, upper surface glossy, lower paler and dull; flowers heavy-scented, corolla pale yellow).

F. Rosenstromii is the largest flowered Australian species. Among previously described Australian species it has the greatest affinities with *F. Cambagei* Domin, if we recognise that species as distinct from *F. Muelleri* Benth. Judging from specimens in the Queensland Herbarium, Brisbane, the former is the common lowland species in North-east Australia, the latter the mountain one.

Distinctions between the three are as follows:—

Flowers few, in a large terminal cyme; corolla tube 7-10 cm. long .. .. *F. Rosenstromii.*

Flowers many, in a short crowded terminal cyme or several cymes, clustered from the one axil .. ..

Leaves 6 to 10 cm. long and 2-5 c.m. broad, corolla tube, 1 to nearly 2 cm. long .. *F. Muelleri.*

Leaves up to 15-25 cm. long, 7-9 cm. broad, corolla tube, 2-3·5 cm. long .. .. *F. Cambagei.*

Order Convolvulaceæ.

Ipomaea Brassii sp. nov.

Herba vel suffrutex glaber; caules repentes, fistulosi. Folia cordata ovato-cordata, vel late et obtuse hastata; lamina 5-7 cm. longa, ad basem 5-7 cm. lata; petiolus 4-5 cm. longus. Pedunculi petiolos æquantes vel superantes, 1-3-flori; bracteae ovato-lanceolatae, acutissimae, 2 mm. longae. Flores incarnati (?); pedicellus 5 mm. longus; sepala ovato-lanceolata, acutissima 1 cm. longa; corolla 4·5 cm. longa. Capsula globosa; semina villosa.

Northern Territory.—Near Queensland border—Settlement Creek, L. J. Brass, No. 122 (type; flowering specimens); January, 1922. North Queensland: Tolkuru, between Prairie and Hughenden, F. G. A. Kriesel; (immature seed capsules); February, 1935. Received through R. W. Bambrick, Inspector of Stock, Hughenden.

Among previously described Australian species has most affinities with *I. reptans* Poir., which differs in having obtuse sepals, those of *I. Brassii* being very acute. The leaves of *I. reptans* Poir. are also usually much narrower.

Brass's specimens were included in the Queensland Herbarium under *I. Muelleri* Benth., but this species differs in being a slender twiner, not a creeping plant, in having obtuse, or scarcely acuminate, not very acute, sepals, and in having a smaller corolla.

Order Solanaceæ.

Anthocercis albicans A. Cunn. in Field's, New South Wales, p. 335, tab. 2 (1825).

Between Wyberba and Wallangarra, on granite hills, C. T. White, No. 9360 (flowering specimens); 13/10/33; (subshrub, 1·5 m., fls. white with purple lines).

Not previously recorded for Queensland.

Order Scrophulariaceæ.

Browallia demissa L. Syst. ed. X. 1118.

Armstrong Creek, near Dayboro'—a weed hard to get rid of; H. F. Mead, August, 1934.

A native of South America, commonly cultivated in Queensland gardens, but not previously recorded as naturalised.

Order Gesneriaceæ.

Coronanthera australiana sp. nov.

Arbor gracilis 13 m. alta (Brass), ramulis junioribus patentim hirsutis. Folia opposita, inaequalia obovato-lanceolata, apice acuta vel subacuminata basi longe cuneata, margine dentata, utrinque leviter scaberula; petiolis dense hirsutis, 0·5-1 cm. longis; laminis 7-18 cm. longis, 2·5-6 cm. latis. Flores axillares pedunculo dense hirsuto 2 cm. longo, plerumque 1-floro vel rarius 3-floro; bracteis linearibus hirsutis deciduis. Calyx hirsutus alte 5-lobatus, tubo 5 mm. diam., lobis 7 mm. longis. Corolla aurantiaca vel lutea (''orange-yellow'' Brass) tubulosa extus tomentosa, intus juxta basem filamentorum dense piloso ceteris glabra; tubo 1·5 cm. longo, lobis perbrevis 1·5 mm. longis rotundis. Stamina 4, propius ad basem corollae affixa; filamentis validis basem versus pilosis et leviter dilatatis, 2 longioribus 1·2 cm., 2 brevioribus 1 cm. longis. Ovarium tomentosum. Fructus indehiscens (?), ovoideus, rostratus cum rostro 3·5 cm. longus; seminibus minutis laevibus rubro-brunneis.

Mt. Demi, alt. 2,500 ft., in rain-forest; L. J. Brass, No. 2087 (type; flowering specimens); 6th February; (slender tree attaining 40 ft.; young branches, leaves, and inflorescence pubescent, upper surface of leaves rather scabrous; flowers orange-yellow). Mt. Spurgeon, A. L. Merrotsy, No. 27; (fruiting specimens, without date of collection).

A very interesting find. The genus was previously only known from New Caledonia. The leaf and floral characters are exactly those of Coronanthera, but the only fruit available to me, and collected by Mr. A. L. Merrotsy, seems indehiscent, and I think, judging from the appearance of the seeds, it is ripe. It has the appearance of being fleshy when fresh, but of this I cannot be sure. If when better known the plant is found to bear definitely fleshy, indehiscent fruit, then it may have to form the basis of a new genus.

Fieldia australis A. Cunn. in Field's New South Wales, 363. (1825).

Roberts' Plateau, Lamington National Park, common at altitude of 1,000 m. and over. C. T. White, No. 6063; (flg. and ftg. specimens); 28/5/1929. (Epiphyte on trunks and branches of *Nothofagus Moorei* (F. v. M.) Maiden; leaves green above, paler, often with a reddish colour, beneath, flowers cream; fruits white, 2·5 x 1·5 cm. when fresh. Springbrook, alt. about 1,000 m.; C. T. White; (climbing up rock-faces and tree trunks in deep rain-forest gorge, rather rare). Mount Lindesay J. E. Young and C. T. White.

First recorded for Queensland by Ferd. von Mueller in the Victorian Naturalist, Vol. XII., p. 99 (1896). The record was simply made among a list of exhibits, and the plant was in consequence omitted from F. M. Bailey's ''Queensland Flora.''

Order Myoporaceæ.

Pholdidia Gilesii (F. v. Muell) Baillon Hist. Pl. IX. 421. (1888).

Eulo, South-west Queensland, L. Tambling, October, 1930.

Not previously recorded for Queensalnd. Mr. Tambling's specimens agree well with the right figure in Mueller's "Descriptions and Illustrations of the Myoporinous Plants of Australia."

Order Verbenaceæ.

Oncinocalyx Betchei F. v. Muell. in Wing's South. Sc. Record, Vol. 3, p. 70 (1883).

Goondiwindi. Not previously recorded for Queensland.

Received from Mr. J. A. H. Fraser, Land Commissioner, Goondiwindi, who writes:—

> "I am forwarding samples of a shrub which grows to a height of three feet, and carries a white flower and a lot of seeds with claws. These flowers with seeds hang over like little white bells. The plant grows mostly on stony ground and will not grow in swamps. If one root is left it will shoot. Spraying with pentoxide only kills the top; the roots are hard to kill. Owing to the number of claw-like seed sheep carry it about in their wool and spread it. These specimens I am forwarding were sent into this office with the request to have them identified. Any information you can give me on the matter I will gladly pass on to the selector."

Order Labiatae.

Prostanthera albo-hirta sp. nov.

Frutex 1·25 m. altus, ramulis robustis albo-hirsutis. Folia petiolata, ovata vel subrhomboidea, utrinque pilis paucis albis longis praedita, supra nervis impressis, subtus nervis valde elevatis, lamina dense nigro-punctata margine crenulato-dentata, recurva; petiolo 1-1·5 mm. longo; lamina 7-8 mm. longa, 5-6 mm. lata. Flores axillares solitarii, leviter pedicellati, bracteolis linearibus albo-hirsutis 2 mm. longis; pedicello 1-1·5 mm. longo. Calyx manifeste bilabiatus, extus glandulosus albo-hirsutus; nervis et venis prominulis; tubo 3 mm. longo, labio superiore 3 mm. longo, 5 mm. lato, labio inferiore 2 mm. longo. Corolla lilacina ("flowers lavender"—Brass) pubescens, 1 cm. longa, bilabiata, labio superiore 2-lobato, labio inferiore alte 3-lobato, lobo intermedio longiore. Stamina 4; filamentis glabris; antheris 2-locularibus, 1·75 mm. longis, loculis basi in apiculum minutum productis, connectivo leviter cristato. Pistillum glabrum.

Summit of Mount Demi, alt. 3,000 ft., on exposed cliff faces; L. J. Brass, No. 2102 (flowering specimens); 6th January; (erect densely foliaged shrub, 4 ft. high, flowers lavender).

Among previously described species most closely allied to *P. rugosa* A. Cunn., of New South Wales, which has much smaller leaves, sessile or nearly so, and smaller flowers; the floral characters are much the same as those of *P. denticulata* R. Br., which has linear or lanceolate leaves, and the flowers in terminal racemes.

Prostanthera linearis R. Br. Prodr. 509. (1810).

Mount French, South-east Queensland, E. J. Smith, October, 1933.

Only previously recorded in Queensland from Wellington Point (collected by J. Wedd); these latter specimens are not typical; they are somewhat fragmentary, but differ markedly from all other Prostantheras known to me in possessing very long pedicels.

Order AMARANTACEAE.

**Brayulinea densa* (Willd.). Small, Fl. South East United States, 394. (1903).

Gympie, C. T. White, No. 9614 (flowering specimens) 11th November, 1933 (Prostrate weed, common on roadsides and earth footpaths).

A native of the Southern United States and Mexico. I am indebted to the Director of the Royal Botanic Gardens, Kew (England), for the determination.

Trichinium corymbosum Gaud. in Freyc. Voy. Bot. 444 (non Spreng).

Yanna, near Charleville, G. D. Hutchinson.

Recorded by both Mueller and Bailey for Queensland, but these are the first authentic Queensland specimens I have seen.

Order CHENOPODIACEAE.

Bassia stelligera F. v. Muell. Inconogr. Aus. Sals. Pl. tab. LXVIII. (1889).

Maranoa District: Roma, C. T. White, No. 9546 (nearly ripe fruit); 25/10/1933. Noondoo Station, via Dirranbandi; S. L. Everist, No. 762, 14/12/1934 (rather loosely branched subshrub, fairly common as scattered plants, but nowhere dominant).

Not previously recorded for Queensland.

Kochia Georgei Diels in Engl. Jahrb. XXXV. 184.

Gregory North District: Elderslie, Winton, J. F. Kennedy, No. 19, 24/9/1934. Only in the mountains.

Not previously recorded for Queensland. Determination by S. L. Everist.

Order MONIMIACEAE.

Palmeria coriacea sp. nov.

Frutex scandens, ramulis subrobustis. Folia opposita, petiolata, glabra, coriacea, saepe rugulosa vel supra leviter bullata, elliptico-lanceolata, apice acuminata vel subacuminata; costa media et nervis praecipuis supra impressis, subtus elevatis; venis et venulis reticulatis supra sub lente prominulis subtus leviter elevatis; petiolo 0·7-1 cm. longo; lamina 7-11 cm. longa, 2·5-5·5 cm. lata. Paniculae axillares 2-3 cm. longae; ramulis stellato-pubescentibus. Flores ignoti. Perigonium maturum rubrum irregulariter dehiscens extus glabrum, intus pilis stramineis longis sparsis vestitum. Drupae pisiformae nigrae 6 mm. diam.

Thornton Peak, alt. 4,000 ft., L. J. Brass, No. 2282, in low scrub (ripe fruits); 14/3/32. (Scandent shrub with wrinkled recurved leaves; fruit bursting irregularly, the fleshy red pericarp persistent after the black seeds have fallen.)

The present species was very different from the two previously described Australian ones. Judging from descriptions it seemed to be close to *P. Arfakiana* Becc. A sheet was forwarded to the British Museum (Natural History), where it was examined by Mr. J. E. Dandy, who reported as follows:—

> "The only specimen of *Palmeria Arfakiana* Becc. at the Museum is Gibbs 5676, collected in the Arfak Mountains. This is not a very good specimen, consisting only of a branch with seven leaves and a few detached flowers. It is not a good match of the Queensland plant (Brass 2282), the leaves in the Arfak specimen being of rather narrower (more oblong) shape with longer acumen, and of somewhat thinner texture. I should be inclined to keep the two plants specifically distinct on the material, but of course I have not seen Beccari's type of *P. Arfakiana*."

Order Lauraceae.

Endiandra reticulata sp. nov.

Arbor 25 m. alta; cortice grisea; partibus novellis furfuraceis, ramulis junioribus angulatis. Folia subcoriacea, elliptica, apice subacuta, basi acuta, in sicco utrinque minute et valde reticulata, 13-17 cm. longa, 4-6 cm. lata; petiolus crassus, furfuraceus. Paniculae terminales vel in axillis superioribus orientes; 4-8 cm. longae; ramulis floribusque dense pubescentibus. Perianthii tubus brevis, late turbinatus; lobi 6, subaequales, late ovati. 1·5 mm. lati. Stamina ordinum I. et II. nulla, ordinis III. 3, bilocularia, extrorsa; filamentis crassis, applanatis, puberulis; staminodia ordinis IV. nulla; glandulae 6 glabrae. Ovarium glabrum, ovatum, sub-trigonum.

Daintree River, swampy rain forests, L. J. Brass, No. 2244 (flowering specimens); 7th March; (erect grey-barked tree, 80 ft. high; leaves coriaceous and rather stiff, flowers white).

Among previously described Australian species most closely allied to *E. dichrophylla* F. v Muell, which differs in possessing differently veined leaves, markedly paler beneath, stronger and less pubescent panicles.

Order Hernandiaceae.

Valvanthera gen. nov.

Flores dimorphi; abortivi pedicellati vel stipitati ovoidei; normales sessiles, hermaphroditi. Flores normales:—Involucellus (vel calyx) tubulosus vel cupularis. Corollae tubus brevis; limbo 6-8 lobato; lobis inaequalibus. Stamina 6, filamentis brevis, connectivo incrassato, antheris bilocularibus, loculis valva dehiscentibus. Ovarium semi-inferum (uniloculare ?); uniovulatum; ovulum pendulum ?; stylus columnaris, stigmate 2-lobato, lobis recurvis. Fructus drupaceus, ellipsoideus vel ovoideus; endocarpio crustaceo; semen solitarium, exalbuminosum.—Arbor. Folia alterna. Flores paniculatae; paniculae axillares, ebracteatae.

Valvanthera albiflora sp. unica.

Frutex debilis (Brass) vel arbor parva ad 15 m. alta (Kajewski), ramulis glabris. Folia petiolata, lanceolata apice acuminata, basi acuta, carnosula (in sicco papyracea); nervis lateralibus utrinque 5-7 subtus leviter elevatis; petiolo ca. 1 cm. longo; lamina 12-18 cm. longa, 4·5-6 cm. lata. Paniculae axillares, pauciflorae, 3-4 cm. longae; ramis (vel pedunculis) tenuis, albo-virentibus; floribus dimorphis; abortivis parvis pedicellatis, normalibus majoribus sessilibus. Flores normales: involucellus (vel calyx?) tubulosus 1-1·5 mm. longus; perianthium (vel corolla?) album irregulariter 6-8-lobatum, tubo brevi, lobis inaequalibus, majoribus ovatis ad 2 mm. latis, in sicco venosis. Stamina 6, filamentis 1 mm. longis, connectivo incrassato, antheris 2-locularibus, loculis valva dehiscentibus. Ovarium glabrum; stigmatis ramis 2, recurvis. Flores abortivi obovoidei basin versus in stipitem 1 mm. longum angustati. Drupa ellipsoidea, atropurpurea, in sicco 2·5 cm. longa, 1·2 cm. diam.

Daintree River, common in rain-forest. S. F. Kajewski, No. 1407 (type: flowering specimens), 29th November, 1929 (small tree up to 15 m. high; flowers on long stems, buds light pink, petals waxy white). L. J. Brass, No. 2226 (fruiting specimens), 2nd March, 1932 (slender tree, 30 ft.; leaves pale, fleshy, paler on under side; fruit fleshy, 1-1½ in. long, reddish-purple). L. J. Brass, No. 2366 (single sheet with one immature fruit), March, 1932 (tall rain-forest shrub). Mossman River Gorge, in rain-forest, L. J. Brass, No. 2124 (flowering specimens), 9th February, 1932 (tall, weak-branched, and sparsely leaved bush; leaves dull green, fleshy, paler on under side, margins narrowly recurved; flowers white; petioles and peduncles greenish-white).

Though the present plant is represented by several sheets in both the Kajewski and Brass collections, the flowers are poorly preserved, evidently not lending themselves to good preservation by the ordinary methods of drying, and it is much to be desired that an examination of flowers, either fresh or preserved in formalin or alcohol, be made at a later date.

The plant presented difficulties to me as to its relationships, and I therefore sent specimens to the Royal Botanic Gardens, Kew, England, where they were examined by Mr. V. S. Summerhayes and Mr. B. L. Burtt, who came to the conclusion that the plant might belong to the Lauraceae, though they recognised several objections to this.

Its principal affinities with the Lauraceae lie in its valvate anthers, a rather unusual dehiscence, though this might, as Hutchinson has pointed out in the Berberidales and Laurales, be due to parallel lines of descent, rather than to definite affinities.

After some consideration I have placed the plant in the Hernandiaceae, though when fresh floral material is available this decision may have to be altered.

Order Proteaceae.

Hakea verrucosa F. v. Muell. Fragm. Phytogr. Austr., V. 25, 1865.

Kupunn, via Dalby, Western Queensland. H. Cannington, 2nd September, 1931.

Only previously known from specimens cultivated in Botanic Gardens, Melbourne. The present ones differ from these in the branches being glabrous, in the floral rhachis being shorter and glabrescent, and in the flowers being on longer pedicels. The fruit is not verrucose, but neither are those from the plant as cultivated in the Melbourne Botanic

Gardens. Specimens of the Queensland plant were forwarded to the National Herbarium, Melbourne, where they were reported on by Mr. P. F. Morris, who wrote:—

> "The specimen forwarded agrees fairly close with *Hakea verrucosa* F. v. Muell., but your specimen has flowers with longer pedicels. I enclose a specimen from material labelled 'ex Horto Botanico Melb.' In Fragm. V., p. 25, Mueller states 'Capsulis erostribus copiose et prominenter verrucosis majusculis.' I am of the opinion that he referred to fruiting specimens of *H. propinqua,* which he had labelled *H. verrucosa.*
>
> "The description by Bentham covers the material which we have from the Botanic Gardens. It is difficult to know which is the type specimen, and date of collection is not given."

Order Thymelaeaceae.

Pimelea dioica sp. nov.

Frutex erectus, 1 m. altus, ramulis foliisque dense sericeo-villosis. Folia alterna, sessilia, lanceolata vel obovato-lanceolata, apice acuta, ca. 1 cm. longa, 2·5-4 mm. lata. Bracteae involucrantes 6, suborbiculares 5-8 mm. latae. Flores masc. numerosi conferti, in capitula terminalia 2-3 cm. diam. dispositi. Flores fem. ignoti. Perianthii tubus 8 mm. longus, dense sericeo-villosus; lobis late ovatis, 5 mm. longis, 3 mm. latis, extus sericeis intus glabris. Antherae 2 mm. longae, 1·5 mm. latae; filamentis perbrevibus.

An erect shrub about 1 m. high, the branches and leaves densely covered with silky hairs. Leaves alternate, sessile, lanceolate or obovate-lanceolate. Apex acute, about 1 cm. long, 2·5-4 mm. broad. Involucral bracts 6, suborbicular 5-8 mm. broad. Male flowers numerous, crowded, in terminal heads 2-3 cm. in diameter. Female flowers unknown. Perianth tube 8 mm. long, densely clothed with silky hairs, longer in the upper than in the lower portion. Lobes broadly ovate, 5 mm. long, 3 mm. broad, silky outside, glabrous inside. Anthers 2 mm. long, 1·5 mm. broad. Filaments very short, the anthers being sub-sessile.

Near Goondiwindi, Darling Downs district, growing profusely on a sandy ridge; W. Dixon (flowering specimens, 23/7/1934).

The present species is very closely allied to *P. ammocharis* F.v.M., but may be distinguished by the following characters:—

Leaves imbricate or densely crowded; involucral bracts not markedly different from the leaves. Capitula 1 cm. diam., 10-20-flowered. Perianth tube 6 mm. long, lobes 2·5 mm. long .. *P. ammocharis*

Leaves not imbricate nor densely crowded; involucral bracts different from the leaves orbicular or suborbicular. Capitula 2-3 cm. diam., 30-or more-flowered. Perianth tube 8 mm. long, lobes 5 mm. long .. .. *P. dioica*

Order Loranthaceae.

The *Loranthaceae* of the L. J. Brass collection referred to in the introductory note have been determined by Mr. W. F. Blakely, of the Botanic Gardens, Sydney, the well-known authority on the Australian members of this family. It contained the following previously undescribed variety and species:—

Loranthus signatus F. v. Muell. var *petiolata*, Blakely, var. nov.

Folia oblonga vel obovata, obtusa vel emarginata, margine leviter revoluta, basem versus in petiolum sublongum breviter angustata, supra subnitida subtus opaqua et pallidiora; venis distinctis paucis irregularibus. Petala in parte superiore viridia, in parte inferiore rubra.

Leaves opposite, oblong to obovate, obtuse or emarginate, the margins slightly revolute, shortly tapering at the base into rather long semi-terete petioles, thin, somewhat glossy above, dull and pale-coloured beneath, the veins distinct, few, and irregular. Flowers somewhat similar to those of the typical form. Lower half of petals red, upper part green.

Mount Molloy, alt. 1,200 ft., parasitic on *Casuarina;* L. J. Brass, No. 2514 (flowering specimens), 17/4/32.

Korthalsella Brassiana Blakely sp. nov.

Planta gracilis subrigida glabra articulata, 4-9 cm. alta, omni articulo florescens. Articuli manifeste compressi, angusti-cuneati, uninerves, in sicco, rugosissimi, luteo-brunnei, subcarnosi, 5-10 mm. longi, 1-3 mm. lati. Flores masculi, trimeri; pedicellis gracillimis, ca. 0·5 mm.; petalis lateralibus gibbosis, supra medium connatis, medio petalo glabro majore; antheris connatis, ad centrum perianthii affixa. Flores feminini subsessiles, ovati; petalis triangularibus crassis persistentibus; stigmate nigro, pulviniformi. Fructus ovatus brevipedicellatus, circ. 2 x 1 mm.; semina cordata, compressa, vix 1 mm. longa.

Slender sub-rigid glabrous jointed plants 4 to 9 cm. long, flowering at every joint; the union causes the host to expand into a small depressed globular swelling at the point of attachment, while the parasite does not show any marked enlargement, the only change that takes place is in the terete nature of the first joints, the remainder being markedly compressed, narrow-cuneate, 1-nerved, conspicuously wrinkled when dry, yellowish-brown, sub-carnose, 5 to 10 mm. long, 1 to 3 mm. broad. Flowers, both male and female, surrounded by minute moniliform cilia shorter than the flowers, protruding from the rather broad smooth floral band which encircles every joint; the female flowers more numerous than the male flowers, especially on old joints, but on young tips there are usually two female and two male flowers, the latter slightly larger than the former, male flowers trimerous, on very slender pedicels, the whole about 0·5 mm. long, and scarcely as broad, lateral petals gibbose, much larger than the smooth central one, united above the centre. Anthers sessile, connate, depressed-globular, attached to the centre of the perianth. Female flowers sub-sessile, usually ovate, with three thick, triangular persistent valvate petals; stigma black, pulviniform, nearly always exposed, scarcely exceeding the petals. Fruit ovate, brevi-pedicellate, about 2 x 1 mm.; seeds cordate, compressed, less than 1 mm. long, enclosed in a white reticulate membrane; endosperm green; hypocotyl green, terete, the disc acutely conical; cotyledons not seen.

It is readily separated from all other endemic species by its smaller size, linear, uninerved jointed branches, very slender pedicels to the male flowers, and in the very short moniliform cilia at the base of the flowers.

"Parasitic on the branches of many of the various trees. Thornton Peak, alt. 4,000-4,500 ft." L. J. Brass, No. 2298 (flowering specimens), 14/3/1932.

Order Euphorbiaceae.

Bridelia minutiflora Hook. f. Fl. Brit. Ind. V. 273 (1887).

Mossman River, W. Sayer, 1886 (ex Nat. Herb., Melb.) ; Johnstone River, H. G. Ladbrook, No. 142.

A species with a wide range through the Malayan and Papuan region, but not previously recorded for Australia.

Croton Maideni R. T. Baker in Journ. Proc. Royal Soc., N.S.W., XLVIII., 444, tab. XII.

Near Roma, J. G. Cumming.

Not previously recorded for Queensland.

Dimorphocalyx australiensis sp. nov.

Frutex, partibus novellis pubescentibus, ramulis junioribus lenticellatis. Folia glabra, alterna, elliptica vel elliptico-lanceolata, basi obtusa vel subobtusa, apice subacuta (subcarnosa, supra nitida, subtus pallidiora —Brass) in sicco utrinque opaca chartacea supra atro-castanea, subtus multo pallidiora; petiolus 0·5-1·5 cm. longus; lamina 7-11 cm. longa, 3-6 cm. lata; nervi secundarii ca. 7 in. utroque latere. Inflorescentia racemoso-cymosa, terminalis, strigosa ca. 3 cm. longa; bracteis ovatis 2 mm. longis, extus strigosis intus glabris. Flores masculi albi, pedicellis 2 mm. longis, strigoso-pubescentibus. Calyx alte 5-lobatus, extus pubescens, intus glaber, lobis elliptico-oblongis. Petala 5 elliptico-oblonga, calyce duplo longiora. Disci glandulae 5, carnosae, magnae. Stamina 8-9, 5 exteriora filamentis liberis, 3-4 interiora filamentis plus vel minus alte connatis. Flores feminei ignoti.

Mowbray River, in rain-forest, L. J. Brass, No. 2019 (male flowers, 23rd January) (very showy large shrub, leaves shining above, paler beneath and rather fleshy in texture; showy white flowers 1·5 cm. across when expanded).

The genus has not previously been recorded for Australia. Though only male flowers are known, there seems no doubt of the plant belonging to Dimorphocalyx, though it has apparently fewer stamens than others previously described. It is highly desirable that female flowers and fruit of this interesting addition to the Australian flora should be obtained.

**Euphorbia prostrata* Ait. Hort., Kew 2, 136 (1789).

Common about Brisbane on gravelled roads and footpaths, also a common farm and garden weed, C. T. White; Laidley, C. T. White; Townsville, a common weed, C. T. White; Proserpine, Rev. N. Michael; Fernlees, Central Queensland, J. Garvey; Torrens Creek, C. T. White, No. 8793 (prostrate on sandy soil) ; Rosedale, L. G. Dovey, fairly common in yards and gardens about the township; May's Creek, Gympie, V. Cross, common weed in banana farms; Cloncurry, J. Legg, suspected of causing deaths of rams imported from New South Wales.

A common tropical weed now very common in Queensland. It has probably been established here for some years, but in the past was confused with *E. Drummondii* Boiss. A record by W. F. Blakely in Proc. Linn. Soc., N.S.W., Vol. XLVII., p. xxxi., of *E. prostrata* Ait. from New South Wales, induced me to examine the *Euphorbia* material in our collections. We also have specimens from Lautoka, Fiji, collected by W. Greenwood, and the plant recorded as a form of *E. Drummondii* Boiss. by me in these Proceedings, Vol. XXXIV., p. 40, for Papua, belongs here.

Phyllanthus Brassii sp. nov.

Frutex glaber ca. 60 cm. altus; ramulis robustis angulatis ruguloso-striatis. Folia breviter petiolata, coriacea, lanceolata vel elliptico-lanceolata, utrinque nitida et valde reticulata, margine leviter incrassata et recurva; lamina 4·6·5 cm. longa, 1·5-2·5 cm. lata; petiolo incrassato, 2-3 mm. longo. Flores masc.: axillares fasciculati, pedicellis gracilibus, ca. 1 cm. longis; sepalis 4, oblongo-ovatis 2 mm. longis, 1·25 mm. latis; disco crasso alte 4-lobato; staminibus 2, filamentis liberis crassis applanatis sub antheros valde dilatatis; loculis antherarum divaricatis longitudiner dehiscentibus. Flores fem.: axillares, pedicellis ca. 1 cm. longis subvalidis apicem versus leviter incrassatis, sepalis perfectis non visis, ovario 3-lobo, stylis 3, alte bilobis, lobis valde recurvis.

Thornton Peak, alt. 4,000 ft., in low scrub near the summit, L. J. Brass, No. 2303 (male and female flowers), 14th March (bush, about 2 ft. high, leaves thick and coriaceous, smooth and shining on both sides).

A very distinctive plant, very dissimilar in appearance from previously described Australian species, and without any close affinities with any of them.

According to the account of the genus by Pax and Hoffmann in the "Pflanzenfamilien" (second edition), Vol. 19 c., pp. 60-66, I should place *P. Brassii* in Section XXV., Eriococcodes, Muell. Arg.

Phyllanthus tenellus Roxb., Fl. Beng. 69 (1814). *P. brisbanicus,* F. M. Bailey, Queens. Fl., V. 1418 (1902).

This plant, a native of Madagascar, but now naturalised as a weed in most tropical and subtropical countries, is a very common weed in Queensland, growing in shady places, such as along fences, in bush-houses., &c. It was named provisionally by F. M. Bailey, l.c., as *P. brisbanicus,* though he doubted whether it was really a native. As I was under the impression that it was an alien here, specimens of the type were forwarded to the Director, Royal Botanic Gardens, Kew, and were examined by Mr. V. S. Summerhayes, who reported:—"The type specimen of *P. brisbanicus,* F. M. Bailey, agrees perfectly with *P. tenellus* Roxb., apparently a native of Madagascar, and found as a weed in Mauritius, Seychelles, &c."

Order Orchidaceae.

Dendrobium bigibbum Lindl. var. *Georgei* n. var.

Planta robusta; flores 4·5-5 cm. diam. atro-violacei vel purpurei venis intensius coloratis; labelli discus tuberculorum atro-violaceorum 5-lineis distinctis notatus; lobo intermedio apiculato.

Australia: Dayman Island (?), Torres Strait.

Described from cultivated specimen grown by Mr. H. J. Hockings, Brisbane, and named at his request after Mr. J. George, who first found the variety.

The present variety is distinguished from typical *D. bigibbum* Lindl. by the dark-coloured (not white) calli on the disk of the labellum. The calli are perhaps not quite so prominent as in typical *D. bigibbum,* and on this account appear to be in more definite rows. The end of the labellum in *D. bigibbum* varies from emarginate to minutely apiculate.

Probably a hybrid between *D. bigibbum* Lindl. and *D. superbiens* Reichenb., as in growth it is intermediate between the two, being much more robust than typical *D. bigibbum* or *D. bigibbum* var. *phalaenopsis.* The above describes the typical form, though since the description was drawn up I have seen some slight colour variations, principally in the lines of tubercules on the disk being lighter in colour.

Dendrobium teretifolium R. Br. car. *album,* var. nov.

Racemi ca. 12 cm. longi ad 15-flori. Flores magni. Sepala petalaque alba; mentum albo-cremeum. Labellum in parte superiore candidum, in parte inferiore albo-cremeum et parce purpureo-maculatum.

Racemes mostly about 12 cm. long, up to 15-flowered. Flowers large. Sepals and petals pure white, 4 cm. long; mentum very pale cream. Labellum pure white in the upper part, very pale-cream in the lower, and marked with a few purple spots. Column coloured and marked similarly to the labellum.

Mount Spec, North Queensland, B. D. Grimes (flowered under cultivation, 6/10/1933).

Differs from the typical form in the sepals and petals lacking any purple marking. A very beautiful form, distinctive enough, I think, to bear a varietal name.

Eulophia Carrii sp. nov.

Herba terrestris aphylla. Rhizoma carnosa 3-3·5 cm. crassa. Scapus robustus cum racemo ca. 50 cm. altus in parte inferiore vaginatus; vaginis ad 6 cm. longis, submembranaceis. Racemus 18 cm. longus. Flores atrovinosi; bractea membranacea, lineari ovario breviore. Sepala elliptico-lanceolata, acuminata, 2 cm. longa, 1 cm. lata. Petala sepalis minores, breviter et obtuse acuminata. Labellum cremeum (?), rubro-vel purpureo-venosum, petalas fere aequante, trilobum, lobis lateralibus rotundis, lobo intermedio latis ad apicem acuminato, acumine ipso incurvo; disco 2-carinato, carinis in lineas indistinctas valde pupillosas desinentibus; calcare brevi. Gynostemium flavo-virens, 1·3 cm. alta; anthera leviter biloba; polliniis suborbicularibus.

Rhizome horizontal, fleshy, with a fresh "potato" smell when cut, 3-3·5 cm. thick. Leaves none (?). Flowering scape robust, including the flowering portion 50 cm. or more high, 1·5 cm. thick at the base, sheathed at the base for about 10 cm. with brown submembranous bracts, the bracts themselves up to 6 cm. long. Raceme 18 cm. long. Flowers dark vinous purple or vinous red. Floral bracts membranous, linear, shorter than the ovary. Sepals elliptic-lanceolate, acuminate, 2 cm. long, 1 cm. broad. Petals smaller and more shortly and bluntly acuminate. Labellum cream (?) with dark-red veining, almost the same length as the petals, produced behind into a short obtuse spur, 3-lobed, nearly as broad as long, lateral lobes broad, rounded, middle lobe broad with an incurved, very shortly acuminate apex; disk with two more or less distinct keels radiating out on the middle lobe into several indistinct lines of crowded, stellate papillae. Column yellowish-green, 1·3 cm. high, the foot slightly stained or streaked with reddish-purple. Anther shallowly 2-lobed at the apex; pollinia suborbicular.

Julatten, North Queensland; T. Carr.

The present species is easily distinguished from the two previously-described Queensland leafless species of *Eulophia* by its dark vinous purple flowers.

Order PALMAE.

Bacularia intermedia sp. nov.

Palma parva 1·25 m. alta; caudice laevi annulato. Folia petiolata 2-4-juga; petiolo cum rhachide 25-50 cm. longo, petiolo ipso 13-40 cm. longo, basi in vaginam dilatato, vaginis apice bilobis et demun in fila marcescentibus; segmentis chartaceis oppositis vel alternis linearibus vel lineari-oblongis in foliis adultis 25-30 cm. longis, segmentis lateralibus in latitudine saepe valde inaequalibus, angustioribus uninervis, 1-1·5 cm. latis latioribus 5-8-plicato-nervosis 2·5-4 cm. latis; apice acutis et valde obliquis, margine superiori integris, margine inferiori apicem versus inciso dentatis; segmentis terminalibus basi confluentibus apice inciso-dentatis oblique truncatis 4·5-6 cm. latis. Spicae erectae densiflorae interfoliaceae ca. 20 cm. longae pedunculatae; pedunculis in fructu elongatis ad 50 cm. longis; spatha completa subpersistenti. Alabastra juvenilia modo visa, subglobosa. Fructus cylindricus aurantiacus 1·2 cm. longus. Sepala sub fructu rotunda 1.5 mm. diam.; petala rotunda apice breviter et obtuse acuminata 2·5 mm. diam.

Mowbray River, alt. 1,000 ft., in rain-forest; L. J. Brass, No. 1975 (type: very young flower buds and immature fruits), 21st January (a forest floor plant up to 4 ft. high; lower stem smooth, mottled and ringed with old leaf-scars, a few dead leaf-sheaths persistent below living foliage; inflorescence axillary, erect, spathes persistent long after opening). Daintree River, in rain-forest; L. J. Brass, No. 2214 (a few ripe fruits), 29th February (slender palm 2-4 ft. high, ripe fruits orange-coloured). Kuranda, C. T. White, No. 1550 (leaves only), 28/2/1922.

The genus Bacularia as now understood is represented in Queensland by six species, which fall naturally into two groups: the minor group, consisting of *B. minor* F.v.M., and the very closely allied *B. microcarya* Domin and *B. aequisegmentosa* Domin, palms characterised by possessing all similar and narrow segments; and the *monostachya* group, consisting of *B. monostachya* F.v.M., *B. Palmeriana* F. M. Bailey, and the present species. The differences between the various species of Bacularia are rather difficult to follow, and the following key is therefore given, showing the intermediate position of the species here described between *B. Palmeriana* F. M. Bailey and *B. monostachya* F.v.M. This group is characterised by possessing either all broad-leaf segments or broad and narrow segments on the same leaf. In the latter case the terminal pair is always very much wider than the lateral ones and markedly incise-dentate at the apex.

Leaves with only two pairs of comparatively short and broad segments (very rarely a single intermediate segment on one side of the rachis). Petiole 8-15 cm. long .. *B. Palmeriana*

Leaves with 2-4 opposite or alternate segments on either side of the rachis. The intermediate segments and sometimes the lowest pair much narrower than the uppermost. Spikes upright. Petiole 13-40 cm. long, very early quite glabrous .. .. *B. intermedia*

Leaves with 4-12 (usually 5-6) opposite or alternate, very dissimilar segments. Most of the intermediate and lower pairs narrower than the uppermost, but usually at least one pair nearly as wide. Spikes soon curved, at length pendent. Petiole 11-22 cm., stout, furfuraceous .. *B. monostachya*

Order GRAMINEAE.

Glyceria Fordeana F.v.M.

Darling Downs district: Yelarbon. S. L. Everist, No. 917, 19/12/1934 slender grass in shady situations beneath *Melaleuca* trees. Stems pale, panicle branches spreading. Growing in heavy white clay soil associated with *Carex* sp.

Not previously recorded for Queensland.

I am indebted to Mr. S. T. Blake for kindly comparing the specimens collected with type material at the National Herbarium, Melbourne.

Essential Oils from the Queensland Flora—Part VI. —*Eremocitrus glauca.*

By L. F. Hitchcock, M.Sc., and T. G. H. Jones, D.Sc., A.A.C.I.

(*Read before the Royal Society of Queensland, 26th August,* 1935.)

Eremocitrus glauca is a small to medium sized tree abundant in parts of New South Wales and Queensland, stretching from near the coast at Marmor, in Central Queensland, westwards almost to the South Australian border. Northwards it extends as far as Charters Towers (Queensland) and southwards to the neighbourhood of Dubbo (New South Wales). In its young stages it is a thorny, intricately branched, almost leafless shrub, but this character changes as the tree develops. The adult trees are leafy, the leaves being somewhat leathery in texture, of a greyish-green colour, and mostly 1-1½ inches long; the small flowers are borne in clusters in the leaf-axils, and the berries are about the size and shape of an average marble. It is mostly known as "Wild Lime," or "Wild Kumquat," sometimes as the "Desert Lime," though this last is rather a misnomer, as the tree thrives best in country with a rainfall of 23-34 inches.

Supplies of leaves with occasional green fruit attached, obtained from Dalby, collected by the Forestry Department, on distillation gave a yield of oil approximately ·4 per cent. The odour of the oil was pleasant, but in no way resembling oil of lemon, which is, however, a product from the rind of the latter fruit and not the leaves.

The principal constituent of the oil was found to be d-α-pinene 60-70 per cent. with nonylic aldehyde 12 per cent. and sesquiterpene as important minor constituents. Other minor constituents were nonoic acid (free and combined), isovaleric acid (combined), p-cymene, linalol, a trace of phenolic bodies (probably eugenol and another crystalline substance), and a trace also of citral. The higher boiling fractions of the oil contained a constituent which readily resinified on heating, thereby rendering isolation of minor constituents difficult. Some evidence was obtained of the presence of dipentene in small amounts and of an alcoholic body which occurred along with linalol, probably nonyl alcohol. It was not found possible definitely to characterise these and possibly other minor constituents present in the oil with the supplies available, and as the oil does not appear to possess economic value, it was not considered advisable to obtain further supplies of leaves owing to the relatively high cost of collection.

Experimental.

The oil, of which 700 ccs. were available for investigation, was found to possess the following constants—little variation being noticeable in samples of oil from different localities and collected at different periods of the year:—

$d_{15 \cdot 5}$ = ·8686

$[\alpha]_D$ + 14

N^D_{20} 1·4691

Acid number 7

Ester value 19

Acetyl value (including acid number and ester value) 50.

Aldehyde content (hydroxylamine method) 12 per cent. (expressed as nonylic aldehyde).

The oil 600 ccs. was washed with—

(*a*) Dilute Na_2CO_3 solution.
Nonoic acid (1 c.c.) was recovered and identified (as subsequently described).

(*b*) 4 per cent. NaOH solution.
A trace only of phenolic bodies was recovered. The smell strongly suggested eugenol, but a few crystals were slowly deposited on standing.

After washing, the oil was submitted to hydrolysis by refluxing with dilute alcoholic sodium hydroxide solution. From the alkaline liquor after removal of the oil, isovaleric and nonoic acids were obtained, separation being effected by fractional distillation of the ethyl esters. Isovaleric acid was identified by means of its characteristic silver salt (Ag = 51·5 per cent.), and nonoic acid was identified by means of analysis of its silver and barium salts. (Found Ag = 40·4 per cent. Ba = 30·4 per cent.)

The amide of the acid prepared in the usual way, melted at 99·5° C.

The oil recovered from the hydrolysis was next treated with a solution of sodium sulphite and sodium bicarbonate[1]. A voluminous deposit of the sulphite compound soon filled the liquid, the separation of which from unchanged oil presented considerable difficulties. The crystals were finally collected on the filter, pressed free as far as possible from liquid impurities and then washed with ether. The crystals, on decomposition in the prescribed manner with sodium hydroxide, gave a liquid possessing the physical constants of nonyl aldehyde.

$d_{15 \cdot 5}$ = ·8290 N^D_{20} = 1·4300

b.p. 195°–197° C. (Found C. = 75·6 H = 12·5)

Oxidation with acetone permanganate gave nonoic acid (identified as recorded above).

The semicarbazone prepared in the usual manner had a somewhat low melting point (95° C. in lieu of 100° C.), indicating a somewhat impure nonyl aldehyde, a result in agreement with the recovery of a small amount of unidentified liquid, presumably a ketone, which had not been attacked, from the acetone permanganate oxidation.

The sulphite liquor, obtained after removal of the crystalline nonyl aldehyde compound, was washed with ether and carefully decomposed with sodium hydroxide. A very small quantity of liquid separated, which possessed the strong smell of citral. Although too small to identify in the usual way, it gave the characteristic colour reaction of citral on treatment with benzidine acetic acid solution[2], and there could be little doubt of its identity with citral. It is possible that the occurrence of citral in minute quantities in the oil was due to the presence of a few small immature fruit attached to the leaves used for the original steam distillation, citral being the important constituent of the rind of citrus fruits.

The oil, 400 ccs. free from aldehydes, was then fractionally distilled under diminished pressure, the following fractions (with several intermediate fractions) being ultimately obtained. It was found impracticable to push the fractionation of higher fractions too far owing to pronounced loss due to resinification. Fractions (*a*), (*b*), and (*d*) were finally distilled over metallic sodium:—

(*a*) 250 ccs. b.p. 155° C.

$d_{15 \cdot 5}$ ·865 $[\alpha]_D$ = + 27

N^D_{20} 1·4658

This fraction, which comprised the bulk of the oil, consisted of d-α-pinene.

The nitrosyl chloride melted at 104° C., and on oxidation pinonic acid (melting point of semicarbazone 200° C.) was obtained.

No evidence was obtained of the presence of β-pinene.

(*b*) 15 ccs. b.p. 173°–178° C.

$d_{15 \cdot 5}$ ·8529 $[\alpha]_D$ + 1

N^D_{20} 1·4780

This fractionation was stable to Beckmann's chromic acid mixture in the cold, thus indicating the absence of terpinene. No solid derivatives could be prepared—dipentene was suspected, but the characteristic crystalline tetrabromide could not be obtained and the amount of bromine combining with a portion of the fraction was less than half that theoretically indicated for dipentene. The presence of p-cymene was confirmed by removal of terpene with cold permanganate and oxidation of the recovered oil with hot permanganate in the prescribed manner[3], p-hydroxy isopropyl benzoic acid (M.P. 155° C.) being formed.

P-cymene apparently comprised the bulk of the fraction, but the authors are of the opinion that some dipentene was present, although definite confirmation was rendered impossible owing to the small amount of the fraction separable in a pure condition from fraction (*a*). The density of the fraction, which was lower than that either of cymene or pinene, confirmed this view.

(*c*) 15 ccs. b.p. 220-235° C.; 95°-100° C. 5 mms.

$d_{15 \cdot 5}$ ·9121 $[\alpha]_D$ = − 13

N^D_{20} 1·5001.

This fraction possessed a pleasant rose-like odour. It gave, however, the usual bromine acetic acid test for sesquiterpene and combustion analysis indicated some 40-50 per cent. sesquiterpene.

Extraction with phthalic anhydride in boiling benzene solution gave only a very small quantity of acid phthalate, from which was recovered 1 cc. of alcohol, with the following constants:——

b.p. 200–210° C.

$d_{15 \cdot 5}$ ·859; $[\alpha]_D = 0$; $N_{20}^{D} = 1{\cdot}43$

The constants suggested a primary aliphatic alcohol and in particular nonyl alcohol, although the density of that alcohol is ·940. The alcohol readily reacted with phenyl isocyanate, but the melting point was not recorded owing to accidental loss. The results indicated that the oil contained only very small amounts of primary alcohols.

The fraction recovered from the phthalate extraction possessed constants—

$d_{15 \cdot 5}$ ·923; $[\alpha]_D = -10$; N_{20}^{D} 1·4805

The presence of linalol was indicated by oxidation with chromic acid and testing for citral with benzidine acetic acid solution—positive tests (not shown by the original liquid) being obtained.

Final attempts to extract the alcohols from the fraction with metallic sodium in dry ether solution gave only about 1 cc. of alcohol, probably linalol, while the recovered liquid still possessed the original pronounced laevo rotation and did not react with phenyl isocyanate. Combustion results still indicated sesquiterpene mixed with oxygenated derivative, but further examination was prevented by absence of sufficient material.

(*d*) 15 ccs. b.p. 110–115° C. (5 mms.).

$d_{15 \cdot 5}$ ·9236 $[\alpha]_D$ + 6

N_{20}^{D} 1·4940

Combustion results indicated sesquiterpene and the bromine acetic acid colour reaction was most pronounced.

No solid derivates could be obtained and the sesquiterpene did not appear identical with any known sesquiterpene.

The authors wish to express their thanks to Mr. C. T. White, Government Botanist, and officials of the Forestry Department for their usual courteous assistance.

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[1] Compare Hibbert and Cannon, J.Am.C. Society, Vol. 6, 1924, page 121.

[2] Van Eck. Pharm. Weekbl., 1923, 60, 1204.

[3] Gildemeister and Hoffman, Vol. I., p. 284.

Vol. XLVII., No. 7.

Notes on Some Pasture Problems of Western Queensland.

By S. T. Blake, M.Sc., Walter and Eliza Hall Fellow in Economic Biology, University of Queensland.

(*Read before the Royal Society of Queensland, 26th August,* 1935.)

The grazing lands of Queensland form one of the State's greatest assets, and on their condition depends to a great extent the prosperity of this country. In many districts, unfortunately, these lands have deteriorated very considerably. The deterioration is brought about either by the more or less complete disappearance of edible plants or by the replacement of palatable species by less palatable species. In the latter type species of *Bassia* are very prevalent. This genus is widely spread in Queensland, and is represented by numerous species. Many of these assume considerable importance either as fodder plants or as weeds. There follow below some notes on this and some related problems gleaned from a field study in many parts of Queensland during the past two years.

Bassia Birchii (galvanised burr or camel burr) has received considerable publicity of late. Although originally described from the Longreach district, it is now impossible to say where was its original home. At present it is very widely distributed, chiefly on sandy soil or on stock routes. Only very rarely has it been noticed invading black soil paddocks, and then only when these paddocks have been heavily overstocked.

Quite diverse opinions are held as to its palatability, but certain it is that in some places, even where there was abundance of good grass nearby, it has been readily eaten by cattle, and has been known to be preferred to green pigweed (*Portulaca* sp.). But there is no doubt that in denuded pastures it serves a useful purpose as a soil binder and seed protector. An outstanding example of this came under observation in the Springsure district. A paddock which had been rather heavily overstocked had been invaded by the burr, which soon took complete possession. The paddock was then spelled, and shortly after one of the more useful star grasses, *Chloris divaricata,* made its appearance and gradually replaced the *Bassia.* The replacement is not yet complete, but it seems only a matter of a brief time before the burr will have completely disappeared, even with comparatively light stocking.

Bassia bicornis (Goathead) is a species frequently confounded with galvanised burr on account of its very white appearance and rather similar habit. It is, however, easily distinguished by the narrow leaves common to most *Bassias* and the large two-spined "burr" (fruit). In *B. Birchii* the leaves are exceptionally broad and flat, and the fruit has five irregular spines, much shorter than in *B. bicornis.* Goathead is fairly abundant on the so-called "black soil" downs between Winton and Boulia, particularly near the latter town, where the over-grazed country has been thickly coated with sand deposited by dust storms.

Bassia longicuspis is a species which is likely to become a very great pest in some districts. So far as observed at present, it is confined to very stony ground. It is much more woody than the preceding species, and the fruits have stout rigid spines up to 1½ inches long. It is not likely to be eaten except when very young. Near Quilpie, where it is known as Pinkilla burr, it occurs in boree country, and has spread with alarming rapidity within the last three years; and it is stated that no horse will pass through badly-infested country. It has also been observed as being very common west of Winton and near Emmet, where it has apparently but recently arrived. In both these areas it is associated with gidgee. It has been recorded from near Longreach. There seems little doubt that it came from further west and may not be truly indigenous in Queensland. It was first collected in Queensland in 1914, near Longreach.

Bassia quinquecuspis (roly-poly) is more noticeable on heavily stocked or definitely over-grazed country. It is an annual, and becomes a nuisance from the fact that the dead plants readily become detached from the ground and are bowled over the ground by the wind until they are piled against fences or become lodged in bore-drains, which soon become blocked up. The species seems almost to be confined to heavy soils, and like most other species is more common in the southern and central parts of the State than in the north.

Of the more useful species, *B. anisacanthoides* and *B. echinopsila* are characteristic of eaten-out Mitchell grass pastures of the south-west and central-west. They are nearly always associated with *Threlkeldia proceriflora* and *Atriplex Muelleri* (annual salt bush).

These *Bassias* are low-growing rather succulent plants with small short-spined fruits, and are reported to form with the *Threlkeldia* and *Atriplex* an excellent fattening pasture. As the *Bassias* and *Threlkeldia* are almost indistinguishable without examination of the fruits, it is difficult to form any real opinion as to the forage value of the individual species.

It is commonly stated that over-stocking is chiefly responsible for pasture deterioration, and in a sense this is completely true. In times of severe drought almost any stocking is over-stocking. Rabbits, marsupials, and emus play a big part in eating out existing forage, but there is another factor—that of seed destruction—which is frequently overlooked, and which is largely responsible for the failure of a pasture to regenerate even under favourable conditions. Galahs play a major part in this seed destruction. Another factor is grain abortion, or failure to set seed. It has been no uncommon experience for the writer to observe apparently full heads of Mitchell grass which, when examined, proved to contain a large proportion of aborted grain. Similar cases have been observed in other grasses, notably in the genera *Aristida, Panicum,* and *Iseilema* (Flinders grass).

It is probable that this abnormality is due to the plants having received sufficient rain to induce flowering, but then, owing to extreme heat or lack of further effective rain, the grain did not mature. It should be realised that rainfall averages are frequently very misleading. It is not the total rainfall in any given period that matters, but when and how that rain falls. In no district is it yet known with certainty what is the minimum effective fall—i.e., what is the smallest fall of rain which will produce a definite positive response in the vegetation. It is, however, quite certain that under certain circumstances rain can do more harm than good. Light showers in winter, for instance, while insufficient to induce new growth, invariably cause Mitchell grass and Flinders grass to "blacken." The leaf becomes distinctly dark in colour, crumbles when touched, and is rendered quite unpalatable. The pasture is thus destroyed. Good winter rains, however, promote in many districts the growth of "herbage," which is considered a better fattening pasture than dry Mitchell grass.

Another factor which militates against a good recovery after a dry spell is the practice of allowing stock access to a pasture before what young growth there is has had time to become firmly established. The result is that these plants are destroyed before maturity, and thus there is no seed left to regenerate the pasture.

Many of these problems, including that of galvanised burr, could be mitigated, if not completely avoided, by attention to a few points. On any run there are two sources of water supply—"temporary water" and "permanent water." On most runs at least little appears to be done to make the maximum use of the "temporary water." It is suggested that if tanks, permanent waterholes, river frontages, and the like were fenced off and stock were forced to water at the temporary holes while these lasted, not only would the temporary water be used to the best advantage but also the pasture about the permanent holes and frontages would be given a chance to recuperate, and when stock had to be removed from the failing temporary water they would come on to really good pasture.

Further, if the water were pumped from the permanent sources into troughs there would be no risk of beasts being bogged, the water would be cleaner, and there would be much less chance of the holes silting up. A further aid in keeping a pasture up to standard, or in improving a depleted pasture where artificial sowing is impracticable is suggested as follows:—

In each paddock one or more narrow strips might be fenced off at right angles to the direction of the prevailing wind. The strips need not be very long ones, but care should be taken that they are animal-proof. K-wire or netting would be preferable. This strip serves as a natural nursery, the seed being dispersed by the wind. A few such nurseries scattered about the run would be of immense value in keeping up a regular seed supply.

In conclusion, the fact must be stressed that conditions vary so much in different districts that it is difficult to generalise on any pasture problem. For the complete elucidation of every problem, it would be necessary to study each district over a long period of years, and would need the close co-operation of a large number of workers, both resident and travelling, including ecologists, pedologists, meteorologists, entomologists, veterinarians, and practical experienced graziers.

Essential Oils from the Queensland Flora—Part VIII.—The Identity of Melaleucol with Nerolidol.

By T. G. H. Jones, D.Sc., A.A.C.I., and J. M. Harvey, B.Sc.

(*Read before the Royal Society of Queensland*, 14*th November*, 1935.)

During the course of their investigation of the essential oils from Australian Melaleucas Smith and Baker[1] isolated from the higher fractions of *Melaleuca Smithii* an alcohol, $C_{15}H_{26}O$, to which the name melaleucol was given. This alcohol, from consideration of physical constants, was adjudged to closely resemble nerolidol, a sesquiterpene alcohol already known occurring in neroli oil, the oil from the fresh flowers of the bitter orange (*Citrus Bigardia*, &c.). The chemistry of nerolidol had not, however, been sufficiently investigated to admit of definite proof of the identity of melaleucol with nerolidol. During the course of an investigation, now in progress, of the oil from a variety of *Melaleuca viridiflora* we have isolated the same alcohol in considerable quantity, and have been able to prove the identity of melaleucol with nerolidol. The name melaleucol is therefore unnecessary.

The chemistry of nerolidol is closely connected with that of the isomeric alcohol farnesol, and the constitutions of these alcohols are represented by the following formulae:—

1. $$CH_3-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH-CH_2-CH_2-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH-CH_2-CH_2-\overset{\displaystyle OH}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}}-CH=CH_2$$

nerolidol

2. $$CH_3-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH-CH_2-CH_2-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH-CH_2-CH_2-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH-CH_2OH$$

farnesol

It was demonstrated by Ruzicka that under the influence of acetic anhydride nerolidol is isomerised to farnesol in a manner analogous to the well-known linalol geraniol change, thereby losing its optical activity. Farnesol may be characterised by oxidation to an aldehyde farnesal and preparation of the semicarbazone. Nerolidol, similarly, may be oxidised by chromic acid to farnesal. We have succeeded in carrying out a similar series of changes with the alcohol "melaleucol," and have prepared farnesol, farnesal, and farnesal semicarbazone, possessing properties identical with those recorded in the literature for these substances.

EXPERIMENTAL.

The physical constants of melaleucol isolated by us were as follows, those of nerolidol being given for comparison:—

	melaleucol.	nerolidol (from Neroli oil).
$d_{15 \cdot 5}$	·8816	·880
N_{20}^{D}	1·4795	1.4802
b.p.	110°C (3 mms.)	125 (4.5 mms.)
$[\alpha]_D$	+14	12.48

On treatment with acetic anhydride and isolation of the product the optical rotation was found to be nil. In order to isolate a pure sample of farnesol the oil was hydrolysed to decompose the acetate, and farnesol extracted as its acid phthalate, from which farnesol was isolated by hydrolysis.

The following constants were observed:—

$d_{15 \cdot 5}$	·8956
N_{20}^{D}	1·4901
$[\alpha]_D$	·0

These are in close agreement with those recorded in the literature for farnesol.

Oxidation of—

(*a*) Melaleucol 10 grammes

(*b*) The farnesol obtained above, 10 grammes,

with chromic acid (4 grammes) in acetic acid solution gave in each case a liquid possessing all the characteristics of an aldehyde. Identity with farnesal was demonstrated by consideration of physical constants [$d_{15 \cdot 5}$ ·891; N_{20}^{D} 1·4986] and preparation of the semicarbazone M.P. 133° C.

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[1]SMITH and BAKER, 1913: Royal Society of N.S.W., Vol. xlvii., pp. 207-208.

ERRATA.

A Review of Queensland Charophyta, by James Groves, completed by G. O. Allen. These Proceedings Vol. XLIV. (4), 34-59, 1934.

Mr. Allen did not have an opportunity of reading the proofs of this paper. The following alterations are necessary:—

Contents page—for H. J. Groves read J. Groves; p. 34, 10 lines from bottom—for 14,000 read 15,000; p. 36, line 8—for six read sixty; p. 38, last line—for fig. 2 read fig. 1b; p. 39, top line—for fig. 3 read fig. 1c; p. 39, line 24—for fig. 4 read fig. 1d; p. 39, line 28—for fig. 5 read fig. 1e; p. 39, line 30—for fig. 6 read fig. 1f; p. 40, last four paragraphs should be arranged as on separate slip; pp. 40 and 41, key to species 3-18 should be arranged as on separate slip; p. 41, line 10—for *comptonii* read *Comptonii;* p. 41, line 17—for *oligospora* read *oligospira;* p. 42, line 13 from bottom—for oosporte read oospore; p. 43, line 2—for Queensland, pl. read Queensland Pl., for 1, c read l.c.; p. 43, line 19—for fig. 7 a-c read fig. 2 a-c; p. 44, line 12 from bottom—for Coc. read Soc.; p. 45, line 4—mucosa should be in italics; p. 46, line 2—for 1 c read l.c. and for fig. 8 a-e read 3 a-e; p. 46, line 3—for *Complonii* read *Comptonii;* p. 47, line 13 from bottom—for 1 c read l.c.; p. 47, line 15 from bottom—for *Microcarpa* read *microcarpa;* p. 48, line 2—for Those read Three; p. 48, line 10—for *Orientalis* read *orientalis;* p. 48, line 12—for 1 c read l.c.; p. 48, line 27—for *Furcata* read *furcata;* p. 48, line 2 from bottom—for *Myriotricha* read *myriotricha;* p. 49, line 1—for 1 c read l.c.; p. 49, line 21—for *Diffusa* read *diffusa;* p. 49, line 23—for 1 c read l.c.; p. 49, line 2 from bottom—for *Cristata* read *cristata;* p. 50, line 2—for 1 c read l.c.; p. 50, line 8—between crest and membrane insert a semicolon; p. 51, line 13—for 1 c read l.c.; p. 51, line 19 from bottom—for *hookeri* read *Hookeri;* p. 51, line 16 from bottom—for 1 c read l.c.; p. 52, line 2—for *lhotzkyi* read *Lhotzkyi;* p. 52, line 21—for 1 c read l.c.; p. 52, line 15 from bottom—for septenrionalem read septentrionalem; p. 53, line 20—for *stuartii* read *Stuartii;* p. 53, line 7 from bottom—for *stuartii* read *Stuartii;* p. 55, lines 8 and 9—for *braunii* read *Braunii;* p. 56, line 9—for *preissii* read *Preissii;* p. 56, line 21—for *preissii* read *Preissii;* p. 57, line 15 from bottom—for Sipulodes read Stipulodes; p. 57, line 14 from bottom—for DIPLOSTACHÆ. *Corticla-cells* read DIPLOSTICHÆ. *Cortical-cells;* p. 58, line 21—for 1 c read l.c.; p. 59, line 19 from bottom—for Prodomus read Prodromus; p. 59, lines 11 and 12 from bottom should be transposed; p. 59, line 7 from bottom—for Act, read Act.; p. 59, line 2 from bottom—insert inverted commas before Australasian.

(PAGES 40, 41.)

KEY TO CERTAIN SPECIES OF NITELLA.

Gymnocephalous (young fruiting heads not enveloped in mucus).

Rays at second forking of branchlet usually 2-3 (rarely 4), the rays at each forking usually conspicuously unequal. Apical cells shortly conical .. .. 3. *N. phauloteles.*

Rays at second forking of branchlet 4 or more, the rays at each forking usually about equal. Apical cells long, conical .. .. 4. *N. pseudo-flabellata.*

Glœocephalous (young fruiting whorls enveloped in a cloud of mucus).

Homœomorphous (having the fruiting whorls similar to the upper sterile whorls). Branchlets usually 3-times forked .. .. 5. *N. mucosa.*

Heteromorphous. Branchlets of fruiting whorls much shorter than those of the sterile whorls and usually forming definite clusters.

Branchlets twice forked, 3-5 rays at each forking; oospore 310-350 μ long, membrane "thickly dotted with small acute elongated spines" .. .. .. 6. *N. leptosoma.*

Branchlets usually 3-times forked; fertile whorls often forming small spherical heads. Oospore c. 300 long, membrane finely granulate .. .. 7. *N. Comptonii.*

Dactyls (or some of them) much abbreviated.

Uppermost node of branchlets almost always sterile .. .. *Brachydactylæ.*

Upper cells of coronula not conspicuously elongated.

Oospore membrane reticulate.

Oogonia solitary. Dactyls some abbreviated, some elongated .. .. 8. *N. oligospira.*

Oogonia clustered (2-3). Dactyls usually all abbreviated and divergent .. .. 9. *N. microcarpa.*

Oospore membrane tuberculate, Dactlys some abbreviated, some elongated .. 10. *N. orientalis.*

Upper cells of coronula (or some of them) conspicuously elongated.

Oogonia clustered. Dactyls all abbreviated and divergent. Membrane reticulate .. 11. *N. furcata.*

Dactyls all (or mostly) 3-6 celled .. .. .. PLURICELLULATÆ.

Dioecious.

Branchlets many (3-5) times forked.

Ultimate cell of dactyl ± cylindrical at base, acuminate at apex .. .. .. 12. *N. myriotricha.*

Sterile branchlets simple or once or twice forked, fertile 1-3 times forked.

Sterile and fertile whorls ± alike, the fertile, not forming dense heads. Ultimate cells of dactyls conical .. .. 13. *N. diffusa.*

Sterile and fertile whorls dissimilar, the fertile forming ± dense heads.

Oospore large (300-380 μ long) with very strong prominent ridges; membrane thick and decorated with tubercles .. 14. *N. cristata.*

Oospore small (200-270 μ long); membrane reticulate; fertile heads in mucus.

Fruiting whorls forming small dense very gelatinous heads. Ultimate cells of dactyls μ cylindrical, obtuse .. .. 15. *N. gelatinosa.*

Fruiting whorls forming comparatively loose heads. Ultimate cells of dactyls μ tapering, acute .. .. .. 16. *N. tasmanica.*

Oospore very small (160-180 μ long); five ridges. Mucus not conspicuous .. .. 17. *N. polycephala.*

Monoecious .. .. 18. *N. Hookeri.*

The Royal Society of Queensland.

Report of Council for 1934.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its report for the year 1934.

The first meeting of the year was the fiftieth anniversary of the inauguration of the Society, and a suitable programme was arranged for the occasion. Dr. C. F. Marks and Mr. J. H. Simmonds, who, with Mr. H. Tryon, were the only foundation members still alive, were unanimously elected Honorary Life Members.

Eleven original papers were accepted for publication in the Proceedings, and nine of these were actually read at ordinary meetings of the Society.

During the year the following lectures were delivered:—Dr. F. W. Whitehouse on "Some Geological and Geographical Problems of Central Australia"; Professor L. S. Bagster on "Heavy Water and the New Hydrogen"; Dr. L. G. Miles on "Some Recent Advances in Plant Genetics and Cytology"; Miss Ursula McConnell on "The Place of Drama and Ritual in Wikmunkan Society"; and Dr. J. Legg on "Tick Fevers (Piroplasmic Diseases) of Cattle in Queensland."

One evening was devoted to a discussion on the discovery and natural history of Moreton Bay, the leading speakers being Professors Cumbrae Stewart and Richards, and Messrs. J. Simmonds, H. A. Longman, and C. T. White.

Your Council takes this opportunity of thanking those who assisted in the above phases of the Society's work; those who provided the numerous exhibits which were displayed for the interest of members; the University of Queensland for housing the library and providing accommodation for meetings; and the Assistant Librarian of the University, Miss McIver, for superintending the lending of periodicals from the Library.

The resignation of Mr. L. F. Hitchcock, Honorary Librarian of the Society, was received at the end of the year, and the Council wishes to place on record its appreciation of his services to the Society during his term of office.

Again the Council reminds members that the Government subsidy has been withdrawn, and that the whole of the income is from subscriptions, and trusts that all members will endeavour during the year to get as many new members as possible, particularly from among professional workers who depend for their livelihood on a knowledge of science and scientific methods. It must be stressed that practically the whole of the income is utilised in the publication and distribution of the Proceedings.

Prof. H. C. Richards and Mr. E. W. Bick represented the Society at the A.N.Z.S. meeting which was held in Melbourne in January, 1935. At this meeting the following five members of the Society were the Presidents of their respective sections:—Prof. R. W. Hawken, Engineering and Architecture; Mr. J. B. Brigden, Economics, Statistics, and Social Science; Dr. J. V. Duhig, Medical Science and National Health; Prof. J. K. Murray, Agriculture and Forestry; and Dr. D. A. Herbert, Botany.

The membership roll consists of 3 honorary life members, 6 life members, 4 corresponding members, 179 ordinary members, and 4 associate members. During the year there were 6 resignations, one name was removed from the list under Rule 15, and 23 new members were elected. It is with deep regret that the death is reported of Professor Sir T. W. E. David, F.R.S., and Professor B. D. Steele, F.R.S., both of whom were old and valued members of the Society.

There were ten meetings of the Council during the year, the attendance being as follows:—L. S. Bagster, 6; E. W. Bick, 8; W. H. Bryan, 10; R. W. Cilento, 0; D. A. Herbert, 7; L. F. Hitchcock, 9; J. S. Just, 9; H. A. Longman, 4; F. A. Perkins, 10; H. C. Richards, 7; R. Veitch, 8; J. Vickery, 7; C. T. White, 6.

In terms of the amendment of Rule 19, Prof. H. C. Richards, Senior Member of the Council, automatically retires, but will be eligible for re-election in 1936.

J. S. JUST, President.

F. A. PERKINS, Hon. Secretary.

THE ROYAL SOCIETY OF QUEENSLAND.

STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDED 31st DECEMBER, 1934.

Cr. | Dr.

RECEIPTS.

	£ s. d.
Bank Balance, 31st December, 1933	72 10 4
Subscriptions	154 11 0
Sale of Reprints and Volume	8 9 2
Exchanges	0 8 0
Interest, Commonwealth Bank	2 12 10
Newnham College. England, Contribution towards Expenses, Dr. Dorothy Hill's Paper. Paid to Zinco Collotype Co., Edinburgh	10 0 0
	£248 11 4

EXPENDITURE.

	£ s. d.	£ s. d.
H. Pole and Co., Printing Abstracts and Receipt Books	..	3 10 11
H. Pole and Co., Balance Cost of 1933 Volume	..	31 9 4
Zinco Collotype Co., Edinburgh, Blocks and Printing Illustrations, Dr. Dorothy Hill's Paper	20 0 0	
Export Charges, Freight and Insurance	2 7 6	
		22 7 6
Zinco Collotype Co., Edinburgh, Exchange and Expenses of Draft for £12 7s. 6d.	..	3 3 6
Government Printer, Printing Abstracts and Annual Report	..	8 16 8
*Government Printer, On Account 1934 Volume	..	50 0 0
Hon. Secretary (Postages)	..	9 0 0
Hon. Librarian (Postages)	..	1 10 0
Hon. Treasurer (Postages and Duty)	..	1 0 0
State Government Insurance on Library	..	0 13 0
Lanternist	..	0 10 0
Cheque not Collected	..	0 12 0
Balance in Commonwealth Bank, 31st December, 1934	..	115 18 10
		£248 11 4

* This represents only part of the cost of publishing 1934 volume.

Examined and found correct.

A. J. M. STONEY, B.E.E., Hon. Auditor.

E. W. BICK, Hon. Treasurer.

Abstract of Proceedings, 25th March, 1935.

The Annual Meeting of the Society was held in the Geology Department of the University at 8 p.m. on Monday, 25th March. The President, Mr. J. S. Just, occupied the chair, and about forty members and visitors were present. Apologies were received from His Excellency the Governor, Drs. Bradfield, Duhig, and Graham Brown, and Messrs. Gurney, Gipps, Bick, and Morton. The minutes of the previous meeting were read and confirmed. Messrs. R. S. Mitchell, B.Sc.Agr., and T. H. Strong, B.Sc.Agr., for ordinary membership, and Miss L. Archibald for associate membership were proposed by Mr. Perkins and Dr. Herbert. The following were unanimously elected ordinary members of the Society:—Miss Ursula McConnell, M.A., Drs. Clifford Croll, Grahame Brown, and C. Thelander, and Messrs. J. Mann and St. G. Thorn.

The Annual Report and Balance-sheet were adopted.

The following officers were elected for 1935:—President, Mr. R. Veitch; Vice-Presidents, Mr. J. S. Just and Professor J. K. Murray; Hon. Treasurer, Mr. E. W. Bick; Hon. Secretary, Mr. F. A. Perkins; Hon. Librarian, Mr. E. A. O'Connor; Hon. Editors, Drs. W. H. Bryan and D. A. Herbert; Members of the Council, Professor L. S. Bagster, Dr. E. O. Marks, Mr. H. A. Longman, Dr. J. Vickery, and Mr. C. T. White; Hon. Auditor, Mr. A. Storey.

Mr. J. S. Just delivered his Presidential Address entitled "The Commercial Application on Scientific Research."

A vote of thanks to the retiring President, moved by Mr. Henderson and Professor Murray, was carried by acclamation.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 23rd April, 1935.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre, on Tuesday, 23rd April, at 8 p.m. The President, Mr. R. Veitch, occupied the chair, and about twenty members and visitors were present. Apologies were received from Drs. Bryan and Grahame Brown, and Mr. Weddell. The minutes of the previous meeting were read and confirmed. Messrs. R. S. Mitchell, B.Sc.Agr., and T. H. Strong, B.Sc.Agr., and Miss L. Archibald, B.Sc., were unanimously elected members of the Society.

Mr. H. A. Longman exhibited (*a*) The fossilised vertebra of a large fish, which had been found by Mr. John Struby in a sewerage tunnel at a depth of 30 feet below Davies Park, South Brisbane, at a distance of 40 feet from the shaft. When removed from the matrix, the structure and contours suggested a Teleost of at least 5 feet in length, comparable with a large groper. No definite age was suggested, but the condition of the fossil was similar to that in certain tertiary fishes. (*b*) The fossilised femur of a rodent collected by Mr. R. Frost at King's Creek, Darling Downs. The preservation in almost perfect condition of so small and fragile a bone had surprised Mr. Frost, who had collected many of the large extinct marsupials and reptiles from Diprotodon beds.

Mr. F. A. Perkins exhibited living glow-worms collected in a cave at Numinbah on the 21st April, 1935. They were the larvæ of a Mycetophilid fly belonging to the genus *Arachnocampa,* and had previously been recorded from Waitomo, New Zealand, and Bundanoon, New South Wales. They were numerous on the roof and walls of the cave, but only those in the darkest corners were glowing. A pair of adults collected on the roof of the cave were also exhibited. They agreed very closely with the description of the New Zealand species *Arachnocampa luminosa* Sk., differing only in the colour pattern of the thorax. In *A. luminosa* the thorax is black or very deep brown, with a median yellow stripe, whereas the specimens exhibited had a pale-brown thorax, and no yellow stripe. An examination of a longer series would probably prove that the Numinbah species was *A. luminosa.* Mr. Longman, in discussing the exhibit, mentioned that he had found similar glow-worms under a ledge at the foot of Mount Lindsay about twelve years ago.

Mr. W. T. Robertson read a paper entitled "The Significance of a pH Putrefactive Grade Test in Bacteriological Water Analysis." The so-called "pH putrefactive grade test" in water supply bacteriology shows itself superior to the routine lactose bile salt broth test in the detection of members of the Coli-Aerogenes group and other putrefactive bacteria. Test to be strictly one of forty-eight hours' duration for grading purposes. Waters may be graded according to the absence or presence of the various lactose fermenters per media of an adjusted lactose broth, and a pH reading after forty-eight hours' incubation at 37° C. Claims put forward in respect to investigations embodying test:—(*a*) Grading waters as to potability; (*b*) checking purification effect both in respect to filtration and chlorination; (*c*) checking potability of raw waters where treatment is being considered.

Dr. D. A. Herbert read on behalf of Mr. E. C. Tommerup, M.Sc., a paper entitled "Some Plant Geological Studies in South-Eastern Queensland." The paper was an account of the distribution of forest trees and their associations in South-Eastern Queensland, special attention being paid to the influence of environmental factors. The geology, soils, and topography of the areas was considered in detail, and recommendations for forest management and utilisation suggested. The paper was discussed by the President, Dr. Herbert, and Mr. Gipps.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 27th May, 1935.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University, on Monday, 27th May, 1935, at 8 p.m. The President, Mr. R. Veitch, occupied the chair, and about thirty members and visitors were present. The minutes of the previous meeting were read and confirmed. Mr. A. R. Riddle was unanimously elected a member of the Society.

The main business of the evening was an address by Dr. M. White entitled "Some Modern Aspects of Nutrition."

The lecturer dealt mainly with those more recent developments in animal nutrition with an economic rather than a purely biological interest.

After outlining the events which brought about the present intensive cultivation of types, the theme of feeding for maximum production was discussed.

The chief outcome of modern research in nutrition has been the solution of many "deficiency disease" problems which had previously made economic production impossible.

These so-called deficiency diseases are marked physiological reactions in the animal when insufficient amounts of certain nutrients are supplied in the diet.

Though these deficiencies are chiefly of minerals and vitamins, the problem of special protein deficiency also occurs.

A virtual type of deficiency is found in animals which have been so selectively bred for production that the ability to produce exceeds the powers of assimilation. This is common in very well bred dairy cows. So much lime, phosphorus, and protein is voided in the milk that even a high level of concentrate feeding does not prevent the animal from robbing her natural stores to meet the demand. Unless a liberal amount of concentrates is fed and the breeding regulated serious disturbances, resulting in disease, abortion, and possible sterility ensue.

Marked lime deficiency in a diet is soon reflected in the second generation. Weak or still-born offspring is common, and in the second or third reproduction abortion supervenes. Ordinary powdered limestone, bone-meal, or wood ashes remedies the fault.

Phosphate deficiency has a number of manifestations. Inability to fatten, brittle bones, rickets, poor digestion, and, in advanced cases, unnatural craving for bones, wire, tins, &c., are almost invariably ascribable to phosphate deficiency. Almost any phosphate will check these symptoms, but bone-meal is the only one which cures the specific craving for offal.

Iron deficiency is uncommon, but anæmia in young pigs is occasionally reported. In Queensland this trouble only occurs in ultra-clean sties. Relatively large doses of iron salts are required to restore health, but a trace of copper with the iron reduces the dosage to a fraction of a milligram daily.

The discovery of thyroxin—an iodine containing protein degradation product—induced a world-wide application of potassium iodide to livestock problems. It is quite safe to say that the expensive iodide foods advocated were without additional value. Iodine deficiency is very rare. Hairlessness and goitre in pigs are almost too rare to bear mention.

The extensive use of sulphur in concentrates has little or no scientific data to recommend it. There is, however, a real need for combined sulphur in protein form. Sulphur containing proteins exert a beneficial effect on wool production. In Australia evidence of this is being obtained from merino sheep studies, and its commercial value is undoubted.

The question of vitamins, though of great importance, has been overstressed in most published works. In practice adequate supplies of vitamins are obtained if wholesome sources of the major food groups are used. In young animals deprived of their natural upbringing, vitamin deficiency is the main precursor of ill-health and susceptibility to disease. All green foodstuffs, cereals, roots, and well-stored hay are valuable sources of vitamins, and, in general, where these are unobtainable, starvation problems are more important than vitamin deficiency.

In summing up the knowledge of "deficiency diseases" it is found that those foodstuffs which contain the widest range of limiting essentials unquestionably are the best. The high lime, phosphate, iron, sulphur, vitamin, and protein content of lucerne, for example, has made Argentina the pre-eminent beef cattle country of the world.

A vote of thanks, moved by Mr. Hines and supported by Drs. Vickery and Marks, and Messrs. White and Gurney, was carried by acclamation.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 24th June, 1935.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University, on Monday, 24th June, at 8 p.m. The President, Mr. R. Veitch, occupied the chair, and about thirty members and visitors were present. Apologies were received from Dr. Bryan and Messrs. Kemp and Longman. The minutes of the previous meeting were read and confirmed.

A paper entitled "A Suggested Co-enzyme Hypothesis for the Ripening of Fruits by Ethylene Gas Treatment," by L. J. Lynch, B.Sc.Agr., was communicated by Dr. Herbert. From the purely physical aspect the effect of ethylene may be twofold. It hastens the production of the normal ripe colour in such fruits as the banana, pineapple, and tomato, while internally it brings about other changes in texture, flavour, and degree of sweetness or other characteristic of the edibly mature condition. This internal effect, however, is not produced in all ethylenized fruits, and it is a peculiarity of citrus fruits that no internal ripening occurs as a result of commercial gas treatment. Pre-ripe bananas will not ripen in the absence of oxygen, despite the presence of ethylene in appropriate concentration, and the ripening of bananas which have passed the pre-ripe stage is not necessarily accelerated by traces of ethylene. It is deduced that ripening is a respiratory phenomenon, the intensification of which provides energy for an acceleration of metabolism, which in turn cuts down the length of the pre-ripening semi-dormant phase of the fruit. It has been shown that ethylene is capable of hastening the ripening of fruits or of certain tissues of the fruit only when those fruits or tissues contain oxidising enzymes, and it would appear that the gas exerts its effect through oxidising enzymes. It is claimed that ethylene plays the role of co-enzyme together with the oxidising enzymes not only in the artificial process, but in the natural ripening of fruits. If this hypothesis is correct, one should be able to predict whether fruits are or are not amenable to artificial gas ripening. Fruits containing oxidases, either as laccases or as peroxidases distributed evenly throughout their tissues, should respond entirely to gas treatment. The paper was discussed by Dr. Vickery, Professor Bagster, Mr. Hines, and Dr. Herbert.

The main business of the evening was a lecture entitled "The Origin of the Alphabet," by Professor Cumbrae Stewart, D.C.L.

The introduction of the alphabet into Europe is ascribed by Herodotus to people whom he calls "Phœnicians," from Tyre in Syria. Without accepting all that he says of the circumstances of the introduction, we may accept his account as true in the main.

The similarity of the Greek and Roman alphabets points to a common origin, while the name "alphabet" adopted by both Greeks and Latins, as well as the names of the letters themselves, are generally accepted as conclusively proving a Semitic origin.

The Carthaginians, colonists from Tyre, used letters recognised as Semitic, and the Carthaginians described themselves as "Canaanites," a mixed race with Semitic culture. The discovery of the Moabite stone in 1868 afforded definite proof of the similarity of the letters used in Moab in 840 B.C. and the European letters. This is seen from a table showing the Greek and Moabite stone alphabets. In 1929, at Ras Shamra, on the coast north of Tyre, clay tablets were found giving indications of similar writing of a date fixed provisionally about 1350 B.C., the writers of which represented themselves as coming from the country between the Dead Sea and the Gulf of Akabah. In 1932-3 excavations at Tel el Duweir, about 30 miles from Jerusalem, resulted in the finding of a ewer by Mr. J. L. Starkey, which he dated as about 1280 B.C. On it was writing in the earliest form of Semitic letters, closely resembling the old Hebrew found on Judæan coins of the Second Century A.D. A slide of the inscription was shown. The Semitic origin of the alphabet from this and other indications seems established. But whence came the proto-Semitic script? Various theories have been propounded. In 1906, Flinders Petrie found an inscription at Sarabit, in Sinai, which has raised the question of the origin of the Semitic alphabet. Gardiner, in a paper read before the British Association in 1915, contended that, not later than 1500 B.C., there existed in Sinai on Semitic soil a form of alphabetic writing. Gardiner contended that this writing was modelled on Egyptian heiroglyphics. In the twenty years since Gardiner's view was published much fresh evidence has been found concerning the south Semitic of Southern Arabia and the Red Sea. This area, known to the Egyptians as the Divine land of Punt, and visited by them as early as 2770 B.C., produced a race capable of inventing an alphabet. Their early civilisation has not yet been examined. The recent discovery of an Indus civilisation, perhaps older than Egyptian, may lead to data from which the ultimate origin of the alphabet may be determined. At present all that can be done is to state the discoveries which have established the proto-Semitic alphabet.

A vote of thanks, moved by Mr. H. Tryon, was carried by acclamation.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 22nd July, 1935.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University on Monday, 22nd July, at 8 p.m. The President, Mr. R. Veitch, occupied the chair, and about 110 members and visitors were present. Apologies were received from Dr. Herbert and Mr. Harding Frew. The minutes of the previous meeting were read and confirmed.

The main business of the evening was a very interesting lantern lecture on the habits and biology of spiders by Dr. J. Baum. Miss Ursula McConnell, Messrs. Gipps, Sylow, Hines, Nixon, Nebe, and Dr. Turner took part in the discussion which ensued, and a vote of thanks, moved by Messrs. Longman and Barker, was carried by acclamation.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 26th August, 1935.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University, on Monday, 26th August, at 8 p.m. The President, Mr. Veitch, occupied the chair, and about forty members and visitors were present. Apologies were received from Professor Murray, Mr. J. F. Bailey, and Dr. Bryan. The minutes of the previous meeting were read and confirmed.

Dr. A. Jefferis Turner, F.R.E.S., read a paper entitled "New Australian Lepidoptera." This contribution contains the description of twelve new genera and nearly fifty new species belonging to various families, ranging from the *Saturniadæ* to the *Cossidæ*, but more than half the species are *Noctuidæ*. Most of them were collected by Mr. W. B. Barnard, Mr. E. J. Dumigan, Mr. W. W. Froggatt, Mr. G. Lyell, Mr. T. J. Campbell, and several local collectors, Mr. F. J. Dodd of Kuranda, Mr. J. Macqueen of Millmerran, Dr. B. L. Middleton of Murrurundi, and Mr. H. Nicholas of Scone. For the study of our Lepidoptera local collectors such as these will prove most valuable. Even in comparatively well collected localities there have been unexpected discoveries, and in any untouched district a rich harvest of new species will be found by anyone who will look for them.

A paper entitled "Contribution to the Queensland Flora," No. 5, was read by Mr. C. T. White. Since the publication of the previous contribution (Proc. Roy. Soc. Queensland, Vol. XLI., pp. 139-143, 1929), some important collections of Queensland plants have come into the hands of the author for determination. Outstanding among these is the collection made by Mr. L. J. Brass in North Queensland in the early months of 1932. Mr. Brass's work was subsidised by the Arnold Arboretum of Harvard University, U.S.A., and among the material collected and here described from this large collection is an apparently undescribed genus of *Hernandiaceæ*, and members of the genera *Coronanthera* (*Gesneraceæ*) (New Caledonia) and *Dimorphocalyx* (*Euphorbiaceæ*) (Malaya), previously unrecorded as Australian. A particularly interesting find was *Ostrearia* (*Hamamelidaceæ*), of which flowers were previously unknown.

New species in the Brass and miscellaneous collections are described in the following genera:—*Hibbertia, Garcinia, Pittosporum, Sida, Melicope, Arytera, Mischocarpus, Vigna, Ceratopetalum, Backhousia, Rhodomyrtus, Polyscias, Symplocos, Randia, Wendlandia, Lucuma, Linociera, Parsonsia, Tylophora, Fagræa, Ipomæa, Coronanthera, Prostanthera, Palmeria, Endiandra, Pimelea, Loranthus, Korthalsella, Dimorphocalyx, Phyllanthus, Dendrobium, Eulophia, Bacularia.*

A description of a new *Korthalsella* (*Loranthaceæ*), by Mr. W. F. Blakely, is included.

A paper entitled "Essential Oils from the Queensland Flora," Part VI., *Eremocitrus glauca*, by L. F. Hitchcock, M.Sc., and T. G. H. Jones, D.Sc., was tabled. *Eremocitrus glauca*, the wild kumquat, is a small to medium-sized tree, abundant in parts of New South Wales and Queensland, the leaves of which on distillation were found to yield 0·4 per cent. of an oil of pleasant odour, but showing little resemblance to oil of lemon. The oil was found on examination to consist of 60 to 70 per cent. of dα-pinene, with nonyl aldehyde 12 per cent. and sesquiterpene as important minor constituents. Other substances present in very small amounts were nonoic acid, isovaleric acid, and p-cymene, linalol, traces of citral, and phenolic bodies. It is not considered that the oil possesses any commercial value in view of its constituents and the relatively high cost of collection.

A short paper entitled "Notes on Some Pasture Problems of Western Queensland," was read by Mr. S. T. Blake, M.Sc. Among the Queensland species of Bassia there are several weeds and several plants of apparently excellent fodder value. Of the former, *B. Birchii* (galvanised burr or camel burr) is practically confined to stock routes and over-grazed sandy land. It serves a useful purpose as a soil binder and as a lodging place for seed. If such country is rested useful grasses appear and gradually replace the burr.

B. longicuspis (Pinkilla burr) favours stony ground. It is associated with boree (*Acacia homalophylla*) near Quilpie, and with gidgee (*Acacia Cambageana*) where seen elsewhere. If allowed to spread it will probably be a far worse pest than *B. Birchii.*

B. bicornis appears to be ecologically equivalent to *B. Birchii,* but does not appear to spread so rapidly, nor does it grow so thickly. It has a much more restricted range.

B. quinquecuspis (roly poly) is a pest in so much that in its old stages it is not eaten and the dead plants block up bore drains and damage fences.

Of the more useful species, *B. anisacanthoides* and *B. echinopsila* are characteristic of eaten-out Mitchell grass pastures of the South-West and Central West. They are almost always associated with *Atriplex Muelleri* (annual salt bush) and *Threlkeldia proceriflora.* All (or nearly all) species appear to be eaten more or less, at least when very young. Attention is drawn to the fact that seed-eating birds, particularly galahs, are very largely responsible for seed destruction, and so limit the chances of pasture regeneration by natural means. It is further pointed out that rain is not necessarily beneficial, and in some cases it is definitelly harmful, causing blackening. It is also shown how a potential pasture may be destroyed by stocking it too soon. A means of water and forage conservation is suggested by fencing off "permanent" water supplies and utilising to the utmost the temporary supplies, while a semi-natural scheme of pasture regeneration by fencing off small plots to act as natural nurseries is also proposed.

These papers were discussed by Dr. Herbert and Messrs. Gipps and Just.

The main business of the evening was a very interesting address by Dr. F. G. Holdaway on "Standard Laboratory Colonies of Termites for Testing Timber for Termite Resistance." In this address, which was illustrated by lantern slides, Dr. Holdaway gave a full account of the difficulties associated with the problem, and how they had been overcome.

A vote of thanks moved by Dr. Turner and supported by Messrs. Weddell, Tryon, Perkins, and Blake was carried by acclamation.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 3rd October, 1935.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University, on Monday, 3rd October, at 8 p.m. Dr. Herbert occupied the chair, and about forty members and visitors were present. Apologies were received from Messrs. Veitch, White, Kemp, Bick, and Blake. The minutes of the previous meeeting were read and confirmed. The chairman drew attention to the recent death of Mr. A. G. Jackson, one of the oldest members of the Society and hon. lanternist for many years. A motion expressing sympathy with Mrs. Jackson and family was moved by Messrs. Bailey and Bennett, and carried.

Dr. W. H. Bryan exhibited scoriaceous lava and volcanic bombs (including both the bipolar rotational and breadcrust varieties) recently collected from the lip of the crater of the extinct volcano, Mt. Le Brun (Coalstoun Lakes), in the Burnett district. The perfect and as yet unmodified form of the volcano, together with the great amount of relatively unweathered superficial slaggy material still lying upon the surface, show clearly that the volcano was in eruption in geologically recent times. This conclusion is supported by the fact that lava streams have flowed down the present valleys of Barambah Creek and several of its tributaries. Dr. Marks and Messrs. Bennett and Gipps commented on this exhibit.

Mr. W. G. Wells explained some of the characters of the cotton fibres which have to be considered in cotton-breeding, and demonstrated by means of samples of cotton, instruments, and lantern slides, the methods used in studying them. The discussion indicated how not only must the cotton-breeder supply cottons which will yield satisfactorily, but which will also produce fibre suitable for the requirements of the cotton-spinning machinery.

Mr. J. S. Just delivered an address entitled "The New Gaseous Discharge Electric Lamp." After briefly outlining the early discoveries of electricity, and tracing the progress of electric light from the first example exhibited before the Royal Society in London about 220 years ago until the present gas-filled filament lamp was developed, Mr. Just showed how these experiments influenced the development of the modern gaseous discharge lamp. He explained that the physicist's "electron" and "ion" theories had considerably enlarged our knowledge of electricity beyond the application of Faraday's electromagnetic induction discoveries, and which had previously constituted such a large part of what we knew as electrical engineering. The added knowledge of the atomic nature of electricity, coupled with Stoney's discovery of the electron, enables a more complete study of electrical discharge in gases. In such discharges the mass of the negatively charged particle (or cathode ray) was calculated to be 1/1850 of the mass of the then lightest known atom, hydrogen. Rutherford further isolated new particles called "Beta rays," and proved that the speed of these rays was approximately 186,000 miles per second, or the speed of light. The electrical discharges within gaseous-filled tubes take different forms, and are influenced by the pressure of gas as well as the distance between the electrodes, being dependent upon the number of gas molecules in the path between the electrodes.

Mr. Just pointed out that during the discharges the electrons and ions of energy, which increased with the potential difference between the electrodes, the gas molecules were in collision; and when the speed of the ion was sufficiently increased its collision with the gas molecule was sufficient to transfer kinetic energy to that molecule. At certain critical stages the atom tends to return spontaneously to its normal state and affects the inner structure of the gas molecule, thereby producing luminous energy radiation.

When passing a gaseous electric discharge, the fall of potential at or near the cathode is very great, and after referring to the various sections of this discharge, such as the Anode glow, the Faraday Dark Space, the Cathode glow, the Crookes Dark Space and the potential gradient across the various sections, Mr. Just pointed out that only by overcoming the pressure drop at the cathode could low voltage energy be used or an appreciable amount of current be passed. Research work revealed that this drop of potential was due to an accumulation of positive "ions" in the neighbourhood of the cathode, and these are now neutralised by adopting alkali metal electrodes which, under positive "ion" bombardment, freely emit neutralised electrons. These factors made possible the present-day hot cathode gas lamp now being tested out in Queen street and other parts of the metropolitan area. For the commercial lamp the new gases developed during research into the causes of blackening of the filament electric lamp are used and are associated with the metalic salts of sodium and mercury. The overall length of the new luminous tube is approximately six inches, and differs from the gas sign tube, with which all are familiar, by producing a very high light intensity per unit length of tube, when compared with the light intensity of the gas sign.

Mr. Just pointed out that the field for which the present lamp was suitable was limited to floodlighting of buildings and highway lighting. For highway purposes the absence of glare was most important, and with the new lamp he thought that this absence of glare was probably due more to the sensitiveness of the eyes to the wavelengths of light given out, when compared with the filament lamp, than to the actual lumens available.

Several graphs were displayed as well as an outline of the new gaseous discharge tubes.

A vote of thanks moved by Dr. Herbert, supported by Dr. Bryan and Mr. Bennett, was carried by acclamation.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 28th October, 1935.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University, on Monday, 28th October, at 8 p.m. Mr. Veitch occupied the chair, and about thirty members and visitors were present. Apologies were received from Drs. Vickery, Bagster, and Jones. The minutes of the previous meeting were read and confirmed.

Dr. Herbert exhibited the following fungi:—*Puccinia distincta* parasitic on *Bellis perennis,* from Red Hill; (2) *Puccinia calendulæ* parasitic on *Calendula officinalis,* from Brisbane; (3) *Puccinia lolii* on

Lolium rigidum, from Brisbane; (4) *Sclerotinia sclerotiorum* parasitic on cabbage and lettuce, from Gatton; (5) *Uromycladium alpinum* parasitic on *Acacia decora,* from Gayndah; (6) *Melanopsichium austro-americanum* parasitic on *Polygonum hydropiper, from* South Pine River. He also exhibited a prickly-pear inoculated with *Sclerotinia sclerotiorum,* and specimens of lucerne from Gatton suffering from the recently described virus disease, witches' broom. Messrs. Bick and White commented on this exhibit.

A paper by Dr. T. G. H. Jones and Mr. F. N. Lahey, entitled "Essential Oils from the Queensland Flora," Part VII., *Melaleuca pubescens,* was laid on the table. *Melaleuca pubescens* is a very common tree in the brigalow scrubs of South-East Queensland. The essential oil of leaves collected from the Inglewood district was found to conform to the usual pinene cineol type (cineol 50 per cent. Cocking's method). Terpineol and sesquiterpene were also present as minor constituents.

The main business of the evening was an address on "Wool as a Textile Fibre," by Mr. J. J. Broe, B.Sc.

Three properties of wool, readily perceptible to the user and not possessed by other textiles are—

(*a*) Its elasticity;
(*b*) Its warmth;
(*c*) Its capacity for absorption of moisture.

It was set out to offer some scientific basis for these properties in terms of the structure and nature of the wool fibre itself. Each property was first briefly enlarged upon. That wool is elastic is shown by the fact that a wool fibre, under the most suitable conditions, may be stretched by 100 per cent. of its length, and that if the tension be rapidly removed it will return to its former length having suffered no permanent strain. Silk and cotton fibres may be stretched by only 2 per cent. without undergoing permanent strain. Moreover, the extent to which wool fibre stretches and the extent to which it recovers—each factor of equal importance—are both largely affected by the conditions of heat, moisture, and time of stretching to which it is subjected. The warmth of wool is obvious to all. It possesses this property for these reasons—

1. It is the only textile which can be felted, that is, whose fibres may be made readily to adhere to one another to form a compact mass.
2. Under equal conditons, this felted product diminishes the passage of air as much as 65 per cent. and thus promotes heat insulation.
3. An adherent beard of loose fibres on each side encloses air, which acts an an efficient insulator.
4. Wool substance in itself is a very poor conductor of heat compared with other textile fibres.

Wool absorbs moisture partly chemically—particularly when bone dry—and partly physically, due to a large surface effect within the fibre. A pound of wool fibre liberates on complete wetting sufficient heat to raise the temperature of one pound of water 43 deg. Fahr. Moreover, at high relative humidities the proportion of water absorbed by wool is relatively much higher than in the case of other textiles.

An outline account of the manufacture of a woollen article from raw wool was given. Some wool articles are made with warmth and maximum durability as the desired result. Such are made from short wool and are deliberately felted, such as flannels, velours, blankets, and billiard cloths. Beauty of weave and colour design are more or less impossible as such effects would be lost in the shrinking felting process. Articles to show such effects, varying from worsteds, serges, fine woollens, to carpets, are made from long wool fibres and the whole process aimed at a very minimum of felting. Subsequent shrinking, due to washing, friction, and mechanical twisting of fibres is miniature felting.

Then by means of slides there was shown the detailed structure of the wool fibre as revealed by the microscope. It consists of a multitude of spindle-shaped cortical cells, $\frac{1}{250}$ inch long, surrounded by a thin sheath of membranous elasticum, the whole enclosed in an outer series of imbricated scales fixed at the base and free at the distal end in the manner of the scales on a bamboo shoot, but much more numerous—up to 5,000 per inch in fine wools. The presence of these scales was early seized on as a reason for felting, it being due, so it was said, to scalar interlocking and consequent uni-directional motion of the fibres when the mechanical milling began. This is now known to be only partly the reason, and the cause is more to be sought in a definite plasticity, which ensues when wool fibre swells in slightly alkaline solutions.

The lecture concluded with a number of slides showing the finer structure of the wool fibre as revealed by the new process of X-ray analysis. Photographs by this method revealed all textile fibres to be constructed of micelles or crystallites. Each individual cortical cell is composed of a multitude of minute elongated crystals, running longitudinally. Each crystal, fibrilla, or micelle is in turn composed of a number of individual molecules of wool fibre substance regularly arranged, the regular arrangement leading to the definite structure as revealed by the X-ray photographs. The micelles are of the order of $\frac{1}{1000000}$th of an inch in thickness, but relatively longer, the dimensions of the molecular chains themselves being considerably smaller. Silk and cotton fibres are somewhat similarly constituted except that the latter are of carbohydrate constitution. In both silk and cotton the molecular chains are already fully extended, as revealed by the fact that the theoretical distance apart of certain atoms in the polypeptide chain of silk substance agrees with the length of the repeat of the crystalline structure as found by mathematical analysis of the X-ray fibre photographs. The wool fibre molecules are, however, folded in wave-like structure, as revealed by the same evidence. The polypeptide chain comprising wool fibre is identical with that composing silk, whereas the side chains differ greatly. If tension be now applied, the folded polypeptide chain of wool is drawn out till it ultimately resembles, as far as atomic spacings are concerned, the silk fibre chain. This is shown by the fact that stretched wool, and silk either stretched or normal, reveal the same type of fibre photograph, whereas that from unstretched wool fibre is quite different. Moisture aids the stretching by acting in a two-fold capacity, firstly by lubricating, and secondly by penetrating the micelles and by means of hydrolysis liberating chemical unions existing between neighbouring molecular chains.

Wool fibre once stretched may return to its original conditions or may remain permanently set, according to the treatment it suffers in the stretched condition. If the tension be rapidly removed it returns to its normal condition. If it be steam-heated in the stretched condition, new linkages form across between the molecular chains at new points and complete return to former length becomes impossible. Wet wool fibres give substantially the same X-ray photograph as dry fibres, in spite of a possible 33 per cent. moisture content. This shows that chemical union of water with the wool substance is largely prevented or the dimensions of the crystallites must be considerably altered by the entry of so much foreign substance. The water must therefore be present on the enormous micellar surface presented. This internal surface amounts to 1,000,000 sq. cms. per gram of wool so that the absorption of a large proportion of water is quite to be expected. Some water enters the micelles and reacts chemically as stated above, probably accounting for the large heat of wetting of bone dry wool.

A vote of thanks moved by Mr. Bennett and supported by Messrs. Hines and Wells was carried by acclamation.

F. A. PERKINS, Hon. Secretary

Abstract of Proceedings, 25th November, 1935.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Hall of the University, on Monday, 25th November, at 8 p.m. The President, Mr. Veitch, occupied the chair, and about forty-five members and visitors were present. Apologies were received from Prof. Murray, Dr. Bradfield, and Mr. C. T. White. The minutes of the previous meeting were read and confirmed. The following were proposed for ordinary membership:—Prof. F. E. Helmore, by Messrs. Perkins and Hines; Mr. J. J. Broe, by Mr. Perkins and Prof. Bagster; and Mr. W. L. Haenke, by Dr. T. G. H. Jones and Prof. Bagster.

Exhibits were tabled by Mr. Riddle, Prof. Bagster, Mr. C. T. White, Mr. Weddell, Dr. Jones, and Mr. Longman. Prof. Bagster, Drs. Herbert and Robertson, and Messrs. Veitch, Perkins, and Bennett discussed the exhibits.

A paper entitled "Essential Oils from the Queensland Flora, Part VIII.—The Identity of Melaleucol with Nerolidol," by Dr. T. G. H. Jones and Mr. J. M. Harvey, was laid on the table.

F. A. PERKINS, Hon. Secretary.

Publications have been received from the following Institutions, Societies, etc., and are hereby gratefully acknowledged:—

ALGERIA—
Societe de Geographie et d'Archaeologie d'Oran.

ARGENTINE—
Universidad Nacional de la Plata.

AUSTRALIA—
Commonwealth Bureau of Census and Statistics, Canberra.
Department of Agriculture, Melbourne.
Department of Mines, Melbourne.
Royal Society of Victoria.
Field Naturalists' Club, Melbourne.
Council for Scientific and Industrial Research, Melbourne.
Department of Mines, Adelaide.
Waite Agricultural Research Institute, Glen Osmond.
Royal Society of South Australia.
Royal Geographical Society of Australasia, Adelaide.
Public Library, Museum, and Art Gallery, Adelaide.
University of Adelaide.
Standards Association of Australia, Sydney.
Naturalists' Society of New South Wales.
Department of Agriculture, Sydney.
Department of Mines, Sydney.
Royal Society of New South Wales.
Linnean Society of New South Wales.
Australian Museum, Sydney.
Public Library, Sydney.
University of Sydney.
Botanic Gardens, Sydney.
Australian Veterinary Society, Sydney.
Queensland Naturalists' Club, Brisbane.
Department of Mines, Brisbane.
Queensland Museum, Brisbane.
Department of Agriculture, Brisbane.
Registrar-General's Department, Brisbane.
Royal Geographical Society of Australasia (Queensland), Brisbane.
Field Naturalists' Club, Hobart.
Royal Society of Tasmania.
Mines Department, Hobart.
Mines Department, Perth.
Royal Society of Western Australia.

AUSTRIA—
Naturhistorische Museum, Vienna.

BELGIUM—
Academie Royale de Belgique.
Societe Royale de Botanique de Belgique.
Societe Royale Zoologique de Belgique.

BRAZIL—
Instituto Oswaldo Cruz, Rio de Janeiro.
Ministerio de Agricultura Industria y Commercio, Rio de Janeiro.

BRITISH ISLES—
Royal Botanic Gardens, Kew.
British Museum (Natural History), London.
Cambridge Philosophical Society.
Literary and Philosophical Society, Manchester.
Leeds Philosophical and Literary Society.
Royal Society, London.
Conchological Society of Great Britain and Ireland, Manchester.
Royal Empire Society, London.
The Bristol Museum and Art Gallery.
Imperial Bureau of Entomology, London.
Imperial Agricultural Bureau, Aberystwyth.
Royal Society of Edinburgh.
Botanical Society of Edinburgh.
Royal Dublin Society.
Royal Irish Academy, Dublin.

CANADA—
Department of Mines, Ottawa.
Royal Astronomical Society of Canada.
Royal Society of Canada.
Royal Canadian Institute.
Nova Scotian Institute of Science.
Department of Agriculture, Ottawa.

CEYLON—
Colombo Museum.

CHINA—
Sinensia, Nankin University, China.

CUBA—
Sociedad Geografica de Cuba, Habana.

DENMARK—
The University, Copenhagen.

FRANCE—
- Station Zoologique de Cette.
- Societe des Sciences Naturelles de l'Ouest.
- Museum d'Histoire Naturelle, Paris.
- Societe Botanique de France.
- Societe Geologique et Mineralogique de Bretagne.
- Societe de Geographie de Rochefort.

GERMANY—
- Zoologisches Museum, Berlin.
- Gesellschaft fur Erdkunde, Berlin.
- Deutsche Geologische Gesellschaft, Berlin.
- Naturhistorischer Verein der preus Rheinland und Westfalens, Bonn.
- Naturwissenschaftlicher Verein zu Bremen.
- Senckenbergische Bibliothek, Frankfurt a. Main.
- Kaiserlich Deutsche Akademie der Naturforscher, Halle.
- Zoologisches Museum, Hamburg.
- Naturhistorisch-Medizinischer Vereins, Heidelberg.
- Akademie der Wissenschaften, Leipzig.
- Bayerische Akademie der Wissenschaften, Munich.
- Centralblatt fur Bakteriologie.

HAWAII—
- Bernice Pauahi Bishop Museum, Honolulu.

HOLLAND—
- Technische Hoogeschool, Delft.

ITALY—
- Instituto di Bologna.
- Societa Toscana di Scienze Naturali, Pisa.
- Societa Africana d'Italia, Naples.
- Museo Civico, Genova.

INDIA—
- Geological Survey of India.
- Agricultural Research Institute, Pusa.

JAPAN—
- Berichte der Ohara Institut, Kurashiki, Japan.
- Imperial University, Kyoto.
- Imperial University, Tokyo.
- National Research Council of Japan, Tokyo.

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PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

QUEENSLAND

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VOLUME XLVIII.

Vol. XLVIII., No. 1.

Proceedings of the Royal Society of Queensland.

Presidential Address.

BY

Robert Veitch, B.Sc.Agr., B.Sc.For., F.R.E.S.

(Delivered before the Royal Society of Queensland, 30th March, 1936.)

PART I.—GENERAL.

The preparation of a presidential address in any society is frequently and quite appropriately preceded by a perusal of the addresses delivered by earlier occupants of the presidential chair, a sound practice which I have adhered to partly with the object of refreshing my memory as to the manner in which my predecessors dealt with the subjects chosen by them and partly to ensure that I should select as the theme of to-night's address some phase of scientific activity not previously discussed on such occasions.

The perusal of the volumes of our Proceedings, which was necessitated by this decision, was definitely interesting. One feature that impressed me in their perusal was the extraordinary variation in the length of the presidential addresses, the shortest occupying some two pages of print, whilst the longest extended to a total of eighty-two pages. I decided to steer a middle course in so far as to-night's address is concerned.

While achieving the two main objectives aimed at in the perusal of my predecessors' efforts I came across many interesting items to one of which I desire to make reference to-night. It occurs in the presidential address delivered by Mr. A. Norton, M.L.A., on 8th July, 1887, and is the following short paragraph which I think worthy of quotation:—

> "It is disappointing to have still to hold our meetings in a room for the use of which the Society is indebted to the Trustees of the Museum. In consequence of this it is impossible to give members free access to the many valuable books and pamphlets which have been presented to the Society by numerous donors."

Practically fifty years have passed since these words were spoken and the position is still the same as indicated by President Norton, *i.e.*, the Society is indebted to another institution firstly for a lecture theatre in which to hold its meetings, and secondly for a room in which to house its valuable and steadily growing library. I do not wish to be misunderstood on this subject, for the Society is deeply appreciative of the assistance granted to it by the University of Queensland in making available this splendid lecture theatre in which to hold its meetings and in providing housing for its library. It, nevertheless, appears to me that the time is fast approaching when this and kindred societies should consider whether or no the acquisition of or erection of a building to house all the scientific bodies meeting in the metropolis is desirable and practicable. I realise that very appreciable financial difficulties will have to be faced if a decision be made to proceed with the acquisition of a Science House, but with the transfer of the University to the new St. Lucia site, it may, and probably will, be necessary for this and other societies, which are dependent on the good graces of the University for accommodation, to seek it elsewhere.

The year's activities in the Royal Society of Queensland have been outlined in the Council's report which has already been presented to you, and comment thereon will be restricted to drawing your attention to the fact that a small trust fund of £70 has been constituted during the year under review and additions to that fund will doubtless be welcomed by the new Council and its successors.

Passing now to the realm of general scientific activities and following a custom set by many of my predecessors, I propose to comment briefly on events of general interest in scientific circles in this State during the year 1935.

The celebration of the silver jubilee of the University of Queensland was undoubtedly one of the most important of these events, the jubilee year witnessing the success of negotiations for the establishment of faculties of medicine, dental surgery, veterinary science, and law. The initiation of the last-mentioned faculty was largely the outcome of a munificent gift from Mr. T. C. Beirne, while special Government grants made possible the establishment of the faculties of medicine and veterinary science. The year was also rendered memorable by the decision of the Government of Queensland to proceed with the erection of new University buildings on the St. Lucia site at an estimated cost of half a million pounds for buildings and equipment. I feel sure that these developments must have been extremely gratifying to all members of this Society, but more particularly to those members who, in the earlier years of the existence of the Royal Society, were advocates of the establishment of a University in this State.

The steady expansion of University activities is of very material interest to the Department with which I am associated, namely the Department of Agriculture and Stock, for that Department has a growing list of University graduates on its staff, now numbering in the vicinity of fifty, many of whom are the product of our own University. The policy of recruiting numbers of University graduates thus renders any development of academic training facilities in the various branches of scientific endeavour a matter of considerable importance to the Department. The volume of research work carried on within the Department is expanding rapidly, and in connection therewith an important step was taken towards the end of 1935 in the establishment of a Bureau of Tropical Agriculture to handle the many pressing problems awaiting solution in North Queensland. Considerable additions were made to the Departmental buildings in Brisbane, one of the chief objectives in the building programme being the provision of adequate accommodation for the new Dairy Research Laboratory.

Another noteworthy development during the year under review was the formation of the Australian Institute of Agricultural Science, which is now well established with a membership rapidly approaching the maximum limit of three hundred. This Institute publishes a quarterly journal which appears to be performing a useful function as a medium of publication and as a bond of union between workers in agricultural science in Australia.

The year also witnessed the holding of the fifth triennial congress of the International Society of Sugar-cane Technologists, the formal sessions being successfully held in Brisbane.

Before concluding the general portion of my presidential address I must refer to the death of two highly esteemed members of the Society, namely Mr. E. R. Gross and Mr. A. G. Jackson. Both were respected members of the business community of Brisbane and, as was indicated by their membership of this Society, both were supporters of scientific activities within the State.

PART II.—THE DEVELOPMENT OF APPLIED ENTOMOLOGY IN QUEENSLAND.

As already mentioned I perused the volumes of our Proceedings before commencing the preparation of this presidential address. The perusal disclosed the fact that it was not until January 27th, 1908, that a subject with definite entomological implications was chosen for a presidential address. This address was entitled "Insects and Disease," and was delivered by Dr. A. Jefferis Turner. A few years later, on February 25th, 1911, Mr. W. R. College chose as the title of his presidential address "Notes on a Brush-tongued Mosquito." No president since that date has chosen an entomological subject and as neither Dr. Turner nor Mr. College dealt with general entomology I decided to address you on "The Development of Applied Entomology in Queensland."

I propose commencing the discussion of this subject by briefly outlining the difficulties with which the early settlers were faced in establishing primary production in this continent. We shall then see how the absence of efficient quarantine in the early days of settlement led to the introduction of many pests, and from that point I shall proceed to a consideration of the development of modern quarantine as a means of limiting the spread of pests. The next and final step will be to discuss some representative pests, illustrative of the different methods used, with varying degrees of success, in minimising losses from insect pests already established within the quarantine barrier.

Let us now attempt to visualise the conditions facing the pioneers of Anglo-Saxon civilisation in this continent, and, if possible, let us ascertain what influence, if any, these conditions had on the incidence of entomological problems in Queensland. These pioneers had to travel great distances to reach their new home and the journey had to be made in small slow boats. Food supplies, at least in essential lines, had to be produced locally on a large scale and almost concurrently with the arrival of the earlier batches of settlers, and in this connection it is important to note that Australia did not yield a single plant that could be utilized as an important article of food for a European race, nor did it produce a single animal that could be domesticated.

The general circumstances under which settlement took place therefore necessitated the importation of seeds, plants, and cuttings on a large scale for, as I have just indicated, everything required to make this continent habitable for a white race had to be imported. It is unfortunate that important insect pests accompanied these introductions, but the pioneers can hardy be considered blameworthy on that account. The importance of the insect menace was realised by very few people anywhere in the world at that time, but even had the pioneers realised the risk they were running in such importations imposing a heavy burden on all subsequent generations of primary producers, it is unlikely that they would have been able to do anything about it. They were struggling for a foothold in a strange country in the face of the opposition of a somewhat hostile aboriginal population, and plant quarantine was doubtless a subject that was very far removed indeed from their thoughts.

I have, however, during the course of my official duties, sometimes deeply regretted the fact that there was no effective plant quarantine service in operation in the early days of settlement in this country. We, of course, now possess an efficient organisation which materially reduces the risk of the importation of further insect enemies of plants and animals. It is, however, interesting to note that even had a most efficient quarantine service been instituted at an early stage in our national history, and even if it had been able to exclude all insect pests reaching our shores, a feat that has never been accomplished by the most efficient service in the world, this State would still have been faced with a multiplicity of entomological problems.

This fact is borne out by the results of a classification which curiosity recently prompted me to make of the insects referred to in a handbook at present in course of preparation for publication by the Department of Agriculture and Stock. The insects, which are all important pests, were placed in two categories, namely, native and introduced. The results are rather interesting for they reveal the fact that of the hundred-odd insects dealt with a slight majority are native species. Hence even had a most efficient plant and animal quarantine service accompanied the initiation of settlement, Queensland primary producers would still have had to face a wide range of serious entomological problems. It is nevertheless regrettable that laxity in the early days of settlement has appreciably added to the entomological difficulties of the primary producer. Had adequate precautions been taken some of the important pests that now afflict us might still be on the right side of the quarantine barrier, while the establishment of others might have been deferred for an appreciable number of years.

Intelligently conceived and efficiently controlled quarantine, both domestic and foreign, is such an important weapon in the campaign against insect pests that I think it requires further consideration before proceeding to a discussion of the type of warfare that can be effectively waged against already established insects. So far I have merely indicated what happens in the absence of effective quarantine, but I now wish to show what is possible with modern quarantine methods, while at the same time indicating their limitations.

As has been mentioned our records indicate that many of our introduced pests such as the potato tuber moth (*Phthorimœa operculella* Zell.), the woolly apple aphis (*Eriosoma lanigerum* Hausm), and the codling moth (*Cydia pomonella* L.) arrived during the early days of settlement in Australia, but since these early records many additional introduced pests have been discovered, a large proportion of which have now doubtless occupied all the territory suitable to their development. Others, however, are still spreading slowly but surely, and in quite a number of cases it is rather difficult to formulate any reasonable plan for the prevention of that spread. In making this statement I have in mind such pests as the green vegetable bug (*Nezara viridula* L.) and the brown vegetable weevil (*Listroderes costirostris* Schh.), both introduced species which, during the last few years, have occupied a steadily expanding area of territory in this State.

It is impossible to determine with any degree of accuracy just when and how such relatively recent arrivals broke through our quarantine barrier, but I think we must accept the fact that no matter how efficiently our quarantine service is organised there will be occasions on which an insect will succeed in passing that barrier and subsequently establishing itself on suitable host plants or animals. It is probably correct to say that the United States of America has one of the most efficient quarantine services in the world, and in spite of that fact the dreaded Mediterranean fruit fly (*Ceratitis capitata* Wied.) gained access to Florida, where it was discovered early in April, 1929.

It will, I think, be instructive to review the manner in which the Mediterranean fruit fly problem was tackled in the United States and to ascertain just what measure of success was achieved in dealing with it. In the first place, it is important to note that Congress made available for control and eradication work a sum of $4,250,000, and what was just as important as the granting of such a large appropriation of money was the fact that instalments thereof were made available within a few weeks of the discovery that the fruit fly had reached Florida. The whole of the subsequent eradication campaign was conducted with equal vigour, and on November 15th, 1930, all quarantine restrictions were lifted, *i.e.*, nineteen months elapsed between the date of the discovery of the presence of the fruit fly in Florida and the lifting of all restrictions, thus indicating that in the opinion of the Government eradication had been achieved. That the task of eradication was by no means a simple one is indicated by the fact that 72 per cent. of the total citrus areas of Florida were found to be infested, the degree of infestation in many cases being very high.

Certainly the expenditure involved was great, but a tremendously valuable fruit industry extending north to the New England States and west to California was at stake, and its importance fully justified the drastic and costly measures adopted. The ultimate success achieved in this campaign was due partly to the fact that the entomological staff knew just what to do, because the Mediterranean fruit fly problem had been intensively studied by some of its members in Hawaii and elsewhere for years before the advent of the insect in the United States. The Bureau of Entomology in the United States felt that sooner or later the Mediterranean fruit fly might break through the quarantine barrier, and a tribute must be paid to the foresight displayed by that Bureau in accumulating a vast amount of information to be used for dealing with the problem when it did arise. Another and most important factor influencing the prospects of success was the promptness with which the Legislatures concerned, both Federal and State, took the necessary steps to furnish the financial and legislative weapons for the campaign.

There are other instances of successful efforts to eradicate an introduced insect, *e.g.*, the Colorado potato beetle (*Leptinotarsa decemlineata* Say) has twice broken through the quarantine barrier in England, but on each occasion it has apparently been eradicated.

It must be admitted, however, that these cases are exceptions, and once an insect passes the quarantine barrier and breeds through a few generations its eradication is highly improbable, and it will sooner or later occupy all the territory possessing conditions favourable to its permanent establishment.

What, then, should be done with an insect which has broken the foreign quarantine barrier? Should we remain apathetic and take no steps to stem its progress? My answer to that question is that all reasonable measures should be adopted to delay its spread, and that, generally speaking, it will be found that the expenditure involved in retarding its invasion of uninfested territory is more than recouped by the saving to those districts which obtain a number of years additional freedom from the pest. Indeed in some cases we may succeed in more or less indefinitely postponing the spread of the pest to many important areas suitable for its propagation.

We have in Queensland a very good example of the value of quarantine measures imposed on a pest already established in the State, and here I am referring to the buffalo fly (*Lyperosia exigua* de Meij.). Immediately following the discovery of the presence of that insect in the north-west portion of Queensland certain restrictions were placed on the movement of cattle, the restrictions operating as from late in 1928. It can now be claimed that, in large measure as a result of these and other subsequently imposed restrictions, the territory infested by the buffalo fly at the end of last rainy season was still only a relatively small proportion of the north-west, and what is equally important the fly has failed to cross large stretches of uninfested territory and to establish itself hundreds of miles from its previous boundaries, a possibility that is always present when trucking cattle over long distances from territory containing a blood-sucking fly associated with the cattle day and night, and capable of breeding in the droppings in the cattle trucks. This, I think, is a striking case in which domestic quarantine regulations have successfully protected a most valuable State asset by restricting a serious pest to a relatively small corner of our territory. Long may the restrictions succeed in the objective for which they were designed.

South of our own border we are witnesses of a determined and costly effort to stem the southward march of the cattle tick (*Boophilus microplus* Canes), and here again we are encouraged by the degree of success achieved in the United States where the first Federal appropriation for cattle-tick eradication was made available in July, 1906. Speaking in December, 1927, Harned[1] pointed out that as a result of the tick eradication programme, "750 of the 985 counties had been released from quarantine and 653 were entirely tick free."

Although the instances I have just quoted are encouraging, my listeners should remember that an omnivorous phytophagus insect such as the green vegetable bug already mentioned possesses peculiarly difficult features in so far as the stemming of its progress is concerned. In spite of the common name conferred on it, this species feeds on such plants as maize, lucerne, and citrus, and also breeds freely on a wide range of weed host plants. Its eradication appears to me to be an impossibility, no matter what funds were placed at our disposal, and it is difficult to see just how it would be practicable to prevent its steady spread to areas at present uninfested.

With respect to the future our experience will probably be similar to that of other countries, *i.e.*, insects will still be able to occasionally gain a foothold in spite of the vigilance of our quarantine officers, for it must be realised that the danger of such an eventuality is in some respects an increasing one. The duration of the average voyage to Australia is automatically decreasing with the increasing speed of the steamers serving the main trade routes, the danger of the survival of new insect immigrants being thereby correspondingly increased. Furthermore we now have a weekly air mail service from England and the mail planes pass through tropical countries teeming with insect life. I know that all reasonable precautions will be taken at Darwin, but the danger of insects accompanying planes in their flight across the Timor Sea is pretty obvious, and it is well to remember that the duration of a plane's flight from the Dutch East Indies is a matter of only a few hours, thus permitting a high degree of survival of insect life. It must also be remembered that many airports are of necessity located in the country, where the chances of picking up undesirable insect passengers are definitely greater than in the crowded dockyards of a large seaport.

In this connection I should like to mention that a very considerable amount of information on the association of insects with aeroplanes has been obtained during the course of the field experimental work on cotton boll weevil control in the United States, and writing thereon in November, 1927, Coad, who was responsible for the work, states in a communication to Howard[2]—

> "Certainly, in years to come, a quarantine measure attempting to restrict movement of insects will be forced into consideration of airplane transportation,"

and again—

> "Personally I have very frequently watched insects remain in the cockpit with me for a flight lasting several hours."

Incidentally I might mention that Coad's work on dusting cotton fields from aeroplanes afforded an excellent opportunity for studying the insect fauna of the upper air, and that he has actually found insects at an elevation of eighteen thousand feet. He has demonstrated that air currents can carry wingless insects or delicate insects possessing little power of flight to great elevations, aphids and leaf hoppers being among the insects obtained in the trap collections at great heights. Howard, in discussing this important matter, points out that at extreme elevations the insects are killed by the cold but at lesser heights that is not the case; hence the possibility of our air mail service acting as a means of entrance for insects which might not otherwise reach our shores cannot be ignored. As I have said, however, I do not doubt that the Federal quarantine authorities are alive to this possibility and are doing whatever is practicable to deal with the problem.

Reviewing the existing position it therefore appears to me that reasonable quarantine precautions are now in force to prevent, as far as it is practicable to do so, any new and undesirable insect immigrants establishing themselves in this country. Furthermore, I think the fact must be accepted that there is virtually no hope of eradicating the important introduced plant-feeding insects already established in the State, but that in certain cases much good can be accomplished by local quarantine restrictions designed to prevent the spread of introduced pests for at least a few years and designed in some cases to achieve their more or less permanent exclusion from territories at present uninfested.

Having reviewed the quarantine position, let us now pass to a discussion of the forging of suitable weapons for use in the warfare against the pests that are now with us, the eradication of which we have just ruled out of the realm of possibilities. Much has already been accomplished in that direction, and I think the best procedure will be to select a few important insect pests representative of the different types of problems with which we are confronted and illustrative of the manner in which we have succeeded in solving or are attempting to solve these problems. The insects I have chosen as illustrations are the Queensland fruit fly (*Chætodacus tryoni* Froggatt) the wooly apple aphis, the cattle poisoning sawfly (*Pterygophorus interruptus* Klug), the pinhole borer of North Queensland cabinet woods (*Crossotarsus grevilleæ* Lea), and the paspalum white grub (*Lepidiota caudata* Blkb.). These pests I shall now refer to in varying degree of detail.

Queensland Fruit Fly.

The first insect I desire to discuss in some detail as illustrative of the methods we are adopting in attempting to solve entomological problems is the well-known Queensland fruit fly. The manner in which the maggots of this fly feed in infested fruit is doubtless well known to all of you and therefore requires no discussion; hence we can proceed immediately to the consideration of the problem of its control.

The discussion of this problem occupies a very prominent place in the early entomological literature of the State and Tryon,[3] writing in 1886, produces evidence that fruit fly was well known in Toowoomba orchards in 1853. He, at the same time and in the same publication, made certain recommendations with respect to its control one of which, the collection and destruction of infested fruit, is still a leading feature in any fruit fly campaign.

Since Tryon's report was published the Queensland fruit fly has been the subject of a great deal of attention. Various Departmental officers investigated it from time to time until with the advent of the growing of deciduous fruit on a large scale in the Stanthorpe district, which occurred shortly after the war, the pest assumed still greater importance, because of the marked increase in the production of fruits susceptible to attack. Accordingly, two entomologists were stationed in that district in 1922, one being a special research fellow associated with the Biology Department of the University of Queensland. His appointment was financed by the growers in the Stanthorpe district, and he devoted the whole of his time to fruit fly investigations during the four years in which he was stationed in the district and also carried out large-scale luring experiments during the summer months of a further five successive years. The other entomologist, a Departmental officer, who is still in charge of the Stanthorpe Entomological Field Station, featured the fruit fly problem as the major item in his research programme. Both these investigators accumulated a mass of valuable information on this most difficult problem and as a result of their work important advances have been made in the direction of its successful solution.

The investigators were faced with one very important point requiring elucidation early in the investigations, namely whence did the annually recurring fruit fly infestation in the Stanthorpe district originate? Did the pest survive the rigours of the Stanthorpe winter either as a fly or in one of its immature stages, the surviving population thus renewing infestation of the early fruits in the following season? Alternatively, was the importation of infested fruit from coastal districts or elsewhere responsible for the seasonal reinfestation, or did that occur as the result of the migration of flies from warmer areas in which the insect is able to survive the winter in considerable numbers? These were possible explanations and it will be interesting to see just how the evidence obtained in the course of the investigations supported or discredited the various possibilities.

I think it is now agreed that the evidence secured gives little support to the possibility of over-wintering being the main source of the early summer fruit fly infestation at Stanthorpe. Indeed it very definitely indicates that the fly has little chance of surviving the Stanthorpe winter, although a few individuals may occasionally carry over in an immature stage. In this connection Jarvis[4] obtained evidence that maggots developing in very late fruit, such as quinces and late apples, stored in the district, may survive the winter, but only a very small percentage can do so, and even if such survival does take place in any particular season it is improbable that it is of any consequence in starting the spring infestation. Indeed in all cases observed by Jarvis a breakdown in the tissue of the stored fruit occurred in spring and the insects succumbed before completing their development and emerging as flies. Furthermore, Perkins[5] obtained evidence that pupæ may be alive as late as October 1st, although he was unfortunately unsuccessful in breeding the flies from these pupæ. The fact, however, that they were alive on the date mentioned indicates a possibility of successful over-wintering. All efforts to obtain evidence that the flies themselves may survive the Stanthorpe winter have been fruitless. Hence it would appear that survival within the district during the winter months is merely a remote possibility.

Let us now turn to the second possible explanation, which was that the importation of infested fruit from coastal districts and elsewhere is responsible for the constantly recurring Stanthorpe infestation. The validity of this explanation received no support from a large-scale experiment specially designed to test it. For several years in succession fruit was admitted to the Stanthorpe district only after it had been cold stored for a period sufficiently long and at a temperature sufficiently low to kill any eggs or maggots that might be present in the fruit, the fruit being held in cold storage for three weeks at a temperature not exceeding 35 deg. Fahr. As a further precaution this fruit was carefully inspected at Warwick. It seems reasonable to assume that the elimination of infestation in fruit brought into the district would have been followed by a period of freedom from fruit fly attack, if the importation of infested fruit were the cause of the seasonal reinfestation in the district. Yet severe fruit fly infestation occurred in many orchards during the years in which this interesting and important experiment was in progress.

Our first two possible explanations of the infestation having received little or no support during the progress of the investigations, let us see whether or no the migration theory has fared any better. The evidence in favour of the probability that migration is the major factor in the annual infestation is as follows.

Firstly, it has frequently been observed that the first sign of infestation each season is the appearance of considerable numbers of fruit flies with somewhat frayed wings and well developed ovaries and other features indicating that several weeks had elapsed since these flies emerged from the pupæ. A very careful watch is kept by both the general Departmental officers and the orchardists for the first appearance of the pest, and it is difficult to believe that the first batches of flies would again and again escape detection for several weeks after their emergence from the pupal stage. It is believed that these flies hatched out weeks before their discovery in the Stanthorpe orchards in some areas possessing less rigorous winter conditions and that they migrated thence to Stanthorpe.

Secondly, it is a known fact that the Jarvis fruit fly (*Chætodacus jarvisi* Tryon), which attacks deciduous fruit, occurs in the Stanthorpe district each season, but it does not put in an appearance before the beginning of February. It is well nigh incredible that this fly could remain undetected in the district until so late in the season each year, if it were permanently present therein. Furthermore, it is known to breed freely in the cockatoo apple (*Careya australis* F.v.M.), the distribution of which is from Cairns to the vicinity of the Mary River, and the known circumstances of its appearance in the Stanthorpe district are apparently explicable only on the assumption that it migrates from coastal areas each season to the more elevated and more inland areas such as Stanthorpe, arriving there early in February each year.

Thirdly, the Solanum fruit fly (*Chætodacus dorsalis* Hendel) appears in the Stanthorpe district in early spring and may be taken in fruit fly traps in that district in almost any orchard before the Queensland fruit fly appears. Yet it does not attack deciduous fruit and its common recorded host plants, namely two species belonging to the genus Solanum, do not occur within the Stanthorpe area.

Such briefly, is the evidence on which we have been forced to the conclusion that migration from lower lying warmer areas is the chief means whereby reinfestation occurs each year in the Stanthorpe district.

I would like to make clear the fact that I do not consider the Stanthorpe problem is constituted wholly by migration. Certainly migration is the chief, if not the only, factor causing the initial infestation each season, but much of the continued infestation is due to the local breeding of the flies.

From what I have said it is obvious that the attempt to answer the question as to how the annual infestation of the new crop is initiated has involved a great deal of laborious and expensive work. It was, however, a most important question that we were seeking to answer, because had it been demonstrated that the fly did not over-winter and that it regained its foothold only by means of the importation of infested fruit to the district, then obviously it could have been more or less permanently excluded at little cost by the imposition of cold storage on all fruit going into Stanthorpe.

It may interest you to know that migration of the type now regarded as occurring in the case of the Queensland fruit fly is not unique; *e.g.*, it was recently shown by Smith and Allen[6] that the spotted cucumber beetle (*Diabrotica duodecempunctata* F.) regularly migrates up the Mississippi valley each year during the early spring and summer months and breeds in the northern territory thus temporarily occupied. With the advent of the autumn months the offspring of the northern migrants move southward, none of the beetles surviving the winter in the northern sections of the temporarily occupied territory. The observations on this beetle showed that a distance of "five hundred miles or more may be travelled during a period of three or four days of favourable weather." Collections of beetles made in aeroplane flights showed that the migration may take place at altitudes ranging up to one thousand feet.

Accepting migration as being responsible for the annual reinfestation, the next question is what can be done when it does occur?—and to that question it appears to me that the investigators can supply a fairly satisfactory answer. In the first place a good proportion of the invading flies may be trapped by the use of suitable lures. Harvey produced a lure which succeeded in doing so, while Jarvis[7] demonstrated the value of a cheap lure composed of a synthetic essence of vanilla, household ammonia and water. Subsequently Perkins and Hines[8] obtained promising results in a preliminary experiment with ammonia alone. The possibility of improving the existing lures has not been overlooked, and a new lure is at present being experimented with by the Department of Agriculture and Stock, the first experiments, conducted in citrus orchards by Summerville,[9] giving very hopeful results. The most recent line of investigation at Stanthorpe has been the use of repellent sprays and in the course of these experiments Jarvis[10 11] has obtained definitely satisfactory results on certain fruits with a nicotine sulphate-white oil mixture. Confirmation of these results has recently been obtained by the New South Wales Department of Agriculture in the course of experiments conducted in the Gosford district. The Queensland Departmental work on this pest also included a series of experiments by Weddell[12] with heat treatment of infested fruit, the experiments having been suggested by similar work carried out during the course of the eradication campaign conducted against the Mediterranean fruit fly in Florida.

The investigation of the fruit fly problem has been attended by many difficulties, one of the most important of which is the erratic nature of the incidence of the pest, *e.g.,* the fly is almost non-existent in the Stanthorpe district this season, and that fact has rather played havoc with our plans for the tests of the new fruit fly lure to which I have already referred. Last year fruit fly was much more prevalent, but some of our most promising experiments were ruined by hail. Other difficulties occur, such as those that would be encountered in any attempt to demonstrate the power of the fly to migrate from, say, the Warwick district to the Stanthorpe orchards. All our available evidence indicates that it does so, but we would like to demonstrate the fact by liberating large numbers of marked flies at suitable spots between Warwick or Toowoomba and Stanthorpe and recovering some at least of the marked flies in fruit fly traps, thus ascertaining just how far the flies would travel from the centre at which they were liberated. The difficulties to be faced in such an experiment are, however, very considerable, as attendance upon an enormous number of traps would be necessary, and furthermore, a very cool reception would be the fate of any entomologist who liberated twenty or thirty thousand marked fruit flies even in a district containing practically nothing but backyard fruit.

Not unnaturally the question of the possibility of the biological control of this pest has frequently been raised, but it must be confessed that the prospects of success in this direction are by no means bright. Nevertheless the New South Wales Department of Agriculture has recently thought it worth while to import parasites from India and

Fiji, the importation from the former country having been financed in part by the Federal Government. This experiment will be followed with sympathetic interest and in the hope that some beneficial results may ensue.

The biological control of a species of fruit fly has already been attempted in Hawaii where in 1913 and 1914 four parasites of the Mediterranean fruit fly were introduced and established, three of the parasites having been obtained from Africa and the fourth from Australia. The Australian species is an enemy of certain of our own Queensland fruit flies which has sometimes been recorded as attacking a large percentage of fruit fly maggots in native fruits, *e.g.,* Perkins and Hardy[13] found that of two hundred pupæ of an unknown species of fruit fly obtained in the soil beneath a mock olive tree in the Stanthorpe district, 76 per cent. had been parasitised. Unfortunately, however, parasitism in cultivated fruits in Queensland is far from common, the parasite evidently being more effective in the native fruits possessing a relatively thin pulp.

Reporting on the results of the Hawaiian introductions in the 1922-24 period, Willard and Bissell[14] state that the four species between them "parasitise nearly 50 per cent. of the larvæ about Honolulu, causing a corresponding decrease in infestation of the commercial hosts." They significantly add, in referring to the three Braconid parasites, "The host maggot must therefore be near the surface of the fruit in order to be within reach of the parasite. Consequently in fleshy fruits which afford an opportunity for maggots to burrow some distance beneath the skin parasitism is low, whereas in small fruits and those containing a large seed covered by thin pulp, where the maggots are necessarily always near the outer surface of the fruit, parasitism is high." The fourth parasite, a Chalcid, can reach the fruit fly maggots only through a break in the skin and its usefulness in commercial orchards must obviously be restricted to fleshy fruits, the skin of which breaks readily when the fruit falls to the ground.

Bach and Pemberton[15] were associated with the attempt to control the Mediterranean fruit fly by the introduction of natural enemies to Hawaii, in which country the pest was first recorded in June, 1910. The introductions from Africa took place between May, 1913, and October, 1914, and writing in 1918 these two investigators state "Since adult fruit flies can live many months and lay eggs quite regularly, they have been able, with the aid of the unprecedented variety and abundance of host fruits in Hawaii thus far to keep such an ascendency over their parasites that they cause the infestation of practically all fruits ripening. It would appear that unless effective pupal and egg parasites are introduced, or more care is given to the elimination of host fruits which more thoroughly protect the larvæ from parasite attack, or to the planting of fruits which make possible the reproduction of large numbers of parasites, little practical value will result from the work of the parasites from the standpoint of rendering host fruits free from attack"; and again they state "In Kona, Hawaii, where the percentage of parasitism in coffee berries has been phenomenally high for three years, it has not been high enough to free more than an occasional berry from attack."

This must conclude my review of the fruit fly problem in the State, a problem to which I have given a good proportion of my available time partly because it is a definitely important one, and partly because many, if not all, of you, have some personal knowledge of the fruit fly.

It is a problem in which we have made a considerable amount of progress, but it is one in which we have not yet achieved a wholly satisfactory solution. We claim, however, that we have probably made as much progress with our fruit fly problem as has been made in the attack on other permanently established species of fruit flies overseas.

Woolly Apple Aphis.

Let us now pass to the consideration of another important deciduous fruit pest, namely the woolly apple aphis. As many of you are probably unacquainted with this species, I might mention that it is a very small sap-sucking insect feeding in enormous numbers in colonies on the roots and branches of apple trees. The vernacular name has reference to the insect's habit of covering its body with long waxy threads. Infested trees are very seriously impaired in health if severely attacked by this insect, a characteristic reaction to infestation being the production of large unsightly excrescences where the colonies have been feeding. The control of this serious pest has been attempted and successfully achieved along three distinct lines and it is accordingly a good example for present purposes.

The first attempt at control was in the direction of eliminating infestation of the root system, the attempt, which was crowned with complete success, being initiated in Victoria in 1868.[16] This attempt was suggested by a reference in Lindley's "Guide to the Orchard," in which attention is drawn to the fact that an old apple tree growing at Norwick in England remained conspicuously free from woolly apple aphis infestation above ground, thus being in marked contrast to the neighbouring trees which were all more or less severely attacked. The tree had been grafted at a height of three feet, the graft being Winter Majetin, the whole of which remained completely free from attack. Trees of this variety were accordingly imported from England and were used as root stocks in experiments during the years 1868 to 1870. As was hoped would be the case those root stocks remained free from infestation. Experiments were also conducted with Northern Spy root stock and these were similarly successful. The problem of the control of the root infestation was thus solved by the introduction of resistent root stocks, and it is pleasant to be able to record the fact that Australia pioneered the work in this direction, the innovation being one which was soon followed by California and other large fruit-producing countries.

The problem of the above ground infestation still remained to be solved and eventually, with the introduction and increased popularity of nicotine sulphate, it was generally dealt with by the use of that insecticide. The position was appreciably improved by the use of nicotine sulphate, but it was by no means wholly satisfactory because efficient control could be achieved only by frequent applications of the spray, thus involving the orchardist in a very considerable expenditure of both time and money. Furthermore, the spray applications had mostly to be made at a time when the orchardist was at his busiest harvesting and packing fruit. It therefore not infrequently happened that the applications were not made as systematically as should have been the case and effective control was accordingly not achieved.

Such was the position until 1923, when a colony of a small wasp parasite (*Aphelinus mali* Hald.) was obtained from New Zealand by Jarvis[17] and liberated in the Stanthorpe district. The parasite multiplied rapidly and was soon distributed throughout the whole of the various sections of the district. It has since functioned as a highly efficient control factor during the months in which insect propagation is normally at its peak. It has thus been possible to reduce the number of spray applications from six or seven annually to two—one in spring and the other in late autumn.

Thus we see that root infestation has been controlled by the use of resistant root stocks, the above ground infestation has been largely held in check by the introduction of a parasite and spray applications have been reduced from six or seven per annum to, at most, two. I think we are therefore justified in regarding the woolly apple aphis problem as one which has been well nigh solved.

Cattle Poisoning Sawfly.

The insect to which I now desire to draw your attention is the cattle poisoning sawfly which differs in two important respects from those already dealt with. Firstly, it is really a stock pest, being of importance only as a result of the losses of cattle associated with its presence in certain of our pastoral areas, and secondly, it is an instance of a native species which was of no economic importance in the early days of settlement, but which is now a menace to cattlemen in three important cattle-raising areas.

Perhaps it might interest you to know just why this insect is of economic importance and for that reason I shall give you a brief outline of its association with cattle. Its larvæ feed on the leaves of the silver-leaf ironbark (*Eucalyptus melanophloia* F.v.M.) and are particularly abundant in the Maranoa, Warrego, and Leichhardt districts. They feed voraciously on the leaves, and in those districts in which cattle fatalities occur the larval population is frequently greatly in excess of the available food supply in the shape of silver-leaf ironbark foliage. With the progress of defoliation the larvæ each day drop to the ground in increasing numbers, partly to escape the high sun temperatures to which they are increasingly exposed as a result of the progressive defoliation of the host trees, and partly as a result of hunger following on the decrease of food supplies. In the cool of the evening, however, the movement is reversed, and many larvæ return to the feeding trees. Roberts[18] has pointed out that many soon become too weak to continue the daily upward and downward movement and they die in great masses at the foot of the trees where they form putrid heaps.

Now in portions of the districts mentioned the cattle feed with avidity on the living and dead sawfly larvæ and even on the black putrid decaying heaps. Following the ingestion of the decaying larvæ the cattle are described by Roberts as being affected in the following manner. "They become excited and walk with a high stepping gait in front, and a straggling gait behind and if startled will charge fiercely." Death may occur within forty-eight hours of the appearance of the symptoms and the affected cattle seem to suffer acutely. It has been suggested that death may be due to the presence of a toxin produced by bacterial infection of the heaps of decayed larvæ and that the living larvæ may be eaten with impunity. Such is the problem constituted by the cattle poisoning sawfly, and having stated the problem the next question is, what are we going to do about it?

I think it is obvious that direct control of the insect itself is out of the question, for most of the land involved has such a low capital value as to preclude expenditure on spraying even if an effective spray and spray plant were available. It has therefore been considered necessary to attack this problem from quite a different angle, namely, by attempting to ascertain why the cattle should feed on the putrid heaps of dead sawfly larvæ. It is considered possible that the depraved appetite displayed by the cattle in the consumption of the putrid masses may be a manifestation of a dietetic deficiency. It may be a phosphatic deficiency, a theory that receives some support from the freedom from loss which coincided with the use of phosphatic licks on a large holding whereon serious losses occurred prior to the use of such licks. On the other hand, the deficiency may be in proteins; but whichever, if either, be the explanation of the depraved appetite, we are now obviously in the province of the chemist and the veterinarian, and to them we must look for a solution of the problem. Experiments with cattle whose rations are controlled are now actually under way at the Animal Health Station, Yeerongpilly, and in one of the affected pastoral areas, and we are hopeful that these experiments will tell us whether or no a dietetic deficiency is responsible for the trouble. If the presence of a dietetic deficiency be demonstrated then its correction should be a relatively simple problem and, having eliminated the depraved appetite, the presence of sawfly larvæ on a pastoral holding should no longer be a menace to the cattleman.

The Pinhole Borer of North Queensland Cabinet Woods.

For my next example of entomological investigational methods I shall ask you to accompany me to the domain of forest entomology and to see how we have attacked the problem of the control of the pinhole borer of North Queensland cabinet woods.

Most of you are probably aware that during recent years there has been a steadily growing appreciation of the value of these cabinet woods, one of which, walnut bean (*Endiandra Palmerstonii* Bail.), was lately and still is in great demand both overseas and in Australia for the manufacture of veneers. Unfortunately a pinhole borer is a very common pest of such timbers and if milling of the log is delayed for any reason, it may become seriously infested throughout its whole length. Such infestation does not necessarily reduce its value as structural timber, but its value for furniture making and for veneers is very much greater than for building purposes, and pinhole borer infestation either greatly reduces or completely eliminates its value to the manufacturer of furniture or veneers. Hence this insect constituted a very serious menace to the satisfactory utilization of some of our North Queensland timber resources.

The control of forest pests is generally a more than usually difficult entomological problem and we entered on this investigation with grave doubts as to our ability to produce results that the timber man would regard as at all satisfactory. A comprehensive investigation, however, was undertaken by Smith[19] on the Atherton Tableland where he worked mainly in the forest reserves at Gadgarra and Wongabel. The life history of the insect was closely studied, its association with the various stages in the weathering of logs under different conditions and its reaction to the general environmental factors receiving particular attention.

Some interesting facts emerged from these studies, to three of which I shall refer because of their important bearing on the problem of control. The first is that "Mass infestation of log surfaces takes place when temperatures are in the vicinity of 82 deg. Fahr."; the second that "Logs held under complete canopy where temperatures seldom rise above 80 deg. Fahr. are rarely attacked," and the third that "Similarly logs more than 5 chains outside the rain forest escape infestation. In the latter case the chemotropic stimulus peculiar to the felled log or sap wood surfaces of barked logs is insufficient to draw the insect from the rain forest area."

Control recommendations have been based on these and other important points elucidated during the life history and environment studies and the problem may be regarded as having been solved, for either of two alternatives in the disposal of newly felled logs, not removed immediately to the timber yard, can now be adopted with safety.

The logs may be removed from the rain forest to open country ramps outside the zone of chemotropic attraction to the beetle, which is very definitely a rain forest inhabiting species, and can be held there with a reasonable degree of safety. If, on the other hand, it is impracticable to arrange for the immediate haulage of the logs from the rain forest, they can be held with safety in ramps established under canopy for under unbroken canopy in North Queensland the temperature is normally too low to permit of mass infestation by the beetle. The problem is thus solved by modifications in logging practices, these modifications being designed to eliminate either the chemotropic influence or the temperature essential for severe infestation.

Paspalum White Grub.

The Atherton Tableland also furnishes my final example to-night, the insect in this case being the species commonly known as the paspalum white grub.

Agricultural activities on the Tableland, as most of you are probably aware, consist mainly of dairying and maize growing, the former being dependent in large measure on paspalum (*Paspalum dilatatum* Boir.) pastures, *i.e.*, the farming in the dairying sections is predominantly grassland farming. Malanda may be regarded as the main dairying centre and there the farms have been gradually established in the rain forest belt during the last thirty years.

The paspalum paddocks maintained a high carrying capacity for quite a number of years following the inception of settlement, but in certain localities there has since been a marked deterioration and the present position is that on an area of approximately 25,000 acres, with Peeramon as its centre, the carrying capacity has been seriously affected, heavy white grub infestation being mainly but by no means wholly responsible for the deterioration in the position. In certain cases the situation has become sufficiently acute to cause the temporary abandonment of the properties.

Perhaps I had better explain at this juncture that the white grub feeds in the soil and, when present in large numbers, it completely destroys the root system of the paspalum. The grass naturally dies off, and not infrequently it can then be rolled up in long strips just like a carpet.

This species has a two-year life cycle, the eggs being laid in the soil during the flight period of the beetles, which takes place after the occurrence of good spring or early summer rains. The grubs emerging from these eggs feed in the soil until the second winter after hatching, and it is during the later stages in the development of the grubs that the heaviest injury is inflicted on paspalum paddocks. When full grown, they pass through the pupal stage to the beetle stage, the beetles subsequently emerging when the soil has been softened by the storm rains of spring or early summer.

I have given you a brief outline of the life history of this species as some knowledge thereof is essential to an appreciation of the reason for its abnormal abundance during recent years and to an understanding of what we are attempting to do in the matter of control.

Naturally the investigations, which have been conducted by Smith[20] and Atherton,[21] included an effort to determine why the Tableland should have been practically free from white grub losses until about 1928. In this connection Smith investigated the rainfall records and was forced to the conclusion that the degree of intensity of infestation was largely dependent on the volume of the spring and early summer rainfall, the explanation of this association being somewhat as follows. The grubs pupate at a depth of two or three feet and it was found that the beetles, on the completion of the pupal period, were unable to work their way to the surface of the soil until it had been thoroughly softened by rain. Should the spring or early summer rains fail a very large percentage of the beetles are unable to reach the soil surface and perish without mating and laying eggs. Hence adverse climatic conditions during the flight period automatically reduce infestation.

The weather data show that dry springs maintained an effective check on beetle emergence for quite a number of years but that in 1929, 1931, and 1933 wet springs were experienced and these produced a high percentage of beetle emergence from the soil. The white grub population has as a consequence been steadily building up until a culmination was reached in the disastrous losses of the autumn and winter of 1935.

The investigations disclosed no natural control factor of consequence other than the rainfall influence just mentioned. Furthermore, it was soon evident that little could be hoped for from insecticidal control. Soil fumigation has certainly been demonstrated to be a satisfactory measure for the control of white grubs on the high priced coastal areas under sugar-cane. The cost of such a control measure, however, is prohibitive on the much less valuable dairying country on the Tableland.

It may be that a natural enemy such as the giant American toad (*Bufo marinus* L.) will prove of value in control if and when it spreads from the coastal belt to the Tableland. The prospects, however, of biological control by the introduction of insect enemies are by no means bright for here we are dealing with a native species and experience indicates that the biological control method offers reasonable prospects of success only in the case of introduced pests.

Under these circumstances we have been forced to the conclusion that the solution of the problem lies in the direction of an alteration in farming practice in the infested areas. The required alteration is a change from grassland dairying to mixed farming and it is believed that such a change is desirable agriculturally as well as entomologically.

Although the entomological investigation has yielded no direct measures of control in this particular case, it has made available a very considerable mass of valuable information which is essential to the success of the proposed alteration in farming practice.

The magnitude of the flight of the beetles is an easily observed incident and we know that heavy losses of pasture will occur during the late summer and winter of the second year following a large flight of beetles. We also know that losses will not be severe until then, *i.e.*, until the grubs are in an advanced stage of development. The farmer thus has ample warning of the extent of the losses he is likely to sustain eighteen months from the date of the flight and he thus has a reasonable period in which to make preparations for meeting the impending shortage of grass by growing cow cane or winter cereals and by producing silage. Fortunately general field crops are not menaced by the white grub for ample evidence has been obtained that the beetles do not lay their eggs in cultivated soil. Therefore in view of their freedom from attack, except by carry-over grubs from newly broken up grass paddocks, cultivated crops, which constitute a satisfactory source of milk, should feature much more conspicuously in the programme of the Tableland than is the case at present and grass should be treated as one of a number of crops in a rotation. With this objective the Department of Agriculture and Stock has established a considerable series of experimental plots to obtain information required to facilitate the change to mixed farming.

Conclusion.

In the time at my disposal to-night I have endeavoured to show how we are striving to prevent additions to our entomological problems in Queensland by paying reasonable attention to quarantine measures. I have also endeavoured to indicate how we are dealing with the existing problems, the five insects discussed having been chosen because each represents a different type of problem in which the sum of the various lines of attack covered most of the field of entomological control measures.

As is the case in all investigational work varying degrees of success have been achieved, but the measure of success in entomological work in this State has, I think, been sufficient to warrant some degree of quiet optimism. Whether or no that be the case, the insect menace is a very real one for it is no exaggeration to say that the future may well witness a still more serious struggle between man and insect for the world's available food supply. Even the present position is, in all truth, serious enough and it constitutes a challenge which cannot safely be ignored.

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Essential Oils from the Queensland Flora—Part VII.—Melaleuca pubescens.

By T. G. H. Jones, D.Sc., A.A.C.I., and F. N. Lahey, B.Sc.

(*Read before the Royal Society of Queensland, 28th October,* 1935.)

Melaleuca pubescens is a very common tree in Queensland in the Brigalow (*Acacia harpophylla*) scrubs of South-eastern Queensland where it presents rather a serious problem in clearing the country as it suckers freely and is rather hard to kill. It is a small tree with rather tight blackish bark. The leaves are small and narrow and measure about one centimetre in length. They are commonly recurved. The flowers are borne in great abundance in mid-summer and are white and arranged in spikes of two to four centimetres in length. The seed capsules are borne on the older wood and remain on the tree for some time and are the size and shape of a small pea.

100 lb. of leaves collected from the Inglewood district gave 140 ccs. of oil with a strong odour of cineol. Owing to the cost of collection a second supply was not obtained. The oil on examination conformed to the pinene, cineol type of oil, cineol being present to the extent of 50 per cent. (Cocking's method). Terpineol was also present, together with sesquiterpene, probably aromadendrene.

Experimental.

The oil possessed the following constants :—

$d_{15\cdot5}$	·9098
N^D_{20}	1·4600
$[\alpha]_D$	+8·6
Ester value	4·5
Acetyl value	22·7

After a preliminary washing with dilute sodium hydroxide solution, which removed a trace only of a phenolic body and examination for aldehydes (absent) the oil 120 ccs. was submitted to fractional distillation under diminished pressure 24 mms. and fractions obtained as under *a*, *b*, *c*—

(*a*) The fractions of lower boiling point (60-95° C.) 90 ccs. so obtained were shaken with 50 per cent. resorcin solution to remove cineol and the residue refractionated giving a head fraction with the following constants :—

$d_{15\cdot5}$	·8664
N^D_{20}	1·4637
$[\alpha]_D$	16·2

Identity with d-α-pinene was established by the preparation of the nitrosyl chloride (M.P. 109°C.) and of pinonic acid (M.P. of semicarbazone 204° C.).

Cineol, liberated from the resorcin compound by steam distillation possessed the following constants :—

$d_{15\cdot5}$	·930
N^D_{20}	1·4588
b.p.	176°-177°C.

Identity with cineol was established by formation of the o-cresol compound M.P. 55° C.

(*b*) The fraction 95°-115° C. (10 ccs.) possessed the following constants:—

$d_{15\cdot5}$	·9174
$[\alpha]_D$	—·25
N^D_{20}	1·475

It was washed with resorcin solution and together with tail fractions from (*a*) after separation of pinene and cineol was refractionated.

2 ccs. of liquid with the characteristic odour of α-terpineol were obtained with the following constants :—

$d_{15\cdot5}$	·932
$[\alpha]_D$	—1·5
N^D_{20}	1·480

Combustion results indicated $C_{10}H_{18}O$ (Found C = 78 per cent. H = 11·7) and confirmation as terpineol was obtained by preparing the phenyl urethane (M.P. 113° C.).

(*c*) The fraction 115-130° C. (5 ccs.) possessed the following constants :—

$d_{15\cdot5}$	·9258
$[\alpha]_D$	+1·5
N^D_{20}	1·4910

Presence of sesquiterpene was demonstrated by the acetic acid, bromine vapour colour test. No solid derivatives were obtained, thus suggesting aromadendrene, but the amount available did not admit of further examination.

The authors are indebted to the Forestry Department for collection of leaves and to Mr. C. T. White for botanical assistance.

Notes on Australian Muscoidea II. Subfamily Muscinae.

By G. H. Hardy.

(*Tabled before the Royal Society of Queensland, 27th April,* 1936.)

In Australia only five valid genera of the family Muscidæ come within the subfamily Muscinæ but many more names have been given generic status and brought into the Australian section of this fauna. Also *Gordonia* Malloch has been placed in this section but the description is too inadequate for determining its true status and I have not succeeded in recognising a specimen.

Key to genera of *Muscinæ*.

1. Metallic flies. Ridge bordering squama bare (*Pyrellia*) or hairy. In the latter case the presutural dorsocentrals may be absent (*Pseudopyrellia*) or present (*Orthellia*). Presutural acrostichals absent. Pteropleura with hairs. Prosternum varying from hairy to quite bare. Bristles on lower branch of radial vein extend for a considerable distance .. .. .. *Pyrellia*

   Non-metallic flies. Ridge bordering squama bare 2

2. Pteropleura with hairs. Presutural acrostichals absent. Prosternum hairy only at edges. Bristles on lower branch of radial vein, when present, restricted to the base .. .. *Musca*

   Pteropleura bare 3

3. Arista bare (unique to genus). Presutural acrostichals present. Prosternum hairy. Bristles on lower branch of radial vein restricted to base. Interfrontalia hairy but without outstanding bristles .. .. *Synthesiomyia*

   Arista plumose. Prosternum bare. Bristles extending a considerable distance along lower branch of radial vein 4

4. Both sexes with wide hairy interfrontalia containing a pair of bristles (unique to genus). With presutural acrostichals. Eyes hairy .. *Passeromyia*

   Interfrontalia bare. Eyes bare. Without presutural acrostichals *Graphomya*

Genus *Pyrellia* Desvoidy.

Robineau-Desvoidy, Essai Myodaires, 1830, 462.

There are three sections in this genus named in the key, but as characters are found to grade on exotic forms they cannot be regarded as genera of satisfactory status. The identity of the species listed below, rests on material identified somewhere about 1920 by the late Professor M. Bezzi, by Major E. E. Austen who compared specimens with Walker's types, and by the late Dr. J. M. Aldrich. This material, handled originally by Professor T. Harvey Johnston, has long been under my charge together with some material bred by Johnston and Bancroft.

Key to species of *Pyrellia.*

1. Without presutural dorsocentral bristles. Ridge bordering squama hairy. Vivid blue species with antennæ usually yellow. Upper eye-facets enlarged on male. On female the frons is as wide as, or wider than, the eye-width, and the interfrontalia much narrower than parafrons 2

   With two presutural dorsocentrals, often very short and the second pair of bristles may be weak or even missing. The antennæ are usually black. The frons narrower than the eye-width and the interfrontalia wider than the parafrons on the female 3

2. Larger species. Eyes of the male separated by the width of an eye-facet .. .. *lauta* Wied.
   Smaller species. Eyes of male separated by the width of three eye-facets .. .. *caerulea* Wied.
3. Ridge bordering squama hairy. Legs entirely black 4
   Ridge bordering squama bare. Femora metallic green .. *tasmaniae* Macq.
4. Eyes of male with well defined area of enlarged facets and separated by the width of one facet. Larger bluer species, anterior spiracle usually faun .. *egle* Bigot
   Eyes of male without defined area of enlarged facets and separated by width of ocellar triangle. Smaller greener species with anterior spiracle usually black .. .. *maronea* Walk.

Pyrellia lauta Wied.

Musca lauta Wiedemann, Aussereur. zweifl. Ins. ii. 1830, 410.

Orthellia lauta Aubertin. Ann. Mag. Nat. Hist. (10) xi. 1933, 141.

Musca proerna Walker. List Dipt. B. Mus. iv. 1849, p. 888.

One specimen was identified by Austen under Walker's name and another by Bezzi as being Wiedemann's species. The synonymy has already been published by Aubertin.

Hab.—Queensland. Although it occurs in Brisbane, this is mainly a North Queensland species which extends through the islands, Java being the type locality.

Pyrellia caerulea Wiedemann.

Musca caerulea Wiedemann. Zool. Mag. III., 1819, 23.

Lucilia viridiceps Macquart. Dipt. Exot. suppl. iv. 1849, 249.

Pyrellia proerna Johnston and Tiegs. Proc. Roy. Soc. Queensland, xxxiv. 1922, 100—nec Walker, 1849.

This common Brisbane species breeds in cow-dung and a specimen so bred was identified by Aldrich as *viridiceps*. Johnston and Bancroft did not recognise it as distinct from the prior species and I have been unable to find a satisfactory character for separating the females of these two closely allied forms although they seem to stand separated on colour, the present one being referred to by Johnston and Tiegs as cobalt blue. It is the form known to Johnston, Bancroft and Tiegs as being *prœrna* and they placed it in *Pseudopyrellia* on characters, I think, other than those given in the key and which I find are unsatisfactory for the Australian material. The species also occurs in Sydney. Aubertin placed Macquart's name as a synonym.

Pyrellia egle Bigot.

Pyrellia viridifrons Macquart. Dipt. Exot. suppl. 4. 1849, 251. (Preoccupied by *Lucilia viridifrons* Macq., 1843, also a *Pyrellia.*)

Pyrellia egle Bigot. Ann. Ent. Soc. France (5), viii. 1878, 37. Brauer. Denk. K. Ak. Wiss. m.-n. Cl. cviii. 1899, 527.

Pseudorthellia viridiceps Townsend. Ins. Ins. Mens. iv. 1916, 44. Nec. Macquart, 1849.

In literature this species seems to have been confused owing to Townsend who apparently made it the type of his *Pseudorthellia*, erroneously giving Macquart's name *viridiceps* as genotype. Characters given by Townsend certainly suggest this. Johnston and Tiegs (1922, p.

100) make the remark that Aldrich considered *viridifrons* and *viridiceps* may be the same species. This suggests that a confusion existed in America between two forms and Aldrich was following Townsend. The presutural dorsocentrals are often difficult to detect, leading to possible misalliances, but the frons is so very much narrower in the present case that errors of this nature may be readily detected. No specimen of the present form existed in the Johnston collection and hence it had not been identified.

Of the forms known to me, only two can fit the description of *cgle,* the other one being *maronea.* The latter, however, almost invariably has the anterior spiracle black, only one specimen before me being otherwise coloured, whereas the spiracle is usually reddish on the present species conforming to Bigot's description ''cicitriçe subhumerali fulva,'' and exceptions are rare.

Hab.—Queensland. Common around Brisbane.

Pyrellia maronea Walker.

Musca maronea Walker. List Dipt. B. Mus. iv. 1849, 886.

Orthellia maronea Aubertin. Ann. Mag. Nat. Hist. (10) xi. 1933, 142.

Musca donysa Walker. List Dipt. Brit. Mus. iv. 1849, 886.

Pyrellia nigriceps Macquart. Dipt. Exot. suppl. 4. 1849, 252. Schiner, Novara Reisa. Dipt. 1866, 304.

The synonymy is given by Aubertin and a male specimen before me was compared with the type by Austen, this fixing the identity of the species.

Hab.—Queensland: Brisbane. New South Wales: Sydney.

Pyrellia tasmaniae Macquart.

Pyrellia tasmaniae Macquart. Dipt. Exot. suppl. 1. 1846, 199.

Musca extrema Walker. Ins. Saund. Dipt. 1853, 348.

Pyrellia australis of Authors is probably this species—nec. Macq.

There is only one species of *Pyrellia* known to me from Tasmania and it extends to Brisbane where it is quite common. Macquart's description of this, the first *Pyrellia* he described from the Commonwealth, is very short and unsatisfactory, but Walker mentions the green metallic femora which leaves little doubt concerning the identity of his form.

None of the authors give information for the determination of their identification of *australis* and no specimens are marked as such in the Johnston collection. Moreover I have not seen any *Pyrellia* that fits Macquart's description, the figure of the wing in this case being extraneous to the genus whilst his other figures conform.

Hab.—Queensland to Tasmania. Generally distributed.

Note.—The specimens identified by Froggatt for Johnston as being *tasmaniœ* belong either to *lauta* or *cœrulea,* perhaps both, but the label is attached to the former.

Pyrellia sp.

Specimens bred by Johnston and Bancroft, and identified as being near *australis,* are very small and seem to have a wider frons on the male than is the case with *tasmaniae.* No male captured conforms to them, but a female comes from the Queensland National Park (A. J. Turner, March, 1929) which specimen certainly has a wider frons suggesting it is a new and undescribed minute species, half the length of a normal specimen of *P. tasmaniae,* and a quarter that of *P. egle.* The femora are green, at least in part on the captured specimen, but this character is not apparent on the four bred specimens before me. Presumably the species has been overlooked owing to its minute size.

Hab.—Queensland.

Species unidentified.

P. australis Macquart. Dipt. Exot. suppl. 3, 1848, 57.

P. analis Macquart. Dipt. Exot. suppl. 5. 1855, 114.

Genus *Musca* Linn.

Linnæus. Syst. Nat. 1758, 589.

There have been attempts to divide this genus, the characters given being quite inadequate for the purpose, but Patton has shown that there are quite natural groups within it. The known Australian species were dealt with by Johnston and Bancroft and the synonymy by Patton.

Key to species of *Musca.*

1. With pleural hairs lying in front of anterior spiracle and below humeral callus. Interfrontalia exceptionally wide on both sexes. With two pairs of stripes extending full length of thorax. Abdomen of male reddish-yellow, of female dark .. .. *domestica* L.

   Without pleural hairs lying in front of anterior spiracle. Interfrontalia usually much narrower on female, always narrower on male. Inner stripes of thorax usually shorter than, or fused with, outer ones 2

2. Only the male with abdomen reddish-yellow, that of the female being dark 3

   Both sexes with abdomen reddish-yellow. Eyes of male narrowly separated, stripes of thorax separated 4

3. Larger species, 6 mm. or more with inner stripe of the thorax separated from the outer one. Eyes of male practically contiguous. Interfrontalia of female exceptionally narrow, occupying barely half width of frons .. .. *fergusoni* J. & B.

   Smaller species with inner stripes of thorax fused with outer. Eyes of male separated by width of half ocellar triangle. Interfrontalia of female slightly over half width of frons .. .. *vetustissima* Walk.

4. Larger species, 6 mm. .. .. *hilli* J. & B.

   Smaller species, 4½ mm. .. .. *terraereginae* J. & B.

I do not know how to define differences between *hilli* and *terraereginae.* They are listed as valid species by Patton, but Johnston and Bancroft's specimens show so much variation that a line of demarkation does not seem to be available and the authors did not draw up a list of comparative characters. Evidently they left differences to be inferred by the drawings and these show nothing conclusive, distinctions showing there not always showing on the specimens.

Musca domestica Linn.

Musca domestica Linn. 1758. Johnston and Bancroft. Proc. Roy. Soc. Queensland, xxxi. 1920, 181-203, figs. Johnston and Tiegs. Proc. Roy. Soc. Queensland, xxxiv. 1922, 91. Patton. Bull. Ent. Res. London, xii. 1922, 424; and Philippine Journ. Sci. xxvii. 1923, 312.

Musca australis Macquart. Dipt. Exot. suppl. 4. 1849, 266. Walker. List Dipt. B. Mus. iv. 1849, 901. Patton. Philippine Journ. Sci. xxvii. 1925, 186. Nec. J. and B. 1920 (Preoccupied Boisduval).

Musca minor Macquart. Dipt. Exot. suppl. 4. 1849, 253. Patton. Philippine Journ. Sci. xxvii. 1923, 195.

The very wide interfrontalia on both sexes is a character useful for the ready recognition of this species which occurs throughout the Commonwealth.

Musca vicina Macq.

M. vacina Macquart, described from America, was originally regarded by Patton as an atypical species of *domestica,* but more recently he has established it as a distinct species inhabiting the tropics with a distribution reaching the Mediterranean and North China.

A record of *M. domestica* Linn. as a bush fly in Australia by G. F. Hill (Ann. Trop. Med. and Parisit. xv., 1921, p. 93) may possibly refer to this species for Austen identified material submitted by Hill as being a variety of *domestica* which Hill recorded without accepting.

The possibility of Hill having made an error in his identification must not be overlooked and his is the only reference I have found that suggests *M. vicina* Macq. occurs in the Northern Territory and North Queensland.

The species is to be distinguished by the frons of the male being slightly narrower, and the female has perhaps more brown in its colour pattern. Patton records differences in the terminalia of the male and records overlapping in its distribution and that of *M. domestica.*

Musca fergusoni J. and B.

Musca convexifrons (Thomson, 1868). Patton. Philippine Journ. Sci. xxiii. 1923, 334; and xxvii. 1925, 186, 198.

Eumusca australis Townsend. Ins. Insc. Mens. iv. 1916, 44.

Musca australis Johnston and Bancroft. Proc. Roy. Soc. Queensland. 1920, xxxi., 182. Nec. Macquart, nec. Boisduval.

Viviparomusca fergusoni Johnston and Bancroft. Mem. Queensland Mus. vii. 1920, 31.

Musca fergusoni Johnston and Tiegs. Proc. Roy. Soc. Queensland, xxxiv. 1922, 97. Patton. Bull. Ent. Res. London, xii. 1922, 425; and Philippine Journ. Sci. xxvii. 1925, 198; and Ann. Trop. Med. Parasit. xxvi. 1932, 382.

For the ready recognition of this species it will be noted the eyes of the male are practically contiguous and the interfrontalia on the female is less than half the width of the frons. The species is only known to me from Queensland for certain, as the identified female I examined from Darwin does not conform in head characters whilst the male with it is evidently *vetustissima*. The stripes, often to be distinctly seen with the inner pair short, may be traceable to the full length of the thorax, depending largely on the incidence of the light and the condition of the specimen.

Musca vetustissima Walker.

?*Musca pumila* Macquart. Dipt. Exot. suppl. 3. 1848, 58.

Musca vetustissima Walker. List Dipt. B. Mus. iv. 1849, 902. Johnston and Bancroft. Proc. Roy. Soc. Queensland, xxxi. 1920, 195; and Mem. Queensland Mus. vii. 1920, 41 (*Eumusca*). Johnston and Tiegs. Proc. Roy. Soc. Queensland, xxxiv. 1922, 95. Patton. Philippine Journ. Sci., xxiii. 1923, 315; and xxvii. 1925, 186, 196.

Musca corvina Froggatt, nec. Fabricius. Patton. Philippine Journ. Sci., xxiii. 1923, 314.

Musca pumila Patton. Bull. Ent. Res. London, xii. 1922, 424.

Macquart described two species from Australia, one as *australis* the type of which was found to be *domestica,* and the other Patton first identified as being the present species, then later relinquished the name *pumila* as the type was lost. Macquart's material was obtained entirely from south-eastern Australia and Tasmania where apparently only two species of *Musca* occur, suggesting that Patton's original identification is correct, so the name might be revived with this assurance as to the identity of Macquart's species.

The species is distributed throughout the Commonwealth, and causes considerable annoyance, swarming (sometimes in many hundreds) around persons and animals.

Musca hilli J. and B.

Musca hilli Johnston and Bancroft. Mem. Queensland Mus., vii. 1920, 35. Johnston and Tiegs. Proc. Roy. Soc. Queensland, xxxiv. 1922, 99. Patton. Bull. Ent. Res. London, xii. 1922, 425; and Philippine Journ. Sci., xxvii. 1925, 198.

Hab.—Queensland.

Musca terraereginae J. and B.

?*Musca prisca* Walker. List Dipt. B. Mus., iv. 1849, 903.

Musca terraereginae Johnston and Bancroft. Mem. Queensland Mus., vii. 1920, 31. Johnston and Tiegs. Proc. Roy. Soc. Queensland, xxxiv. 1922, 98. Patton. Bull. Ent. Res. London, xii. 1922, 425; and Philippine Journ. Sci., xxvii. 1925, 198.

Patton examined Walker's type which is in poor condition and suggested the species might be the same as that described by Johnston and Bancroft.

Hab.—Queensland.

Genus *Synthesiomyia* B. and B.

Synthesiomyia Brauer and Bergenstamm. Muscaria Schizometops, iii. 1893, pp. 96, 110, 159, and 178.

Synthesiomyia brasiliensis.

?*Cyrtoneura flavicornis* Macq. 1849, nec. Macq., 1843.

Synthesiomyia brasiliensis Brauer and Bergenstamm. Muscaria Schizometops, iii. 1893, pp. 96, 110, 159, and 178.

In 1843, Macquart gave the name *Cyrtoneura flavicornis* to a fly from "l'isle de France" and again in 1849 to a fly without locality, but the second species had been regarded as Australian and seems to be the form subsequent described by Brauer and Bergenstamm.

I believe this species is also known as *nudistyla* v.d.Wulp, at the British Museum, but no specimens were labelled as such by Austen. Doubtless the synonymy has been published somewhere but I have not found it.

A specimen before me was identified as *S. brasiliensis* B. and B. by Aldrich and was the record upon which Johnston and Bancroft first recognised its presence in Australia. One specimen is labelled as having been reared from larvæ in carrion, presumably by Johnston and Tiegs.

The species is readily recognised by its bare arista and red-brown tip on the abdomen. It is very common in Brisbane over the winter months.

Genus *Passeromyia* R. and V.

Passeromyia Rodham and Villeneuve. Bull. Soc. Path. exot. 1915, 428.

Orthomusca Townsend. Ins. Insc. Menst., iv. 1916, 45.

Passeromyia longicornis Macquart.

Cyrtoneura longicornis Macquart. Dipt. Exot. suppl. 4. 1849, 255.

Muscina heterochaeta Villeneuve. Bull Soc. Ent. France. 1915, 227.

Passeromyia heterochaeta Rodhain and Villeneuve. Bull. Soc. Path. exot., viii. 1915, 428.

Ornithomusca victoria Townsend. Ins. Insc. Mens., iv. 1916, 45.

This fly figures rather extensively in the Australian literature as it is readily bred from newly deserted bird's nests and in these cases it is heavily infested by three genera of blowfly parasites, *Mormoniella*, *Paraspilomicrus* and *Tachinaephægus*. A series bred from nests of *Myzantha garrula* (Noisy Miner) and some captured specimens are before me.

Hab.—Queensland to Victoria, but probably occurs widely over the Commonwealth.

Genus *Graphomya* Desvoidy.

Robineau Desvoidy. Essai Myod. 1830, 403. Mackerras. Proc. Lin. Soc., N.S. Wales, lvii. 1932, 361.

Graphomya maculata rufitibia Stein.

Stein. Ann Mus. Hung., xvi. 1918, 147. Mackerras. Proc. Linn. Soc., N.S. Wales, lvii. 1932, 361.

Hab.—Queensland and New South Wales. Two males and six females before me were taken in Brisbane during the months of June, July, October and November from 1928 to 1933. All were taken at rest on leaves, most of them on a mango tree at Sunnybank. The fly is probably not uncommon though seldom seen.

Graphomya campbelli Mackerras.

Mackerras. Proc. Lin. Soc., N.S. Wales, lvii. 1932, 363.

Hab.—North Australia. The species was described from a unique male.

The Analysis of Co-variance and its Use in Correcting for Irregularities of Stand in Agricultural Trials for Yield.

By L. G. MILES, B.Sc.Agr., Ph.D., and W. W. BRYAN, M.Sc.Agr.

(*Tabled before the Royal Society of Queensland, 27th April,* 1936.)

Irregularities in stand have proved a frequent source of trouble in agricultural yield trials. The effects of such irregularity may be reflected in an increased residual variability, or "error" component, coupled with decreased precision of the experiment, or they may actually affect certain varieties or treatments more than others, resulting in biassed or altogether erroneous conclusions. With root crops or transplanted crops, marked differences in stand may result through the complete failure of certain hills, while even with sown crops such as maize, yield results may be seriously affected by missing hills, or plants. Such gaps with sown crops are often caused by soil pests or diseases which destroy young seedlings, or may be due to inherently poor germination of the seed. In the former case, it is obviously not fair to penalise any one or more treatments because they have chanced to coincide with unfavourable soil areas. Even in the latter case, where the seed itself is at fault, the losses due to poor germination are almost always attributable to age of the seed or lack of care in its handling, and not to any failing of the variety itself. In such cases the question naturally arises: Are we justified in correcting our yields on a basis of stand counts ?

Numerous maize workers have studied the effects of missing hills on the yield of adjacent hills and on the plot yield; the general conclusion has been that, with ordinary rates of sowing, losses due to missing hills may be partially but not wholly counteracted by the increased yield of neighbouring hills or plants.[1 3] Where two or more adjacent plants are missing the reduction in yield will of course be more marked than if the same number of non-adjacent plants had been lost. The actual extent to which variations from a perfect stand affect yields can never be definitely worked out however, as it will vary with season, with soil type, and with rate of planting adopted. Nevertheless, it has been the invariable practice of some workers to correct yields for stand differences before analysing their results. Such corrections, though perhaps very desirable, are quite arbitrary since they imply unity correlation between yield and the figures taken to represent stand. The "co-variance" technique, however, described by Fisher[2] in 1932, and later by Wishart[7] and Snedecor,[5] has offered the most logical and reasonable method of adjusting yields on a basis of stand.

This method of analysis has numerous applications, but in cases such as that in question it aims at determining the residual unit plot correlation between yield and stand, after block and treatment effects have been removed; treatment means are then corrected on the basis of a regression of stand, which is actually proven to exist.

The application of the method is well illustrated in the case of a recent maize varietal trial conducted at the Queensland Agricultural College during the summer 1934-35. Ten varieties were under test (here indicated by the letters A to J), the plan of the experiment being a 10 x 10 Latin

Square, with 6-row plots, 54 ft. by 27 ft. These varieties were from different sources, and examination of the seed lots of G, H, and J showed them to be rather badly damaged by weevil, and to contain a number of dead grains. This condition was reflected in the impaired stands of these varieties after germination. Plant counts were therefore made on all plots, and recorded together with resultant plot yields.

An analysis of variance of Yield (Y), was made in the usual way. Portion of this analysis will be found under the heading Y in Table II. Application of the z test showed that highly significant differences between varieties were to be expected, and a summary of the results is given in Table I. It was evident that the four varieties lowest in yield were also those lowest in stand, so that had stands been equal in all cases, the order might have been very different.

The next step, therefore, was an analysis of variance of stand counts (X), proceeded with in exactly the same manner as that of yield. The salient features of this analysis also appear in Table II. under heading X. Here again the z test showed that the observed inter-varietal differences were probably highly significant, and that therefore correction of yields would be justified if yield were shown to be correlated with stand.

TABLE I.

SUMMARY OF UNADJUSTED YIELDS.

Variety.	Yield.		Significantly Exceeds.
	Lb. per Plot.	Bu. per Acre.	
A	86·76	46·3	DEFGHIJ
B	80·60	43·0	EFGHIJ
C	78·09	41·7	FGHIJ
D	73·51	39·2	IJ
E	69·92	37·3	IJ
F	68·01	36·3	J
G	65·00	34·7	J
H	64·68	34·5	J
I	60·72	32·4	J
J	43·46	23·2	..

S.E. (Mean of 10 Plots) = 3·058 lb. Signif. diff. = 9·17 lb.

The third step was an analysis of co-variance of X and Y. This is proceeded with in a manner closely parallel with that of the analysis of variance of X and Y, except that its basis is sums of products of X and Y, instead of sums of squares of either X or Y. Thus the formula for "total" sum of products becomes $\Sigma XY - \Sigma X(M_y)$; and that for varieties, $\Sigma X_v Y_v \div N - \Sigma X\ (M_y)$; where X_v represents varietal stand totals, Y_v varietal yield totals, and N the number of plots per variety. Similar formulæ of course hold for rows and columns, while the sum of products for error is obtained by subtraction. The quotient, sum of products devided by degrees of freedom, represents "mean product" or "co-variance," and is comparable with the mean square or variance obtained in analyses of variance. The analyses of variance and co-variance are shown in condensed form in Table II.

TABLE II.

ANALYSES OF VARIANCE AND CO-VARIANCE.

Due to—	D.F.	Yield (Y)		Stand (X)		Co-variance (XY)		
		Sum sqs.	Mean Sq.	Sum sqs.	Mean Sq.	Sum Prod.	M. Prod.	r
Rows ..	9	3475·090	386·121	58652·0	6516·89	10456·328	1161·814	·732
Columns ..	9	1184·783	131·642	68660·4	7628·93	6686·631	742·959	·741
Varieties ..	9	13103·303	1455·923	113949·8	12661·09	35225·108	3913·901	·912
Error ..	72	6732·363	93·505	75513·8	1048·80	16722·319	232·254	·742
Total ..	99	24495·539	..	316776·0	..	69090·386	..	..

z (Y) = 1·373. z (X) = 1·245. 1% point (Fisher) approximately ·46.

From the Tables of variance and co-variance, coefficients of correlation (between yield and stand), can be calculated for rows, columns, varieties, error and also total if desired. These are obtained by dividing the sum of products in each line by the square root of the product of the corresponding sums of squares for X and Y. Thus from Table II., r_{xy} (for Error) = $\frac{16722 \cdot 319}{\sqrt{6732 \cdot 3631 \times 75513 \cdot 8}}$ = ·742. The significance of these correlations is determined by the " t " test, or by the use of tables provided by Fisher[2] or by Wallace and Snedecor.[6] It must be remembered in using these tests that the number of degrees of freedom for correlation is in each case one less than in the analysis of variance. All the values shown were significant, those for varieties and error being highly significant. The high inter-varietal correlation coefficient of ·912 is of interest, since it indicates that yield differences between varieties are to a very high degree associated with differences in stand.

The important coefficient, however, is that of ·742, which represents the residual plot correlation after block and varietal effects have been removed. Since this correlation is highly significant, we are justified in correcting our yield values on a basis of their regression on stand. Had it not been significant, it would still have been allowable to make the adjustments, but such procedure would probably have been of little or no value in increasing the precision or validity of the results.

The regression of yield on stand is now determined for the " error " components, by dividing the sum of products by the sum of squares for stand. The regression coefficient, b, is thus found to be ·2214472. The correction equation is now : $Y' = Y - b\ (X - M_x)$; where Y represents actual individual yields, Y′ adjusted yields, X individual stands, and M_x the mean of all stands. The necessary adjustment is made by substituting varietal mean stands and yields for X and Y respectively in the above formula. Table IV. shows the adjusted varietal mean yields and the manner in which they were obtained.

There remains to be computed the analysis of variance of these adjusted yields. The sum of squares now becomes $\Sigma(Y' - M_y)^2$ which (substituting for Y′), equals $\Sigma\{Y - M_y - b\ (X - M_x)\}^2$, or $\Sigma(y - bx)^2$, where x and y are deviations of X and Y from their respective means. $\Sigma(y - bx)^2 = \Sigma y^2 - 2b\ \Sigma xy + b^2 \Sigma x^2$, *i.e.* sum of squares for yield, minus 2b times the sum of products, plus b^2 times the sum of squares for stand. These computations are made using the values for sums of squares and products in Table II., and the computed figures, ·049039 and — ·442894 for b^2 and — 2b respectively. This has been done in Table III. Take for example the computation for varieties : Sum of squares for Y, 13103·3031, is entered unchanged; sum of products, 35225·108, is multiplied by — ·442894 to give — 15600·9890; and sum of squares for X, 113949·8, is multiplied by ·049039 to give 5587·9842. The algebraic sum of these three quantities, 3090·298, is the new sum of squares (using adjusted yields), for varieties. The other sums of squares may be obtained in a similar manner. It is important, however, to remember that one degree of freedom has been lost from the error complement, through the computation and use of the regression coefficient, b. The analysis of variance of adjusted yields is completed by dividing sums of squares by corresponding degrees of freedom to obtain mean squares.

TABLE III.

ANALYSIS OF VARIANCE OF ADJUSTED YIELDS.

Due to	D.F.	Sum Sqs. Y	$-2b$ (S. Prods.)	b^2 (S. Sqs. X)	Sum Sqs. Y'	M. Sq. Y'
Rows	9	3475·0904	−4631·0449	2876·2354	1720·281	191·142
Columns	9	1184·7825	−2961·4688	3367·0374	1590·351	176·706
Varieties	9	13103·3031	−15600·9890	5587·9842	3090·298	343·366
Error	71	6732·3631	−7406·2148	3703·1212	3029·269	42·666

$z = 1{\cdot}043$. 1% point (Fisher) = approximately ·46.

S.E. (Mean of 10 Plots) = $\sqrt{4{\cdot}2666} = 2{\cdot}066$.

In comparing this analysis with that of original yields in Table II., a striking feature is the reduction of the mean square for error from 93·5 to 42·7, indicating that considerably greater precision has been attained by eliminating the effects of stand variability. It is also evident, however, that the mean square for varieties has been still more reduced, though the application of the z test indicates that highly significant inter-varietal differences still exist.

The new standard error for a mean of 10 plots becomes $\sqrt{4{\cdot}266}$ or 2·0656 lb., and the minimum difference between adjusted mean yields which can be classed as significant, 3 × 2·0656 or 6.20 lb. Table IV. presents the 10 varieties in the order of their adjusted yields. It will be seen on comparison with Table I., that the varieties A, B, C, D, E, F, I, and J have not altered their relative positions, though their range has been considerably reduced. H, however, which was previously eighth in order of yield, and significantly below A, B, and C, has now risen to third place, where it is on a par with A and B, and significantly better than E, F, I and J. The only other variety which has improved its position is G, which was previously seventh in order, and significantly superior to J alone. This variety is now in fifth position being superior to I and J, and significantly exceeded only by A.

TABLE IV.

ADJUSTED VARIETAL MEAN YIELDS.

Variety.	X	X − M_X	− b (X − M_X)	Y	Adjusted Yields. Lb. per plot.	Adjusted Yields. Bu. per acre.	Significantly exceeds.
A	279·4	40·0	−8·858	86·763	77·90	41·6	GDEFIJ
B	260·6	21·2	−4·695	80·602	75·91	40·5	DEFIJ
H	201·5	−37·9	8·393	64·681	73·07	39·0	EFIJ
C	266·6	27·2	−6·023	78·095	72·07	38·4	FIJ
G	214·4	−25·0	5·536	64·996	70·53	37·6	IJ
D	267·8	28·4	−6·289	73·507	67·22	35·9	J
E	255·8	16·4	−3·632	69·917	66·28	35·4	J
F	249·0	9·6	−2·126	68·008	65·88	35·1	J
I	232·5	−6·9	1·528	60·719	62·25	33·2	..
J	166·4	−73·0	16·166	43·463	59·63	31·8	..

These results are more in keeping with past experience, since it has been impossible over a period of nine years to separate B and H with respect to yield. The application of the co-variance technique may therefore be said to have raised the trial from one on which little reliability could be placed on account of stand discrepancies, to one of considerable value in the varietal trial series.

This method should be applicable with even more striking results to experiments with wider spaced plants where individual losses might be more scrious than with maize. Sanders[4] has shown how the method might be used to correct yields of plots in an experimental year for variations in yield of the same plots during a preliminary uniformity trial. Probably the greatest application of the analysis of co-variance in field experimentation will be however with perennial crops, where blank tests can be conducted for a number of years prior to the imposition of fertilizer, cultural or pruning treatments. Correction of the experimental yields on the basis of their regression on the preliminary yields will be a very important factor in reducing the standard error, and greatly increasing the precision of such experiments.

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A Small Collection of Fossil Cockroach Remains from the Triassic Beds of Mount Crosby, Queensland.

By R. J. Tillyard, M.A., Sc.D., D.Sc., F.R.S., F.R.E.S.

(*Communicated to Royal Society of Queensland, 31st August,* 1936.)

The small collection of fossil cockroach remains which forms the subject of this paper was made by Messrs. O. A. Jones, M.Sc., and A. K. Denmead, M.Sc., both graduates of the University of Queensland, Portion 205, Parish of Chuwar, near Mount Crosby, South Queensland. The collection was forwarded to me by Dr. W. H. Bryan, of the Department of Geology, University of Queensland.

In his letter to me, Dr. Bryan writes as follows:—"The locality had previously been regarded as of Tertiary age, but these gentlemen (i.e., Messrs. Jones and Denmead) have shown that the beds concerned (including that containing the insects) belonged to the bottom of the Ipswich Series, being even lower than the so-called 'basal conglomerates.' The Denmark Hill insects, you will remember, came from the *top* of the Ipswich Series."

The fossil insects are impressions of cockroach forewings or tegmina on a medium ochreous to greyish shale, of rather coarse and slightly sandy texture, such that the finer details of the venation, though fairly clear, are not as good as those found in shales of finer grain. There are nine specimens in the collection, seven of which are merely fragments, too incomplete for description, while the other two, represented by both obverse and reverse impressions, are of very nearly complete forewings. All the specimens appear to belong to the same genus, and the two complete forewings or tegmina belong to two distinct but related species, both new to science.

Order Blattaria.

(Cockroaches.)

Family mesoblattinidae Handlirsch.

Genus *Triassoblatta* Tillyard.

Tillyard, Mesozoic Insects of Queensland. No. 6. Blattoidea. *Proc. Linn. Soc. N.S.W.*, 1919, xliv., pt. 2, p. 367.

Genotype:—*Triassoblatta typica* Till., from the Upper Triassic Beds of Denmark Hill, Ipswich, Queensland.

The genus contains medium to large tegmina (12 to 21 mm. in length), distinguished by the following characters:—Humeral area narrow to moderately wide, distinctly shorter than the anal area. Subcosta (Sc) ending up on costa at from one-third to nearly one-half the wing-length, and consisting of from four to seven branches. Radial system (R) with posterior main stem, formed originally from Rs, having only very slight sigmoidal curvature, so that its lowest point (about midway along the wing) is well above the middle line of the tegmen. R ends only slightly above apex. Media (M) poorly developed, occupying only a narrow triangular area ending around the apex and extending at most not more posteriorly than about the apical one-fourth of the posterior margin. Anterior cubitus (CuA) well developed, occupying a wide triangular area along posterior margin, and with many branches. Intercalated longitudinal striae occur throughout the cubital, median and distal part of the radial regions. Clavus or anal region large, always longer than one-third of the wing, strongly cultriform; vein 1A and at least the first branch of 2A end on the *vena dividens* (CuP), which is very strongly developed.

The above definition is modified from the one originally given by me (1919, p. 367) but does not differ in any essential particular from the original.

Two species were originally described by me from the Upper Trias of Ipswich, Q., viz. *T. typica* Till., the genotype, having a tegmen only about 12 mm. long, and *T. insignita* Till. with a tegmen about 21 mm. long. The two species differed also in the amount of curvature of the costal margin, which was much greater in *T. typica,* in the size of the humeral area, which was very narrow in *T. typica* but broadly lanceolate in *T. insignita,* and in the branchings of Sc, which was short and had only four branches in *T. typica,* considerably longer and with seven branches in *T. insignita.*

The two new species from Mount Crosby approach *T. insignita* in size, ranging from 18 to 19 mm. in length. They both fit well within the generic definition, but both possess also well marked specific characters which clearly distinguish them from one another and also from the Ipswich species.

In order to make the position quite clear, I give here a Key to the four species of *Triassoblatta* now known:—

Key to the known species of *Triassoblatta* Till.

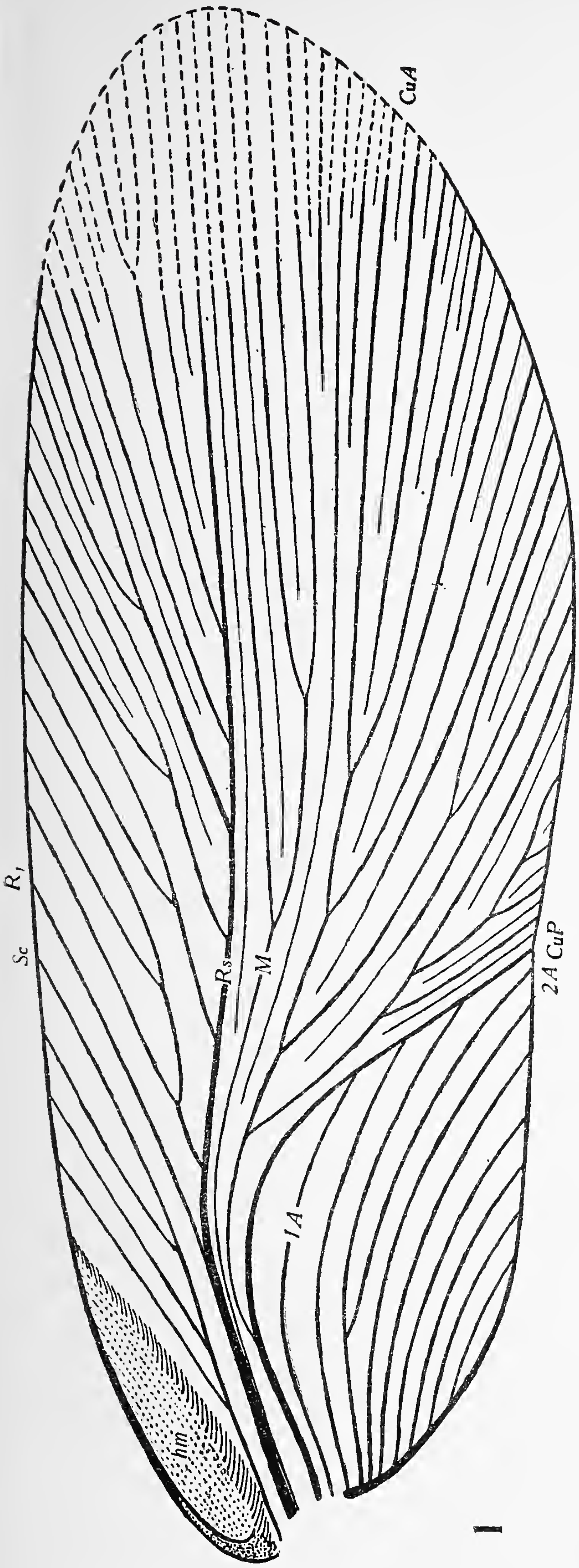
1. Comparatively small tegmina, about 12 mm. long, with narrow humeral area .. .. *T. typica* Till.
   Comparatively large tegmina from 18 to 21 mm. long (Genotype; Denmark Hill, Ipswich). With moderately wide humeral area 2
2. Tegmen about 21 mm. long; Sc. comparatively long, with seven branches *T. insignita* Till. Denmark Hill, Ipswich).
   Tegmen from 18 to 19 mm. long, with Sc. much shorter and only possessing from four to five branches 3
3. Comparatively narrow wing; clavus long and comparatively sharply angled distally .. .. *T. jonesi* n. sp. (Mount Crosby).
   Comparatively broad wing; clavus much shorter and comparatively bluntly angled distally .. .. *T. denmeadi* n. sp. (Mount Crosby).

TRIASSOBLATTA Denmeadi n.sp.

(Fig. 1.)

Forewing or *tegmen* (not quite complete), 17·5 mm. long by 7·0 mm. wide, representing a complete tegmen about 19 mm. long.

Humeral margin strongly curved at base, but quickly flattening out to a gentle curvature, the humeral area being moderately wide and lanceolate in shape. Rest of costal margin only very gently curved. Extreme apex missing, but probably broadly rounded as shown in the restoration in fig. 1. Posterior margin more markedly curved than costa. A slight embayment of the margin at end of *vena dividens* (CuP). Sc ending up on costa at about one-third of the wing-length,



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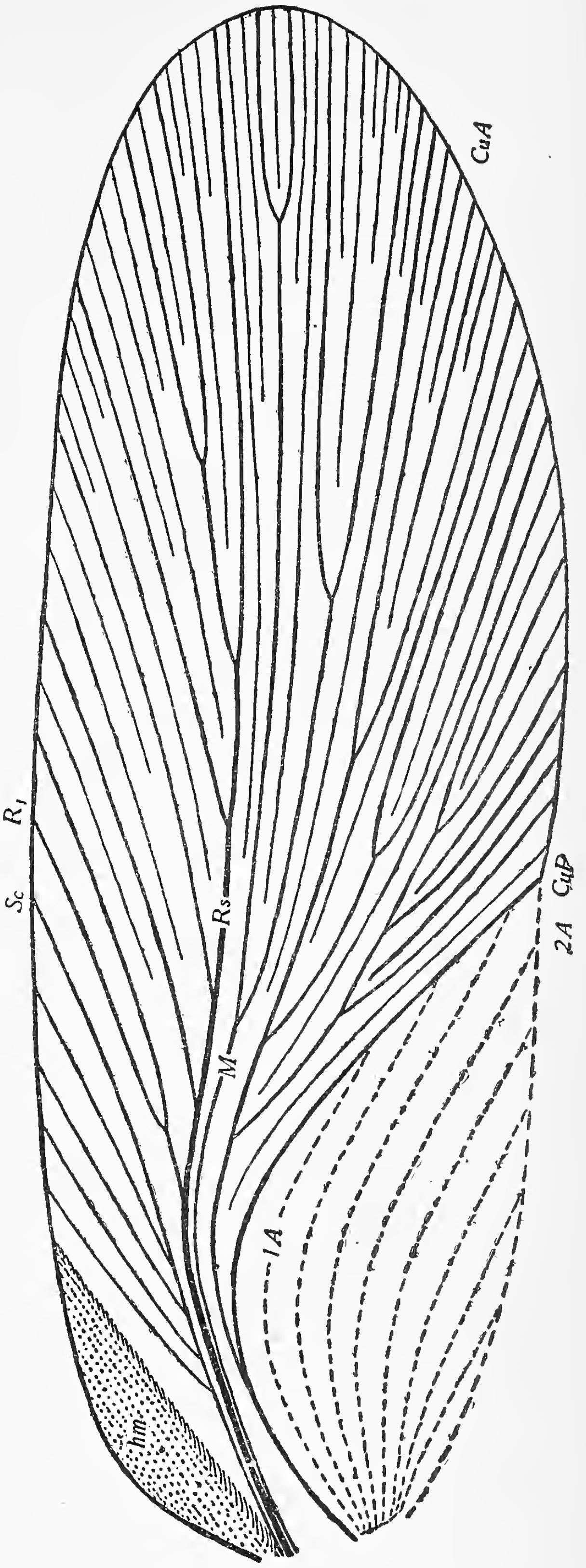

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Fig. 1. *Triassoblatta denmeadi* n.sp. Forewing or tegmen. 1A, first anal vein. 2A, second anal vein (with many branches). CuA, anterior cubitus (convex). CuP, posterior cubitus or *vena divindens*, lying in a deep groove separating the clavus, or anal area, from the rest of the wing. *hm*, humeral area. M, media. R_1, radius. Rs, radial sector, which, in the Cockroaches, becomes the main stem of the raidial system. Sc, subcosta. Length 18 mm.

Fig. 2. *Triassoblatta jonesi* n.sp. Forewing or tegmen. Lenght 19 mm. Lettering as in fig. 1.

In both figures, parts missing in the actual fossils and restored in the figures are shown by broken lines.

with four branches fairly evenly spaced. R_1 a simple vein, subparallel to Sc. Main stem of radial system (Rs) bent slightly at its junction with R_1, then very slightly curved to apex, its lowest point being about the middle of the wing, and the width of the radial area at that point being not more than two-fifths of the width of the wing. Intercalated longitudinal striae developed only in distal half of radial area, all the striae being faint. M weakly developed, with only three branches, the first fork occurring a little before half-way; longitudinal striae strongly developed. CuA apparently arising from the arch of CuP somewhat before its highest point; main stem of CuA faintly sigmoid in curvature and ending not very far below apex; number of branches five, of which the two most basal posterior ones are closest and most strongly curved; of these, the most basal converges very closely to the descending arch of CuP and then diverges strongly away from it, sending off two descending branches to the posterior margin, the first of these being simple, the second branched triangularly and reaching the margin at a slight angle; the second descending branch from the main stem of CuA runs subparallel to the first and forks about half-way; the remaining branches are simple; longitudinal striae are well developed in the cubital region. Clavus strongly cultriform, the arch of CuP being stronger than the curve of the anal margin; the distal angle of the clavus is about 55°, and CuP descends to the margin almost in a straight, oblique line. 1A is markedly less curved than CuP and ends fairly high up on the oblique descending portion of that vein. 2A has eight branches, of which all are simple except the second, which is strongly forked at about one-third from base; the first and second branches of 2A end on the descending part of CuP, the next branch on the wing-margin just before CuP.

Type.—*Holotype forewing, Specimen No.* F. 3175 *a-b*, in the collection of the University of Queensland, Brisbane. Both obverse (F. 3175*a*) and reverse (F. 3175*b*) impressions are equally good, though it is difficult to follow the exact courses of the longitudinal striae in the distal portion of the wing. The extreme apex is missing for about the last 1·5 mm. but is shown restored by broken lines in fig. 1. The specimen represents a right forewing.

TRIASSOBLATTA Jonesi n.sp.

(Fig. 2.)

Forewing or *tegmen* (complete except for missing clavus and a small excision from just above apex) 18·0 mm. long by 6·0 mm. wide.

This species can be distinguished at once from the previous one by the considerably narrower tegmen and by the following characters:—Humeral margin strongly curved at about middle, the shape of the humeral area being a hyperbolic curve cut off by a straight chord. Sc short, as in previous species, but with five branches, all simple and fairly evenly spaced. R_1 forked close to origin; general course of main stem of radial system (Rs) very similar to that in previous species, but with fewer branches. (The details of the branchings of the radial system vary from one individual to another in all cockroaches, so are deliberately not further specified here). M much as in previous species, but the first fork occurs a little nearer to both base and Rs, the second fork considerably further distad (these may possibly be only individual variations). General plan of the forking of CuA much as in previous species, but the forking of the first descending branch from the main stem is much deeper and more complete, this branch covering a much larger triangular area of the wing than in the previous species. Intercalated longitudinal striae beginning faintly in radial area just distad from R_1 and extending throughout radial area; in median and cubital areas, these striae become much stronger, and the longer middle members of the distal sets are just as strongly chitinized as the branches of the main veins themselves. *Vena dividens* (CuP) less strongly arched than in previous species, descending to posterior margin at a much smaller angle, about 45°; length of clavus fully two-fifths of wing-length, as against about one-third in previous species. Clavus missing; in fig. 2, it has been restored by broken lines. A small squarish incision distally above the apex actually spoils the contour of the tegmen in the type specimen, but the small portions of the margin and veins of the radial system missing on this account have been added to fig. 2 without using broken lines.

Types.—*Holotype forewing, Specimen No.* F. 3176 *a-b* in the collection of the University of Queensland, Brisbane. Both obverse (F. 3176*a*) and reverse (F. 3176*b*) impressions are equally good. As in the previous species, the courses of the longitudinal striae become somewhat difficult to follow distally. This specimen, like the previous one, represents a right forewing.

Age of the Mount Crosby Beds.

As both the species of fossil cockroaches discovered in the Mount Crosby Beds belong to the family Mesoblattinidae, characteristic of the Mesozoic (Trias to Lias), and to the genus *Triassoblatta,* so far found only in the Denmark Hill Beds at Ipswich, Queensland, there can be no doubt that the age of the Mount Crosby Beds is not very far removed from that of the Denmark Hill Beds. As already pointed out at the beginning of this paper, Messrs. Jones and Denmead have proved that the Mount Crosby Beds belong to the *bottom* of the Ipswich Series, whereas the Denmark Hill Beds belong to the *top* of the same series. The conclusion reached from a study of the fossil insects of Denmark Hill, of which about one hundred and twenty specimens are known, was that they were of Upper Triassic age, certainly not younger than Rhaetic. Hence it appears safe to place the insects in the present collection as of Upper Triassic age, but older than the Denmark Hill insects.

Without other collateral evidence, it would not have been possible, from the material before me, to state definitely that the insects were older than those of Denmark Hill. The fact that they belong to the genus *Triassoblatta* could only be taken to indicate that they were not far removed in age from the insects of Denmark Hill. A comparative study of the four known species of *Triassoblatta* is of interest in showing that the two species from Mount Crosby are more primitive than the two species from Denmark Hill in one important character, viz., the feeble development of the median vein. This is a character which, curiously enough, separates the most primitive of all Cockroach families, the Upper Carboniferous and Permian Archimylacridae, from other Palaeozoic and Mesozoic families, and, so far as I know, no other Mesozoic cockroaches except only these two species of *Triassoblatta* possess this character. Nevertheless, the archaic condition of the median vein, by itself, does not, in my opinion, justify the erection of a new genus for these two species.

By contrast, the two Mount Crosby species appear to be more specialized than the two Denmark Hill species in the evolution of the anal veins. In *T. typica* Till. (Denmark Hill) 1A ends on the *vena dividens* and the first branch of 2A ends close to the claval angle, possibly just at the end of CuP. The ends of these two veins are missing in *T. insignita* Till. (Denmark Hill). But, in the allied genus *Samaroblatta* Till., also from Denmark Hill, the condition is even more primitive, 1A ending either just near the end of CuP or on the posterior margin. The more archaic condition of the anal veins in the Mount Crosby specimens must be held to counterbalance somewhat the more archaic condition of the media, leaving us with little or no clear indication of the comparative ages of the two sets of species beyond the fact that both should be regarded as Upper Triassic.

Canberra, F.C.T., 7th March, 1936.

Essential Oils from the Queensland Flora, Part IX.—Melaleuca viridiflora, Part I.

By T. G. H. Jones, D.Sc., A.A.C.I., and
W. L. Haenke, B.Sc., B.Sc. (App.).

(*Tabled before the Royal Society of Queensland, 31st August, 1936.*)

Investigations of the essential oil from the broad leafed tea tree, which is a very common tree in Eastern Australia, have been carried out by several workers, and the main constituents of the oils examined by them placed on record.[1] Botanical investigation has likewise proceeded and the tree is referred to in this paper as *Melaleuca viridiflora,* although other names, such as *Melaleuca Leucadendron* (var. *lancifolia*) and *Melaleuca Maideni* have from time to time figured in the literature. Owing to the reported high cineol content of the oil, it has never been of economic value, but in view of several inconsistencies which appeared in the results of various workers, it appeared desirable to make a new and systematic investigation of the whole problem of the essential oils. In this work the authors have had the co-operation of the Forestry Department, which supplied many of the consignments of leaves and assisted the investigation as far as possible. It soon became apparent that at least two varieties of *Melaleuca viridiflora* existed, one in which cineol was the principal constituent, but the other contained no cineol, and trees of this type were readily differentiated from the cineol variety by the marked difference of odour of the crushed leaves. This particular variety was first located from a consignment of leaves from the neighbourhood of Maryborough, and fortunately the leaves were collected from two trees only which were kept separate until their identity was established. Trees of this same type were subsequently discovered in close proximity to Brisbane and, while a complete survey of the Brisbane area has not yet been carried out, it would appear that its distribution is considerably less than that of the cineol variety, although the two varieties grow together.

The investigation of the oil from this variety has been completed and forms the subject of this paper. It is intended to submit the results obtained from the examination of the cineol and possibly other varieties at a later date.

The oil described in this paper has been found to consist almost exclusively of the two alcohols linalol and nerolidol with a little sesquiterpene, citral and traces of a phenol. As the alcohols can be readily separated from one another and appear uncontaminated with other substances, the oil may be regarded as a convenient source of these alcohols, and in view of the linalol content (at least 50 per cent.) is of undoubted economic value.

It appears likely that the oils examined by previous workers were mixtures of the two varieties mentioned above, as indiscriminate picking of leaves was no doubt indulged in by collectors.

Experimental.

One and a-quarter cwt. of leaves collected at Antigua (near Maryborough) on 18th June, 1935, gave 700 ccs. of oil, while 200 lb. collected near Brisbane gave 1,000 ccs. of oil, the yield being in each case approximately 1 per cent. In the case of the Maryborough consignment the leaves were from two trees only and kept separate till their identity was established, while with the Brisbane leaves, careful selection of trees was resorted to in order to obtain samples from the same variety.

The following constants were recorded:—

	Maryborough Sample.	Brisbane Sample.
$d_{15 \cdot 5}$	·8764	.. ·880
N_{20}^{D}	1·4700	.. 1·4719
$[\alpha]_D$	+ 15·5	.. + 14·26
Ester Value	Nil	.. Nil
Acetyl Value	146·2	.. 150
$[\alpha]_D$ after acetylation	— 2	.. — 2

Both oils possessed a pleasant rose-like odour due to the presence of linalol.

The oils were washed with dilute Na_2CO_3, and then dilute NaOH solutions. The NaOH washing gave in each case about ½ ccs. of dark-coloured oil smelling of eugenol. The colour reaction with ferric chloride solution was reddish-brown (eugenol gives a green). Tests for β diketones were negative. A small quantity of crude benzoyl derivative was obtained, but it could not be sufficiently purified for identification.

The oil 790 ccs. (Brisbane sample only described as the Maryborough oil gave similar results) was next submitted to fractional distillation under diminished pressure 4 mm. and the following fractions collected:—

	Temp.	Vol.	$d_{15 \cdot 5}$	N_{20}^{D}	α_D
I. ..	0–59°C.	18 ccs.	·884	1·4654	+ 9·39
II. ..	59–62°C.	355 ccs.	·868	1·4607	+ 16·70
III. ..	68–118°C.	20 ccs.	·900	1·4780	+ 5·29
IV. ..	118–121°C.	370 ccs.	·884	1·4785	+ 11·54
Resinous Residue		25 ccs.			

Repeated refractionation ultimately resolved the various fractions into two main fractions (*b*) and (*d*) with a small head fraction (*a*) and a sesquiterpene fraction (*c*).

The small head fraction (*a*) 10 ccs. possessed the following constants:—

$d_{15 \cdot 5}$	·8858
N_{20}^{D}	1·4660
α =	+ 6·65
b.p. app.	186°C.

Examination revealed the presence of linalol (as would be expected in view of fraction (*b*), which required, therefore, that some constituent of density higher than ·8858 should be present. Cineol was naturally suspected under these circumstances, but only negative tests were obtained and similarly tests for pinene and other terpenes were negative.

It appears certain however by analogy with other oils containing linalol that some linalol monoxide ($d_{15 \cdot 5}$ ·9520) would be present.[2] Aerial oxidation of linalol while still in the tree is stated to give rise to small amounts of linalol monoxide. In all probability fraction (*a*) consisted of linalol with some contamination with monoxide sufficient to raise the density to that indicated.

Fraction (*b*) consisted essentially of linalol. The following constants were determined:—

$d_{15\cdot5}$	·868
N^{D}_{20}	1·4607
$[\alpha]_D$	+ 18·5
b.p.	60°C. 4 mms.

The fraction was submitted to critical examination in the following experiments:—

Primary alcohols.—Extraction with phthalic anhydride in benzene solution gave no indication of primary alcohols.

Terpenes.—Purification of the linalol was accomplished by the formation of sodium linalol; the non-alcoholic portion being then removed by vacuum distillation. Dihydromyrcene (a by-product of the action of sodium on linalol) was identified by means of its tetra bromide M.P. 88°C. The constants for this dihydromyrcene were as follows:—

$d_{15\cdot5}$	·783
N^{D}_{20}	1·4523

indicating that it was almost pure and that there could not be any appreciable quantities of non-alcoholic bodies in fraction (*b*). Linalol purified from its sodium compound possessed the following constants:—

$d_{15\cdot5}$	·869
N^{D}_{20}	1·4618
$[\alpha]_D$	+ 18.5

which do not differ markedly from those of the original fraction.

Identification of Linalol.—The phenyl and napthyl urethanes (M.P's 66°, 54°C.) were prepared and oxidation with dichromate gave good yields of citral. M.P. of semicarbazone 164°C. *Acetylation.* The acetylation of the fraction gave geramyl acetate as main product while the rotation became slightly negative in accordance with the well-known behaviour of linalol in this reaction.

Acetic Acid Benzidine Test.—The main linalol fraction gave a pronounced test with acetic acid benzidine solution, indicating the presence of an aldehyde. This test was also readily given by a sample of commercial linalol, but not with linalol prepared from sodium linalol. Extraction with semicarbazide acetate solution gave on isolation about ½ per cent. of aldehyde material which gave a pronounced benzidene test similar to that of citral (which substance is a normal oxidation product of linalol). It appears therefore that the linalol is contaminated with small amounts of citral insufficient for isolation.

Fraction (*c*).—20 ccs. of this fraction were available. The following constants were determined:—

$d_{15\cdot5}$	·900
N^{D}_{20}	1·4780
$[\alpha]_D$	+ 5·29
b.p.	68–118°C. 4 mms.

The bromine-acetic acid test for sesquiterpene was strongly positive. The usual method of removing alcohols from sesquiterpene fractions, that is distillation over sodium, could not be used in this instance owing to the production of hydrocarbons from linalol and nerolidol (fraction *d*) by the action of sodium.

No solid derivatives could be obtained, and the fraction apparently consisted of some sesquiterpene in admixture with linalol and nerolidol.

Fraction (*d*).—360 ccs. possessed the following constants:—

$d_{15 \cdot 5}$	·8836
N^{D}_{20}	1·4782
$[\alpha]_D$	+ 1·5

Identification of this fraction with nerolidol (melaleucol) has already been described in this Journal.[3]

Purification of nerolidol by the sodium method (as described above for linalol) gave as by-product a hydrocarbon with the following constants:—

$d_{15 \cdot 5}$	·8335
N^{D}_{20}	1·4700
$[\alpha]_D$	0

[Found C = 87·4 H = 12·6 $C_{15}H_{26}$ requires C = 87·3 H = 12·6.]

This hydrocarbon gave a characteristic solid bromide M.P. 131°C. by addition of bromide.

The percentage of bromide was 69·5 per cent. and evidently corresponded with a hexa bromide [Br. = 69·9].

Although this hydrocarbon does not appear to have been previously described, its constitution by analogy with dihydromyrcene and linalol is that of dihydrofarnesene.

$$CH_3-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH-CH_2-CH_2-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH-CH_2-CH_2-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH-CH_3$$

This hydrocarbon was subsequently prepared by reduction of farnesene (from nerolidol via farnesol) with sodium and alcohol, and the same hexabromide prepared, M.P. 131°C., alone or in admixture with the abovementioned sample.

Our thanks are due to Mr. C. T. White, Government Botanist, for critical examination of the leaves submitted as samples.

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[1] The Essential Oils (Finnemore) 556, 557.
[2] Schimmel & Co. Reports 1912. October, 80.
[3] Jones and Harvey. R.S.Q. 1936 2-3.

Erinosis, a Disease of Laportea.

By D. A. HERBERT, D.Sc., Department of Biology, University of Queensland.

(*Read before the Royal Society of Queensland, 30th November, 1936.*)

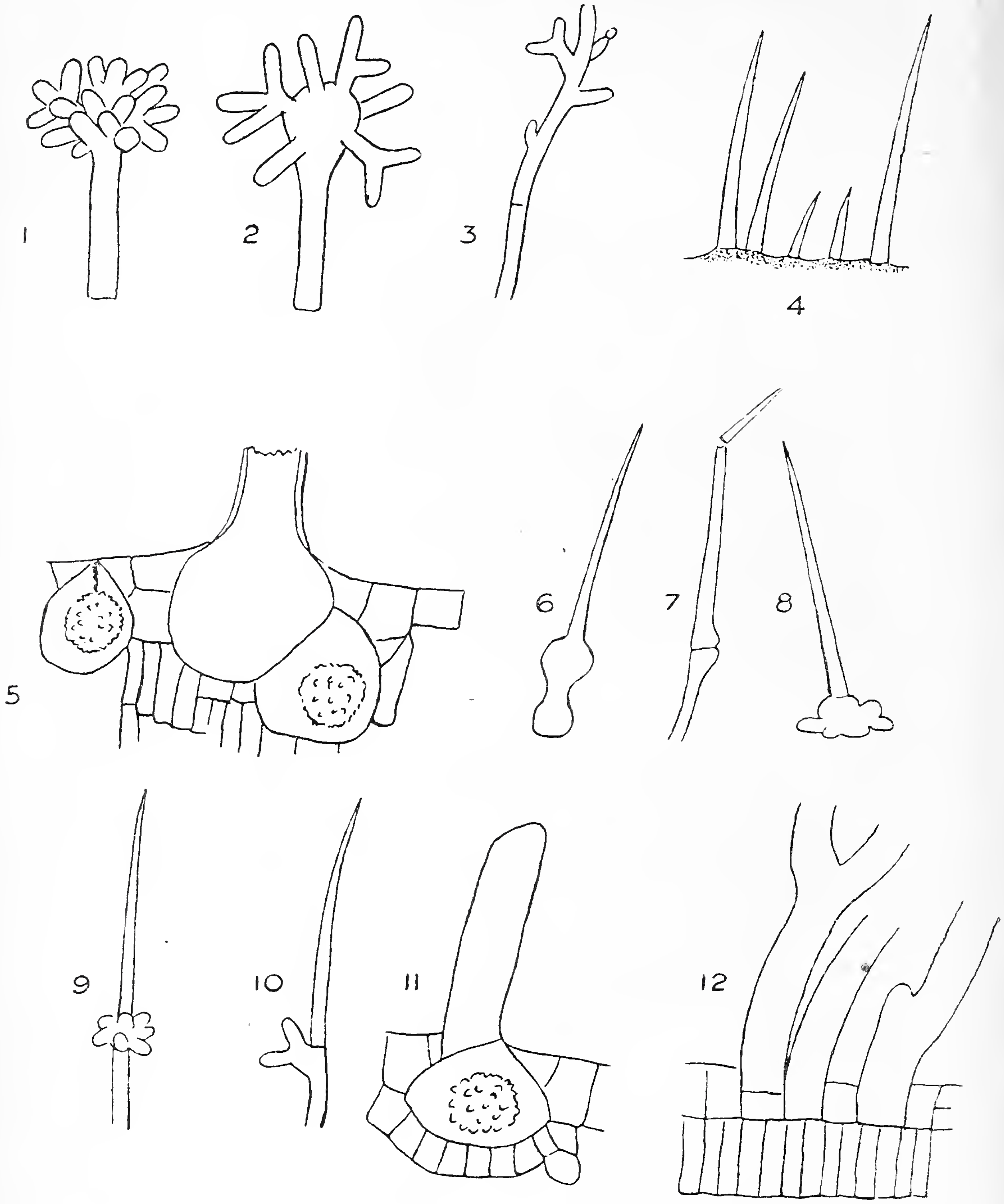
(Plate I.)

The occurrence of downy or velvety islands of hairs on the upper and lower surfaces of leaves is not uncommon. At first the tufts were considered to be of a fungal nature, and were assigned to the genus *Erineum* of Persoon. They are now recognised as an abnormal development of hairs, and the condition is known as erinose or erinosis. Well-known examples are the erinose of the beech in Europe, of the mountain maple in America (the tufts in this case being red or scarlet), and of the various species of Vitis including the cultivated grape vine. In the vine the felt-like patches are suggestive of a downy mildew, and were at one time described as *Erineum vitis,* Dunal. They are figured by Viala.[1]

The leaves of the giant stinging tree (*Laportea gigas,* Wedd.) and of the shining leaved stinging tree (*L. photiniphylla,* Wedd.) are frequently covered by pure white felt-like patches on the upper and lower surfaces (Plate I.). The patches vary in size, but are for the most part about a quarter of an inch in diameter. There is sometimes a tendency for scattered white hairs to be distributed along the veins in the vicinity of the white patches. In *Laportea gigas* the leaf is convex beneath the erinosis patch, which stands up as a white cushion about an eighth of an inch above the surrounding surface, with a corresponding pock-mark, with no hair proliferation, on the other side. As many as two hundred of the patches may occur in a single leaf 9 inches long and 9 inches wide, while the whole of the petiole may be covered with a continuous white tomentum. Typically the patches are pure white, but with advancing age they assume an orange-brown tinge. In *Laportea photiniphylla* the hairs are produced in depressions, and mostly on the upper surface of the leaf. The corresponding convexity on the other side is smooth.

In section, the lesions are found to be a dense cluster of stout hairs with numerous short, blunt branches at the top producing a felt of arbuscules. Figures 1 and 2 represent the common types. Figure 3 represents a type seen vary occasionally. The hairs arise by hypertrophy of epidermal cells, and sometimes of the stinging hairs. They are similar in both species of Laportea.

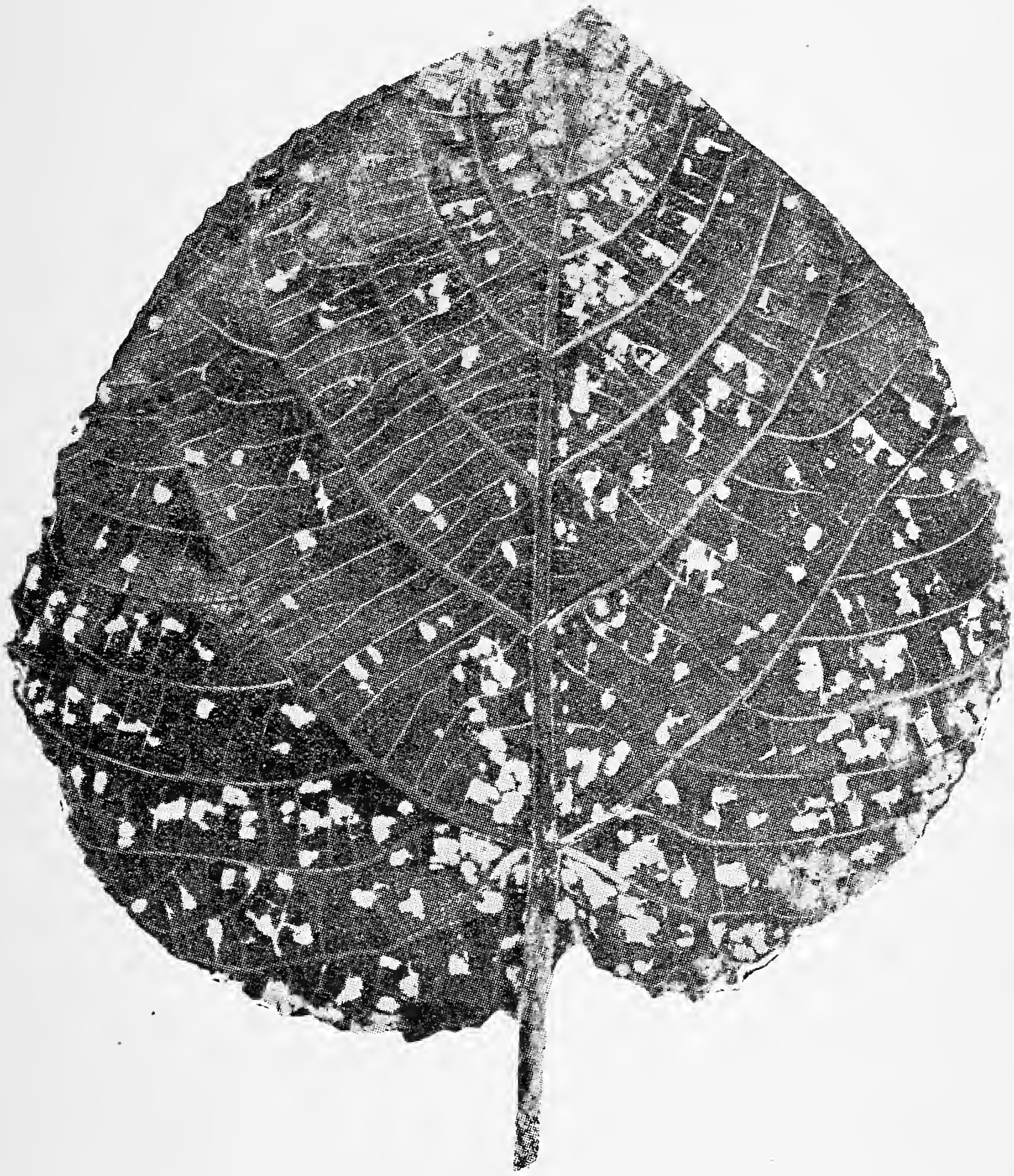
The normal leaf of *Laportea gigas,* the giant stinging tree, is covered with minute hairs interspersed with large rigid trichomes with a bulbous base—the stinging hairs (Figs. 4 and 5). They are figured by Petrie.[2] W. H. Brown[3] figures those of *L. Meyeniana,* a Philippine species. The trichomes of *L. gigas* are silicified to the base. The typical hairs of the erinosis patches are not silicified. They respond readily to the chlor-zinc-iodine test for cellulose, and stain readily with ordinary cellulose stains like normal epidermal cells. Interspersed amongst them, however, are trichomes silicified in the upper part but hypertrophied below. This hypertrophied region is not silicified. It may be irregularly swollen (Figs. 6 and 7), branched at the base (Fig. 8), or unbranched in the lower part and branched just below the silicified apex (Figs. 9 and 10). These partially silicified outgrowths are modified stinging hairs. They are fairly numerous, but are enormously out-numbered by the typical branching hairs with no impregnation of silica.



Erinosis of *Laportea.*

The majority of branching hairs are produced by the proliferation of epidermal cells (Fig. 11 and 12), and not from the alteration of stinging hairs. In *Laportea photiniphylla* the leaves are smooth and sparsely scattered with stinging hairs. The erinosis is, however, similar to that of *L. gigas,* and the felt is of equal density.

Large numbers of species of a mite, *Phyllocoptes* sp., are found associated with the lesions. This acarid may be regarded as standing in causal relationship to the erinosis of *Laportea.* Closely related species cause erinosis of the vine and other plants.



Erinosis, a disease of *Laportea.*

The material examined was collected at Springbrook and Mount Glorious. The disease has also been observed on the same species in other South Queensland localities such as Tamborine Mountain and the Blackall Range, and on the giant stinging tree of the Atherton Tableland near the Tully Falls, North Queensland.

I am indebted to Mr. F. A. Perkins, B.Sc.Agr., for the identification of *Phyllocoptes*.

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2. Petrie, J. M.: The stinging properties of the giant nettle. Proc. Linn. Soc. N.S.W., XXXI., 530-545, 1906.
3. Brown, W. H.: A text-book of general botany, p. 75, Ginn & Co., 1925.

ILLUSTRATIONS.

Plate I.: Leaf of *Laportea gigas* with numerous white erinosis lesions.

Text Figures, 1-12.: 1 and 2, types of branching hair in the erinosis leaves of *Laportea gigas;* 3, type of hair occasionally found; 4, silicified trichomes; 5, section of base of silicified trichome; 6-10, hypertrophied trichomes silicified in the upper part; 11, section of base of a branching hair with a cystolith in the adjoining cell; 12, base of branching hairs, showing epidermal nature.

Essential Oils from the Queensland Flora—Part X.—Melaleuca linariifolia.

By T. G. H. JONES, D.Sc., A.A.C.I.

(*Tabled before the Royal Society of Queensland, 30th November, 1936.*)

The essential oil of *Melaleuca linariifolia* has been investigated by Baker and Smith[1] and later by A. R. Penfold[2] to the latter of whom most of our knowledge of the constituents of this oil are due. As a result of Penfold's investigation with leaves collected near Sydney, the oil was found to contain as principal constituents α and γ terpinene, cymene, terpinenol —4, cineol, sesquiterpene, and sesquiterpene alcohol, and in view of the pleasant odour of the oil and its high germicidal value, it has become of economic importance. The tree also grows in Southern Queensland, notably near Logan Village, and several samples of oil obtained from this latter source have been examined by the author, confirming the results of Penfold, although there appeared to be little, if any, cineol in the oil.

Near Loganlea, however, a second variety of this tree was discovered, the leaves of which possessed a pronounced cineol odour on crushing and later samples of leaves were obtained from Maryborough which gave the same cineol odour.

After confirmation of botanical specimens by Mr. C. T. White, the oil appeared to be worthy of investigation and the results obtained form the subject of this communication.

It is noteworthy that the oil of this new variety bears no resemblance to that of the previously investigated variety, and contains as principal constituents cineol 61 per cent., with lesser quantities of pinene, dipentene, α terpineol, sesquiterpene, and sesquiterpene alcohol. The germicidal value is low and the oil is of little economic value.

EXPERIMENTAL.

Original samples of oil were obtained from the neighbourhood of Loganlea and were submitted as samples by commercial distillers, but the oil from Maryborough was distilled at the University, yield 1·5 per cent. The same results were obtained from both supplies of oil and those of the Maryborough oil only are given below:

The following constants were determined:—

$d_{15\cdot5}$	·9180
$[\alpha]_D$	+4·3
N_{20}^{D}	1·4650
Ester Value	19.6
Acetyl Value	49
Cineol Content	61·5 per cent. (Cockings method)

The oil 900 ccs. was washed with NaOH, which removed only a trace of phenolic body, giving a red-brown colour with ferric chloride and then submitted to fractional distillation at 4 mms. when the following fractions were obtained:—

	Volume.	Temp.	α_D	$d_{15\cdot5}$	N_{20}^{D}
(1)	.. 665 ccs.	0– 50° C.	+ 2	·9076	1·4605
(2)	.. 48 ccs.	50– 55° C.	+ 2	·9080	1·4648
(3)	.. 100 ccs.	55– 77° C.	+ 14	·9372	1·4800
(4)	.. 45 ccs.	77–110° C.	+ 11	·9458	1·4870
(5)	.. 25 ccs.	110–140° C.	+ 3	·9515	1·4850

Fractions (1) and (2) which contained the bulk of the cineol (80 per cent. content) were extracted with 50 per cent. resorcin solution and the voluminous crystalline cake triturated with petrol ether (50°-60° b.p.). The petrol ether solution was further extracted with resorcin solution and finally dried and fractionated giving a terpene fraction 50 ccs. with the following constants:—

$d_{15\cdot5}$	·8546
$[\alpha]_D$	+ 7
N_{20}^{D}	1·4680

It was found (after further fractionation) to consist of a mixture of pinene and dipentene.

A small head fraction $d_{15\cdot5}$ ·8596 $\alpha = +9$ gave a good yield of nitrosyl chloride, M.P. 103° C. and consisted largely of pinene, while the residue readily reacted with bromine in acetic acid solution, giving dipentene tetrabromide in excellent yield. The M.P. after crystallisation was 125° C., and no limonene appeared to be present. No other terpenes could be detected.

The solid cineol resorcin compound was decomposed by steam distillation and the cineol 500 ccs. recovered; the constants agreeing chiefly with those recorded for that substance. The o-cresol compound melted at 55° C.

Fraction (3) was further fractionated to remove cineol and the residue possessed the following constants:—

$d_{15\cdot5}$	·9389
$[\alpha]_D$	+16
N_{20}^{D}	1·4814

It was found an analysis to possess the molecular composition $C_{10}H_{18}O$, and in view of its sluggish reaction with sodium as distinct from the ready reaction with potassium judged to be a tertiary alcohol.

Identity with *a* terpineol was demonstrated by the preparation of the nitrosyl chloride M.P. 115°-116, the phenyl urethane M.P. 113° C. and the naphthyl urethane M.P. 146° C. These derivatives were carefully compared with those from terpinenol —4 the characteristic alcohol present in the other variety of *Melaleuca linariifolia*, and with those from an authentic sample of *a* terpineol, but no evidence of the presence of any alcohol other than *a* terpineol could be obtained.

Fraction (4).—The usual tests for sesquiterpene (bromine vapour in acetic acid solution, &c.) were strongly positive for this fraction. It was repeatedly distilled over metallic potassium and the resultant product possessed the following constants:—

$d_{15 \cdot 5}$	·9359
$[\alpha]_D$	+ 11
N^D_{20}	1·4939

The molecular composition $C_{15}H_{24}$ revealed on analysis, confirmed the presence of sesquiterpene. No solid derivatives could be prepared and as no aromadendrone was obtained on ozonisation, aromadenrene appeared to be absent.

Fraction (5) was treated with metallic potassium until all reaction had ceased and the sesquiterpene removed by distillation at 4 mms. The alcohol recovered from the potassium salt (5 ccs.) possessed the following constants:—

$d_{15 \cdot 5}$	·9404
$[\alpha]_D$	+ 3
N^D_{20}	1·4895
b.p.	120–130°C (4 mms)

It was not further examined but the above results indicate a sesquiterpene alcohol.

1. BAKER AND SMITH: Royal Society of N.S.W. Vol. XL. (1906), p. 65-69.
2. A. R. PENFOLD: Royal Society of N.S.W. Vol. LIX. (1925), pp. 306-324.

Studies in Australian and Oriental Trypaneidae. Part I. New Genera of Dacinae.

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In the subfamily *Dacinae* considerable confusion exists with regard to the limits of the genera. Some workers evade the issue by recognising only one genus, *Dacus* F., with a number of poorly-defined sub-genera, a procedure which only adds to the confusion, and makes many problems for the economic entomologists working on the group. The *Dacinae* contains so many species, is so widely distributed, and is so important, that it is necessary to divide it into clearly defined genera.

A number of authors have erected genera based on quite good morphological characters, but with the exception of Shiraki (1933), have not used such characters consistently. I refer to the chaetotaxy of the thorax, the ciliation on the posterior lateral margin of the third abdominal tergite of the male, the presence of a supernumerary lobe in the wing of certain males, the completeness of the thoracic suture, the length of the antennae compared with that of the face, and the length of the basal segment of the ovipositor compared with the length of the abdomen. African workers use two other characters—the fusion of the abdominal tergites, and the presence of a median abdominal carina, characters which appear to be confined to African species.

These are all good morphological characters, and are used extensively to separate genera in other sub-families of the Trypaneidae, and in other families of the Diptera. If used consistently throughout the *Dacinae,* a number of new genera will be required, and the classification might be criticised on the ground that it is too artificial. Such a criticism might, to a certain extent, be sound; but surely the advantages of having a definite straightforward classification are preferable to the doubt and complexity which have existed for a number of years.

At present I am working on collections of Trypaneidae from the Federated Malay States Museum, Kuala Lumpur; the Australian Museum, Sydney; C. S. I. R., Canberra; McLeay Museum, Sydney; Queensland Museum, Brisbane; Department of Agriculture, Brisbane; University of Queensland, Brisbane; collections which include practically all the more important Oriental and Australian genera and species, many of which are undescribed. Unless I follow Shiraki (1933), and use consistently the characters mentioned above, it is very difficult to classify the material in these collections.

This paper is an attempt to do so for the Oriental and Australian species of *Dacinae*. Six new genera and one new species are described, and comments made on the other genera. Provided the scheme I have put forward is generally adopted, two new African genera will be necessary—one for *lotus*. Bez. and its allies, and another for *mesomelas*. Bez. (*aethiopicus* Mro.). I have not included *Toxotrypana,* an American genus, because it is so distinct that it will fit into any scheme.

I do not regard *Marquesadacus* Mall, as a valid genus; it is only distinguished from *Strumeta* by the number of lower orbital bristles, a character which is very variable in the *Dacinae,* even in a particular species.

In my comments on the genera I shall include a list of species which, according to my card index, belong to the particular genus. This list is by no means complete, and only represents species which I have been able to place generically either by actual examination or by a study of the original, and subsequent descriptions. Naturally it is impossible to place many species owing to lack of material, inadequate description, and, in some cases, the fact that the male has never been recorded.

Genus Dacus Fab. 1805.

Synonym: *Tridacus* Bez. 1915.

Genotype: *Dacus armatus* Fab.

The genus *Dacus* was erected by Fabricius (1805) for the species *armatus, umbrosus, ferrugineus,* and *caudatus.* He did not designate a type, but *armatus* has page priority, and I strongly agree with Speiser (1924), Hendel (1927), and Collart (1935) who have accepted *armatus* as the type. Through the kindness of Dr. C. H. Curran, of the American Museum of Natural History, I have been able to examine specimens of *armatus.* Its generic characters are as follows:—2*sc.,* 1 *a.sa.,* no *pr.sc.* bristles, 3rd abdominal tergite of male with post-lateral cilia, basal segment of the ovipositor shorter than the abdomen, abdomen without median carina, abdominal tergites fused, no supernumerary lope in wing of male, and antennae not noticeably longer than face.

The genus appears to be confined to Africa, and according to my index the following species belong to it:—*armatus* Fab., *bequaerti* Coll., *bidens* Curr., *bivittatus* Big., *chrysomphalus* Bez., *d'emmersi* Bez., *disjunctus* Bez., *eburneus* Bez., *fumosus* Coll., *ghesquierei* Coll., *humeralis* Bez., *linearis* Coll., *lulongaensis* Coll., *pectoralis* Walk., *punctatifrons* Karsch, *purus* Curr., *sphaerostigma* Bez., *schoutedeni* Coll., *sphaeristicus* Speis., *telfaireae* Bez., *transitorius* Coll.

Genus Leptoxyda Macq. 1835.

Genotype: *Leptoxyda longistylus* Wied.

This genus was erected in 1835 by Macquart for *testacea,* a species which was later proved to be a synonym of *longistylus* Wied. The generic characters are: 2*sc.,* no *pr.sc.,* no *a.sa.,* no supernumerary lobe in wing of male, 3rd abdominal tergite of male not ciliated, basal segment of ovipositor as long as abdomen. This last character distinguishes it from all other genera of the *Dacinae.* I have a specimen from North Borneo which has a similar long ovipositor, but I am not certain that it is not an abnormality, the ovipositor having been stretched when the insect was dying. According to Collart (1935) *aspilus* Bez. belongs to this genus.

Genus Bactrocera Guerin-Meneville 1838.

Genotype: *B. longicornis* Guer.

The type of the genus is *longicornis* Guer., and it was described and figured by Macquart in 1835. Since then it has not been rediscovered; and, as the type is no longer available, it is almost impossible to place this genus. Some authors consider *longicornis* Guer. to be a synonym of *umbrosus* F., but the description of the former differs in several respects. The dark middle bands of the wings are confluent towards the hind border of the wing, and the scutellum is said to have a black spot above in the middle.

Bezzi (1913) decided to include in this genus all species with banded wings, but admitted in 1919 that with the discovery of species like *hamatus* Bez. and *trigonus* Bez., which are definitely not congeneric with *umbrosus* F., it was very doubtful whether such a character was of generic value. Most workers will agree that wing markings, because of variation, are very unsatisfactory generic characters, and should be avoided as much as possible. In the *Dacinae* species such as *cucurbitae* Coq., *synnephes* Hend., *pulcher* Tryon, *strigatus* F. A. Perk., *frauenfeldi* Sch., *hamatus* Bez., *umbrosus* F., *curvifer* Wlk., all have banded wings varying from a short incomplete band in *cucurbitae* Coq. to a complex pattern in *umbrosus* F. and *curvifer* Wlk. Moreover, the species mentioned belong to at least three, and possibly four, different genera.

The position of *Bactrocera longicornis* appears to me to be as follows. From the description given by Macquart (1835) it might be assumed that it probably belongs to the *Dacinae*. Until either the type is found, or the species rediscovered, *Bactrocera* must remain a doubtful genus with one doubtful species. The type locality is given as Sydney, N.S.W., but I have examined all the collections in Eastern Australia, and have yet to see a specimen which resembles the description and figures given by Macquart. Bezzi (1913) stated that *Strumeta umbrosus* F. (*conformis* Wlk.) was perhaps synonymous with *B. longicornis* Guer. Apart from the differences mentioned above, the fact that *umbrosus* F. has not yet been collected in Australia, indicates that it is very unlikely that such synonymy is correct. Personally I can find no justification for sinking *Strumeta* as a synonym of *Bactrocera*, and as I shall show later, I regard *Strumeta* as a valid genus with which *Chaetodacus* Bez. is synonymous.

Genus Strumeta Walk. 1856.

Synonymus: *Dasyneura* Saunders 1841 (nec. Rondani 1840).
Chaetodacus Bezzi. 1913.
Marquesadacus Mall. 1932.

Genotype: *Dacus umbrosus* F.

Saunders (1841) erected the genus *Dasyneura* designating *zonatus* as the type. Walker (1856) described the genus *Strumeta* for *conformis* which was afterwards proved to be a synonym of *umbrosus* F. Bezzi (1913) made a new genus, *Chaetodacus,* for *ferrugineus* and its allies. All three species, *zonatus* Saund., *umbrosus* F., and *ferrugineus* F., have the same generic characters, namely, 2 *sc.,* 1 *a.sa.,* 2 *pr.sc.* bristles, 3rd abdominal tergite of the male ciliated, a supernumerary lobe present in the wing of the male, basal segment of the ovipositor shorter than the abdomen, abdominal tergites not fused, and antennae not definitely longer than the face.

Dasyneura was preoccupied by Rondani in the Asilidae, and consequently had to fall. In view of what I have said with regard to *Bactrocera,* I can see no sound reason why *Strumeta* should be regarded as a synonym of *Bactrocera,* and in my opinion *Strumeta* (type *umbrosus* F.) is a valid genus of which *Chaetodacus* Bez. is a synonym. If eventually *Strumeta umbrosus* F. is proved to be a synonym of *Bactrocera longicornis,* then both *Strumeta* and *Chaetodacus* will become synonyms of *Bactrocera.*

For *mesomelas* Bez. (*aethiopicus* Mro.) a new genus is necessary, for it cannot be included in *Strumeta* because the male has no cilia on the 3rd abdominal tergite, and no supernumerary lobe in the wing.

According to my index, the following are species of *Strumeta*:—*antennalis* Shir., *bancroftii* Try., *barringtoniae* Try., *biguttatus* Bez., *bryoniae* Try., *cilifer* Hend., *costalis* Shir., *cucurbitae* Coq., *diaphorus* Hend., *dorsalis* Hend., *ferrigineus* Fab., *hyalinus* Shir., *latifrons* Hend., *limbiferus* Bez., *McGregori* Bez., *musae* Try., *occipitalis* Bez., *okinawanus* Shr., *parvulus* Hend., *passiflorae* Frogg., *pedestris* Bez., *perfuscus* Aub., *sarcocephali* Try., *tryoni* Frogg., *umbrosus* Fab., *zonata* Saund.

The distribution of the genus is very wide, ranging from Egypt, through India and the East Indies to Formosa, Australia and the Islands of the Pacific. It has not yet been found in Central and South Africa.

Genus CALLANTRA Walk. 1860.

Synonym: *Mellesis* Bezzi 1916.

Genotype: *Callantra smieroides* Walk.

Hendel (1927) has already pointed out that this genus is the same as *Mellesis* Bez. erected in 1916 for *crabroniformis* and other species. The chief distinguishing characters appear to be—antennae longer than face, 1st segment of antennae as long as 2nd, the petiolated, club-shaped, abdomen, and the large tubular ovipositor in the female, no *pr.sc.*, 2 *sc.*, *a.sa.* present or absent, no supernumerary lobe in the wing of the male.

I have only seen two species which appear to belong to this genus; one is *aequalis* Coq. which has no *a.sa.* bristle, and in which the 1st antennal segment is not quite as long as the 2nd; and the other, *lounsburyi* which also has no *a.sa.* bristle, but which has the 1st antennal segment quite as long as the 2nd. They are both wasp-like, and have club-shaped abdomens, and in other respects agree with the characters of the genus Callantra. They both have the 3rd abdominal tergite of the male ciliated, a character which, with the exception of *bioculata* Bez. in which it is not mentioned, is common to all the species of the genus, of which a description of the male is available.

Until I have had the opportunity of examining more of the Oriental species of the genus, it is my intention to regard it as a valid genus with the following generic characters:—2 *sc.*, 1 or no *a.sa.*, no *pr.sc.* bristles, 3rd abdominal tergite of the male ciliated, no supernumerary lobe in the wing of the male, antennae definitely longer than the face, and held away from it. I am not satisfied that the proportional length of the 1st and 2nd antennal segments is a good generic character.

At present I include in this genus the following species:—*aequalis* Coq., *apicalis* Shir., *bioculata* Bez., *brachycera* Bez., *crabroniformis* Bez., *destillatoria* Bez., *eumenoides* Bez., *icariiformis* End., *longicornis* Wied., *lounsburyi* Coq., *nummularia* Bez., *pedunculata* Bez., *polistiformis* Sen. White, *smieroides* Walk., *sphaeroidalis* Bez., *subsessilis* Bez., *unicolor* Hend.

Genus MONACROSTICHUS Bezzi 1913.

Genotype: *Monacrostichus citricola* Bezz.

This peculiar genus was created by Bezzi (1913) for *citricola* Bezz. It is easily distinguished from all other *Dacinae* by the fact that the thoracic suture is complete, a most unusual feature in the Trypaneidae, and, in fact, in the Acalyptrata.

Genus Tetradacus Miyaki 1919.

Genotype: *Tetradacus tsuneonis* Miyaki.

This is another genus erected for a single peculiar species. The most important distinguishing feature of the genus is the presence of 2 *a.sa.*, and no *pr.sc.* bristles. The other generic characters have been very fully described by Shiraki (1933).

Genus Daculus Speis 1924.

Genotype: *Musca oleae* Gmel.

This appears to be a good genus, and it is surprising that more species with similar generic characters have not been found. The only species appears to be the type Hendel (1927) included in this genus *annulatus* Beck., which has been transferred to *Psilodacus* by Collart (1935), and *semisphaereus* Beck., of which only the female is known.

Genus Afrodacus Bezzi 1924.

Genotype: *Chaetodacus biguttulus* Bez.

Bezii (1924) created this genus for *biguttulus* Bez., a South African species, which only differs from *Strumeta* in having no *a.sa.* bristles. He does not state whether the abdominal tergites are fused; but in his description he very briefly mentions the characters by which the genus can be distinguished from what he called *Chaetodacus,* so that I think it can be assumed that the tergites are not fused. The name of the genus is rather unfortunate, for *jarvisi* Tryon is congeneric with *biguttulus;* and I also have another undescribed species from New Guinea which also belongs to Afrodacus. I have not seen a specimen of *biguttulus,* but from the published descriptions there seems little doubt that it is a valid genus with a very peculiar distribution.

Genus Zeugodacus Hendel 1927.

Genotype: *Dacus caudatus* F.

This is a good genus which is well represented in the Oriental region, one species at least, *synnephes* Hend., extending its range to Queensland. It is the largest of the five genera with four scutellar bristles. It is rather interesting that no species with four scutellar bristles have been found in Africa, all being confined to the Indian, Oriental, and Australian regions.

The genus has been well defined by Shiraki (1933). According to my index, the following species belong to this genus:—*ambiguus* Shir., *arisanicus* Shir., *caudatus* F., *dobaensis* Shir., *depressus* Shir., *duplicatus* Bez., *hageni* de Meij., *lipsanus* Hend., *maculipennis* Dol., *nigrifacies* Shir., *nubilus* Hend., *okunii* Shir., *quadrisetosus* Bez., *scutellaris* Bez., *scutellatus* Hend., *synnephes* Hend., *tibialis* Shir.

Genus Paratridacus Shiraki 1933.

Genotype: *Dacus yayeyamanus* Matsum.

When erected by Shiraki (1933) the only species was the type, but *garcinae* Bez., certainly belongs to this genus, and in the near future I feel sure that other Oriental species will be added. It is very close to *Zeugodacus,* from which it differs in having no supernumerary lobe in the wing of the male, and no cilia on the 3rd abdominal tergite of the male.

Genus Parazeugodacus Shiraki 1933.

Genotype: *Parazeugodacus matsumurai* Shir.

Another Oriental genus in which a number of previously described species will have to be included. For example, *bipustulata* Bez. belongs to this genus, and I expect to find others before I complete my work on the Oriental and Australian Dacinae. It is very close to *Zeugodacus*, from which it differs in having no supernumerary lobe in the wing of the male.

Genus Psilodacus Collart 1935.

Genotype: *Dacus annulatus* Beck.

A recently described genus, the species of which are confined to Africa. According to my index, the following species belong here:—*annulatus* Beck., *apoxanthus* Bez., *bigemmatus* Bez., *decolor* Bez., *inornatus* Bez., *marshalli* Bez., *maynei* Bez., *mochii* Bez., *purpurifrons* Bez., *rubicundus* Bez., *woodi* Bez.

Genus Lophodacus Collart 1935.

Genotype: *Dacus hamatus* Bezzi.

Collart has recently created this genus for *hamatus* Bez., which has a peculiar medium longitudinal abdominal carina. Apparently it is the only species in the genus.

Genus Didacus Collart 1935.

Genotype: *Dacus ciliatus* Loew.

Although I have not seen enough specimens to be sure about the generic value of the fusion of the abdominal tergites, this appears to be a valid genus with a large number of species all confined to Africa.

According to my index, it contains the following species:—*abbabae* Mro., *africanus* Adams, *attenuatus* Coll., *bistrigulatus* Bez., *blepharogaster* Bez., *chapini* Curr., *ciliatus* Loew., *duplex* Mro., *elutissimus* Bez., *erythraeus* Bez., *ficicola* Bez., *gypsoides* Mro., *immaculatus* Coq., *insistens* Curr., *langi* Curr., *marginalis* Bez., *mimeticus* Coll., *mulgens* Mro., *ostiofaciens* Mro., *plagiatus* Coll., *vertebratus* Bez.

Genus Austrodacus nov.

Genotype: *Dacus cucumis* French.

It is necessary to create a new genus for *cucumis* French, a peculiar species which is so different from other Dacinae that previous workers have had great difficulty in placing it. Usually it has been left as *Dacus cucumis*, in spite of the fact that it is in no way related to *Dacus armatus* and its allies. This new genus may be defined as follows:—*Dacinae* with 4 *sc.*, no *a.sa.*, no *pr.sc.*, and no *hm.* bristles, no supernumerary lobe in the wing of the male, no post lateral cilia on the 3rd abdominal tergite of the male, antennae held close to and not longer than the face, basal segment of the ovipositor not as long as abdomen. It is very easily distinguished from all other genera with four scutellar bristles, by the absence of both the *a.sa.* and *pr.sc.* bristles.

Genus Notodacus nov.

Genotype: *Dacus xanthodes* Brown.

I am compelled to erect this genus for *xanthodes* Brown, a species which differs from all other Australian and Oriental Dacinae in having a strong humeral bristle (I consider that Matsumurania belongs to the subfamily Adraminae), and from most in having no definite supernumerary lobe in the wing of the male.

The genus can be defined as follows:—*Dacinae* with 2 *sc.*, 1 *a.sa.*, 2 *pr.sc.*, and 1 *hm.* bristles, 3rd abdominal tergite of the male with post lateral cilia, no definite supernumerary lobe in the wing of the male, antennae not definitely longer than the face, basal segment of the ovipositor shorter than the abdomen, abdominal tergites not fused. The characteristic form of the scutellum might be included in the list of generic characters, but at present I prefer to regard it as a specific character. *Notodacus xanthodes* is confined to a number of the Pacific Islands.

Genus Nesodacus nov.

Genotype: *Chaetodacus atrichus* Bez.

It is necessary to provide a new genus for *atrichus* Bez. and *ablepharus* Bez. and their varieties. These species agree with some of the African genera in having no *pr.sc.* bristles, but differ in other respects.

It may be defined as follows:—*Dacinae* with 2 *sc.*, 1 *a.sa.*, no *pr.sc.*, and no *hm.* bristles, a supernumerary lobe present in the wing of the male, no post lateral cilia on the 3rd abdominal tergite of the male, basal segment of the ovipositor not as long as the abdomen.

The two species, each with a variety, are confined to the Philippine Islands.

Genus Melanodacus nov.

Genotype: *Dacus niger* Tryon.

I am erecting this genus for *niger* Tryon, a small black species which does not fit into any of the known genera of the Dacinae with four scutellar bristles. Some of the Oriental species which I am studying at the present time will probably fit into this genus. It can be defined as follows:—*Dacinae* with 4 *sc.*, 1 *a.sa.*, 2 *pr.sc.*, and no *hm.* bristles, no post lateral cilia on the 3rd abdominal tergite of the male, basal segment of the ovipositor shorter than the abdomen, antennae shorter than face, a supernumerary lobe present in the wing of the male, abdominal tergites not fused.

It is confined to Eastern Australia, and is close to *Zeugodacus*, from which it differs in having no abdominal cilia on the 3rd tergite of the male.

Genus Asiadacus nov.

Genotype: *Chaetodacus bakeri* Bez.

This genus includes at least two species—*bakeri* Bez. from Philippine Islands and *diversa* Coq. from India and Ceylon. It differs from other genera with two scutellar bristles, in having a supernumerary lobe present in the wing of the male, but no ciliation on the 3rd abdominal tergite.

The genus is defined as follows:—*Dacinae* with 2 *sc.*, 1 *a.sa.*, 2 *pr.sc.*, and no *hm.* bristles, no cilia on the 3rd abdominal tergite of the male, a supernumerary lobe present in the wing of the male, basal segment of ovipositor shorter than abdomen.

Genus Neodacus nov.

Genotype: *Neodacus newmani* n. sp.

In the collection of Trypaneidae belonging to the Council for Scientific and Industrial Research is a small series of an undescribed species of *Dacinae* from West Australia. It is the first member of the sub-family that I have seen from that State, and it differs in many ways from the Dacinae found in the Eastern States. I am compelled to make a new genus, for it does not fit into any of the other genera which I have listed above. In many respects it looks more like an African than an Australian species, and I shall not be surprised if later on some African species are found to be congeneric with it.

The genus can be defined as follows:—*Dacinae* with 2 *sc.*, 1 *a.sa.*, no *pr.sc.*, and no *hm.* bristles, 3rd tergite of male ciliated, a supernumerary lobe present in the wing of the male, antennae not longer than the face, basal segment of the ovipositor shorter than the abdomen, and thoracic suture incomplete. This genus is very close to *Dacus*, from which it can be distinguished by the presence of a supernumerary lobe in the wing of the male.

Neodacus newmani n. sp.

Male and female.—Length of body, 6·5–7·0 mm.; of wing, 4·6 mm. *Head.*—General colour brownish-yellow. Frons nearly as wide as long, the proportions when measured from, but not including, the lunule to the median ocellus being 18:16; with no black spots; ocellar triangle black; vertical calli, and lunule brown. Antennae not quite reaching the lower lateral angles of the face; 3rd segment nearly three times as long as the 2nd; 2nd segment bearing a short black dorsal bristle; dorsal edge of 3rd segment dark brown near the tip. Antennal grooves slightly darker yellow, with a short dark-brown fleck on either side of the facial plate just above the epistoma; normal facial spots absent. Genal spot present. Occiput brownish-yellow with a bright post orbital band extending as far as the genal bristle. Chaetotaxy *vt.* 2, *pvt.* present, *s. or* 1, *i. or* 3 (middle pair weaker than the others), genal bristle; all black; occipital row vestigial.

Thorax.—General colour rich reddish-brown, punctulate, with short pale pubescence, with no black markings, but a faint mottling of dark brown at the sides of the mesonotum, and a very thin faint dark-brown median streak, which starts to expand about the level of the *a.sa.* into a triangular area, which terminates at the scutellum. With the following yellow markings—humeral calli; on each side, a triangular-shaped mesopleural stripe, the anterior border forming an obtuse angle, and cutting the mesopleural suture where it meets the sternopleural suture, the posterior border practically straight, and representing the longest side of the triangle, the upper edge coinciding wth the end of the thoracic suture, and the lower apex being the extension on to the sternopleuron; a very short, post-sutural, median elliptical spot; practically the whole of the upper, and the anterior four-fifths of the lower hypopleural calli; (a peculiar feature is the absence of the post-sutural lateral stripes). Scutellum yellow with a narrow slightly curved dorsal basal band. Mesophragma and post-scutellum with a thin median longitudinal black streak. Chaetotaxy *scp.* 4, *n.pl.* 2, *a.sa.* 1, *p.sa.* 2, *mpl.* 1, *pt.* 1, *sct.* 2 (apical) all black.

Legs.—The same colour as the rest of the thorax, except the first segments of the tarsi, which are paler.

Wings.—Hyaline with a dark costal band which terminates just beyond the end of R4 + 5; it includes the 1st C., the first quarter of 2nd C., all of Sc., all of R1, the distal margin of R3, and a small rounded extension in the upper distal corner of R5; most of 2nd C. is practically hyaline; and an anal streak which, in the male, extends across vein CuI + 1A in the usual way. Vein R4 + 5 slightly wavy beyond the R-M cv. The proportions of vein M1 + 2 in the 1st M2 before and after the R-M cv. 38 : 15. The anal extension of Cu. distinctly lanceolate, i.e., narrowed, then swelling out, and finally tapering to a point, definitely not parallel sided; the proportion of the extension to the rest of vein CuI + 1A being 15 : 12 in the female and 19 : 10 in the male. A definite, but not pronounced, supernumerary lobe is present in the wing of the male.

Abdomen.—General colour a uniform rich reddish-brown, slightly darker at the sides, and covered with pale pubescence; a sub-circular depression on either side of the 5th tergite which is of the same colour as the rest of the abdomen, but is noticeable because of an apparent difference in the texture of the exocuticula. Ovipositor very flat, much darker in colour than the abdomen, nearly black; basal segment slightly longer than the 5th tergite, very broad at the base and blunt at the apex. Sternites slightly darker in colour than the tergites. Male with a row of post-lateral cilia on the 3rd abdominal tergite.

Described from 2 males and 5 females labelled "Bred from native fruit, Carnarvon, W.A., 1918, Newman"; and one female, "Carnarvon, W.A.., Sep., 1929, I. M. Mackerras."

This species differs from all other Australian *Dacinae* with two scutellar bristles, in the absence of the post-sutural lateral yellow stripes; and from most by the absence of *pr.sc.* bristles. I have called it after Mr. L. J. Newman, the Government Entomologist of West Australia, whose work on the control of fruit flies in his State is well known. He was the first to collect specimens of this species.

KEY TO GENERA OF THE DACINAE.

1.	Abdomen club-shaped, narrowed or stalked at base	2.
	Abdomen ovate, not narrowed or stalked at base ..	3.
2.	Ovipositor longer than abdomen, bent, cylindrical ..	*Toxotrypana* Gerat.
	Ovipositor shorter than abdomen, straight	*Callantra* Walk.
3.	One pair of *sc.* bristles	4.
	Two pairs of *sc.* bristles	18.
4.	Thoracic suture complete	*Monacrostichus* Bez.
	Thoracic suture incomplete	5.
5.	Basal segment of ovipositor shorter than the abdomen	6.
	Basal segment of ovipositor as long as the abdomen	*Leptoxyda* Macq.
6.	With a median abdominal carina	*Lophodacus* Coll.
	Without a median abdominal carina	7.
7.	No *pr. sc.* bristles	8.
	One pair of *pr. sc.* bristles	14.
8.	2 *a. sa.* bristles	*Tetradacus* Miyaki
	1 *a. sa.* bristle	9.
	No *a. sa.* bristle	11.
9.	3rd abdominal tergite of male ciliated	10.
	3rd abdominal tergite of male not ciliated	13.

10.	Supernumerary lobe present in wing of male ..	*Neodacus* n.g.
	No supernumerary lobe present in wing of male ..	*Dacus* F.
11.	3rd abdominal tergite of male ciliated	12.
	3rd abdominal tergite of male not ciliated	*Psilodacus* Coll.
12.	Abdominal tergites fused	*Didacus* Coll.
	Abdominal tergites not fused	*Daculus* Speis.
13.	Supernumerary lobe present in wing of male ..	*Nesodacus* n.g.
	No supernumerary lobe present in wing of male .. allies.	(*lotus Bez. and* A new genus required.)
14.	1. *a. sa.* bristle	15.
	No *a. sa.* bristles	*Afrodacus* Bez.
15.	3rd abdominal tergite of male ciliated	16.
	3rd abdominal tergite of male not ciliated	*Asiadacus* n.g.
16.	*Hm.* bristle present	*Notodacus* n.g.
	Hm. bristle absent	17.
17.	3rd abdominal tergite of male ciliated	*Strumeta* Walk.
	3rd abdominal tergite of male not ciliated .. .. and its allies.	(*mesomelas* Bez. New genus required.)
18.	*Pr. sc.* bristles absent	*Austrodacus* n.g.
	Pr. sc. bristles present	19.
19.	3rd abdominal tergite of male ciliated	20.
	3rd abdominal tergite of male not ciliated	21.
20.	Supernumerary lobe present in wing of male ..	*Zeugodacus* Hend.
	No supernumerary in wing of male	*Parazeugodacus* Shir.
21.	Supernumerary lobe present in wing of male ..	*Melanodacus* n.g.
	No supernumerary lobe in wing of male	*Paratridacus* Shir.

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New Australian Pyraloidea (Lepidoptera).

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

(*Read before the Royal Society of Queensland, 30th November, 1936.*)

We still await a revision of the Australian species of this superfamily; and this makes work on this group difficult. The wide range of many species, some of which are found throughout the Eastern Tropics, is another likely source of error. I have tried to avoid this as much as possible, but cannot be sure that a few of the species here described may not have been previously described from other regions. This would be regrettable, but the publication of complete descriptions should be of value, even if a few names may eventually be discovered to be synonyms.

That we are able to work at this group at all, we owe firstly to some admirable papers by Mr. Edward Meyrick, F.R.S., mostly dated before the end of last century. Secondly, to the extensive work of Sir George Hampson, which alone has rendered possible the identification of genera and species by one who has no longer access to the collection in the British Museum. This refers especially to the Pyraustidae. I may say that in former years I have had opportunities of studying this collection, and in the past have had much generous assistance from Sir George Hampson in identifying species. I have never followed Hampson blindly; and have therefore the greater pleasure in acknowledging the debt that we owe to his work, a debt that has not always been recognised. He has provided a large and spacious foundation, on which smaller specialists may build.

Fam. GALLERIADAE.

Gen. *Mecistophylla* nov.

μηκιστοφυλλος, long-winged—

Tongue absent. Labial palpi in male very short; in female very long. Maxillary palpi obsolete. Forewings elongate, cell long ($\frac{3}{5}$ to $\frac{2}{3}$); discocellulars angled inwards; 2 from $\frac{2}{3}$, 2, 3, 4, 5 in male nearly equidistant, in female 3 from near angle, 4 and 5 connate from angle, 6, 7, 8, 9 stalked, 10 and 11 from cell. Hindwings with cell open; 3 and 4 stalked, 5 absent, 7 anastomosing with 12 for more than half its length.

Type *M. stenopepla* Turn. formerly referred in error to *Paralipsa* Butl.

Mecistophylla psara n. sp.

ψαρος, speckled grey—

♂ 25 mm. Head and thorax whitish-grey; face and palpi fuscous. Antennae grey. Abdomen grey; dorsum except basal and apical segments dark fuscous. Legs fuscous mixed with whitish; tarsi fuscous with whitish rings. Forewings elongate-oval, costa straight to $\frac{2}{3}$, thence arched, apex pointed, termen straight, very oblique; whitish-grey; markings and some scanty irroration dark fuscous; a transverse bar from $\frac{1}{3}$ costa, beneath middle continued by a fine line not reaching dorsum; a mark on $\frac{2}{3}$ costa giving rise to a line of dots, angulated above middle, to $\frac{2}{3}$ dorsum; a series of dots on termen and apical third of costa; cilia whitish-grey. Hindwings with termen slightly sinuate, grey; cilia grey.

Queensland: Toowoomba in November; one specimen received from Mr. W. B. Barnard.

Gen. Aphomia Hb.

This name supersedes *Melissoblaptes* Zel.

Aphomia poliocyma n. sp.

πολιοκυμος, grey-waved—

♂ 20 mm. Head, palpi, and thorax pale grey. Antennae grey. Abdomen grey-whitish with three postmedian blackish bars on dorsum. Legs whitish; anterior tibiae and tarsi grey with whitish rings. Forewings comparatively broad, posteriorly dilated, costa strongly arched, apex rounded-rectangular, termen slightly rounded, scarcely oblique; whitish-grey; two broad grey transverse lines; first from $\frac{1}{3}$ costa to $\frac{2}{5}$ dorsum, outwardly curved; second from $\frac{2}{3}$ costa obliquely outwards, above middle curved through a right angle, thence to $\frac{4}{5}$ dorsum; a minute fuscous median subcostal dot, closely followed by a similar dot; a dotted fuscous line on termen and apical $\frac{1}{4}$ of costa; cilia whitish-grey. Hindwings with termen slightly sinuate; grey-whitish; cilia grey-whitish.

New South Wales: Sydney in October; one specimen.

Aphomia astericta n. sp.

ἀστερικτος, unstable—

♂ 19 mm. Head, thorax, abdomen, and legs ochreous-whitish. Antennae pale grey. Forewings suboval, costa strongly arched, apex subrectangular, termen slightly rounded, oblique; ochreous-whitish with some brownish suffusion towards apex and termen, and a few scattered dark fuscous scales; a fuscous dotted line on termen and apical $\frac{1}{4}$ of costa; cilia grey, bases whitish. Hindwings with termen slightly sinuate; whitish-ochreous; cilia as forewings.

♀ 24 mm. Head and thorax pale brownish. Palpi 5; pale brownish. Antennae pale grey. Abdomen whitish-brown. Legs brown-whitish. Forewings whitish densely sprinkled with dark brown, which tends to form streaks on veins towards termen; a large greenish-ochreous dorsal suffusion; a fuscous dotted line on termen and apical $\frac{1}{4}$ of costa; cilia grey with basal and median whitish lines. Hindwings with termen rounded; grey; base and dorsum ochreous, the two colours blending; cilia grey.

I believe these represent one species, but further material is wanted for confirmation, and to determine whether the differences are sexual or varietal.

North Queensland: Kuranda in May (one male); Babinda near Innisfail in September (one female type).

Harpagoneura distorta n. sp.

distortus, deformed—

♂ 26–28 mm. Head ochreous-grey-whitish; face and palpi white. Antennae grey, towards base ochreous-grey-whitish; in male simple. Thorax and abdomen ochreous-grey-whitish. Legs ochreous-whitish. Forewings narrow, oblong, termen nearly straight, apex rounded, termen rounded, not oblique; in male with a short subcostal groove containing altered scales before apex on upper side, cell very long, produced in an oblong process to $\frac{4}{5}$, veins 7, 8, 9, 10 shortened and twisted over prominence corresponding to groove on upper surface; ochreous-grey-whitish slightly pinkish-tinged with a few scattered fuscous scales; a large medium oblong pale fuscous subcostal spot, sometimes grey partly outlined with fuscous; a broad fuscous terminal line, its inner edge more or less crenulate; cilia grey with an ochreous-grey-whitish basal line and an interrupted dark fuscous sub-basal line. Hindwings broad, termen rounded; pale ochreous; cilia whitish-ochreous.

In structure this corresponds with *H. acrocausta* Meyr., which Hampson records from Cooktown.

North Queensland: Kuranda; Dunk I. in May; two specimens. I have seen also a female taken at Yeppoon.

Harpagomorpha catharopa n. sp.

καθαρωπος, of chaste appearance—

♂ 28 mm. Head, thorax, and abdomen whitish-grey. Palpi white. Antennae grey, base whitish; in male simple. Legs ochreous-whitish. Forewings narrow, suboblong, costa slightly arched to $\frac{1}{3}$, thence straight, apex rounded, termen rounded, not oblique; cell in male very long, produced by an oblong process to $\frac{7}{8}$; pale ochreous-grey; a suffused whitish streak on costa to $\frac{3}{4}$; a transverse line of fuscous dots from before apex to tornus; these are connected by pale neural streaks with a submarginal series of fuscous dots; cilia ochreous-whitish. Hindwings broad, termen rounded; whitish and thinly scaled; cilia whitish.

Though lacking the distortion of the subapical veins of forewings, this must be referred to the same genus as the preceding. Its structure corresponds to that of *H. pseudocomplana* Hmps., which is recorded from Innisfail.

North Queensland: Charters Towers in June; one specimen.

Heteromicta xuthoptera n. sp.

ξουθοπτερος, yellowish-winged

♂ 18 mm. Head, palpi and thorax ochreous. Antennae grey; basal joint ochreous. Abdomen and legs whitish. Forewings suboval, costa moderately arched, apex round-pointed, termen straight, oblique; ochreous-yellow; a short fuscous costal streak from base followed by some irroration; a slightly sinuate fuscous line from $\frac{2}{3}$ costa to $\frac{3}{5}$ dorsum; a series of fuscous dots shortly before termen; between this and postmedian line the terminal area is partly suffuse with fuscous; cilia ochreous, on termen fuscous. Hindwings with termen nearly straight; whitish-ochreous; cilia whitish-ochreous, above apex fuscous.

North Queensland: Cape York in April; one specimen received from Mr. W. B. Barnard.

Lamoria inostentalis Wlk. Cat. Brit. Mus. xxvii., p. 88.

♂♀ 28–32 mm. Head, thorax and abdomen ochreous-whitish. Frontal tuft long (1). Labial palpi in male ½, slender, curved, ascending, rough-haired anteriorly; in female 6, porrect, terminal joint curved downwards, ochreous-whitish with a few fuscous scales. Antennae ochreous-whitish, legs ochreous-whitish with a few fuscous scales. Forewings elongate, suboval in male narrower, costa moderately arched, more strongly in female, apex rectangular, termen slightly rounded, slightly oblique; ochreous-whitish with a few scattered fuscous scales; usually a terminal series of dark fuscous dots; cilia ochreous-whitish. Hindwings with termen scarcely sinuate; in male grey, in female whitish; cilia whitish.

North Australia: Darwin in January. North Queensland: Cooktown in April; Magnetic Island in June; also from New Guinea, Borneo, China, and Japan.

Fam. CRAMBIDAE.

Ptochostola asaphes n.sp.

ἀσαφης, indistinct, obscure—

♂ 17–20 mm. Head, thorax, and abdomen ochreous-whitish. Palpi 7; ochreous-whitish sprinkled with fuscous. Antennae grey; ciliations in male minute. Legs ochreous-whitish. Forewings narrow, costa moderately arched, apex subrectangular, termen slightly rounded, slightly oblique; brown-whitish; some fuscous scales in disc between veins; a very fine dentate line, sometimes scarcely perceptible from costa shortly before apex to tornus, fuscous, posteriorly partly edged with whitish, connected with termen beneath apex by two white lines; cilia grey interrupted by continuations of these white lines. Hindwings with termen slightly rounded; pale-grey; cilia whitish.

The forewings have the costa much more rounded than in *P. microphaeella*, and have no central white streak.

North Australia: Darwin in October and November; four specimens received from Mr. F. P. Dodd.

Neargyria persimilis Hmps.

Ann. Mag. Nat. Hist. (9) iii., p. 275 (1919)—

♂♀ 14–16 mm. Head white. Labial palpi 5; golden-ochreous, upper edge white. Maxillary palpi white, at base golden-ochreous. Antennae whitish-grey; in male thickened, slightly serrate towards apex. Thorax white with two golden-ochreous longitudinal lines. Abdomen grey-whitish. Legs golden-ochreous; posterior pair whitish. Forewings triangular, costa slightly arched, apex rectangular, termen almost straight, scarcely oblique; snow-white; markings golden-ochreous sometimes mixed with fuscous; a narrow costal streak from base to middle; a broad line from $\frac{2}{3}$ costa to middle of dorsum, curved and produced on costa nearly to apex; dorsal edge golden-ochreous; a terminal line interrupted by blackish dots; cilia ochreous or ochreous-grey, bases white. Hindwings with termen rounded; white; cilia white.

North Queensland: Cape York in May and June; seven specimens received from Mr. W. B. Barnard. Also from New Guinea.

Calamotropha leptogrammella Meyr.

Mr. A. Brimblecombe has reared this species from larvae feeding on the Nut Grass (*Cyperus rotundus* Lin.). The earliest stages were not observed; the larva tunnels downwards through the stalk, eating all the internal tissue and leaving a silken coating on the inner surface of the ensheathing leaf base. It then eats out the nut and may proceed from this to other nuts. The cocoon is constructed within the nut or stem. The larvae were found in July, the moths emerging in August. Considerable damage was done to the host plants.

Gen. *Phanomorpha* nov.

φανομορφος, of cheerful appearance—

Tongue present. Face smooth, not projecting. Palpi moderately long, porrect; second joint stout, rough-haired above and beneath; terminal joint very short, obtuse. Maxillary palpi large, strongly triangularly dilated. Antennae in male minutely ciliated. Tibiae with outer spurs about $\frac{1}{2}$ inner. Forewings with 2 from well before angle, 3 from angle, 8 and 9 stalked, 7 and 10 separate. Hindwings with strong cubital pecten; cell about $\frac{2}{5}$, 2 from $\frac{3}{4}$, 3 separate, 4 and 5 connate, 6 from upper angle of cell, 7 anastomosing strongly with 12, 12 approximated to cell throughout.

Near *Argyria* Hb., differing in the minute terminal joint of labial and stronger dilatation of maxillary palpi.

Phanomorpha leucoxantha n. sp.

λευκοξανθος white and yellow—

♂ 17 mm. Head white; back of crown blackish. Palpi 2; white, basal half of second joint fuscous. Antennae fuscous. Thorax blackish; tegulae except bases and a post-median pair of spots white. Abdomen pale yellow. Legs fuscous; posterior pair except tarsi whitish. Forewings elongate-triangular, costa straight to near apex, apex pointed, termen straight, oblique; white with blackish markings; a costal streak; narrow transverse fasciae near base, at $\frac{1}{3}$ and $\frac{2}{3}$, the last dilated and touching tornus; a small apical blotch narrowly produced to tornus, containing a white dot on costa before apex; a short oblique streak from apex, and a terminal series of dots; cilia fuscous. Hindwings with termen gently rounded; pale yellow; a broad fuscous terminal band; cilia fuscous, on dorsum pale yellow.

Queensland: Charleville in August; one specimen.

Platytes erythroneura n. sp.

ἐρυθρονευρος, red-veined—

♀ 18 mm. Head and thorax pale red mixed with fuscous. Palpi 4; fuscous, beneath whitish. Maxillary palpi strongly dilated; fuscous, apex whitish. Antennae fuscous. Abdomen ochreous-reddish. Legs whitish, reddish-tinged; tarsi with fuscous rings. Forewings narrowly triangular, costa straight almost to apex, apex round-pointed, termen straight, oblique; grey mixed with pale red and dark fuscous; a broad red streak from beneath $\frac{1}{4}$ costa dividing into neural streaks in terminal area; a similar median streak from base dividing similarly; a suffused red dorsal streak from base to $\frac{1}{4}$; a large oblong median dorsal dark fuscous spot, preceded and followed by whitish spots; costal spots at $\frac{1}{4}$ and $\frac{3}{4}$, and a line between red streaks, fuscous stigmata beneath costa before and after middle, the latter and sometimes the former pale-centred; a fine acutely dentate fuscous line from $\frac{3}{4}$ costa, ending in a suffused tornal spot; cilia whitish, bases barred with dark fuscous. Hindwings with termen rounded; grey; cilia whitish, bases grey.

South Australia: Ooldea in July; one specimen received from Mr. J. A. Kershaw.

Platytes oxycampyla n. sp.

ὀξυκαμπυλος, sharply bent—

♂ 21 mm. Head and thorax grey. Palpi $2\frac{1}{2}$; grey, white beneath towards base. Antennae grey; ciliations in male minute. Abdomen grey; towards base whitish with an ochreous bar on second segment. Legs whitish-grey. Forewings narrowly triangular, costa almost straight, apex pointed, termen straight, oblique; grey; two fine fuscous transverse lines; first from $\frac{1}{6}$ costa obliquely outwards, sharply bent at an acute angle in mid-disc, not reaching dorsum; second from beneath $\frac{3}{5}$ costa to $\frac{2}{3}$ tornus, slightly dentate, followed by two or three fuscous dots in costal area; cilia grey. Hindwings with termen rounded; grey-whitish; cilia grey-whitish.

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

Platytes pediopola n. sp.

πεδιοπολος, living on the plain—

♂♀ 22–28 mm. Head and thorax grey. Palpi 3; fuscous, upper edge grey. Antennae fuscous; in male minutely ciliated. Abdomen pale grey with a sub-basal brown transverse dorsal bar. Legs grey, sprinkled with whitish. Forewings narrow, gradually dilated posteriorly, costa straight to $\frac{3}{4}$, thence arched, apex round-pointed, termen obliquely rounded; grey; markings fuscous, often indistinct; fine streaks on upper and lower margins of cell and on fold; short diverging streaks from cell on veins; short streaks on veins before termen; cilia grey; median line and apices whitish. Hindwings pale grey; cilia whitish with a grey basal line.

Queensland: Mitchell and Cunnamulla in September; Quilpie in August; abundant at light in the last locality.

Sedenia leucogramma n. sp.

λευκογραμμος, inscribed with white—

♂ 22 mm. Head, thorax, and abdomen grey. Palpi 2½; fuscous, lower edge white. Antennae grey; ciliations in male ⅓. Legs fuscous. Forewings triangular, costa straight to near apex, apex rounded, termen almost straight, slightly oblique; grey; a suffused fuscous line from beneath ⅓ costa to ⅓ dorsum; a white discal spot beyond middle, its dorsal portion broader; an outwardly curved oblique white line, anteriorly fuscous-edged, from ⅘ costa, becoming sinuate above dorsum, on which it ends at ⅔; cilia brown-whitish with median fuscous line, apices grey. Hindwings with termen gently rounded; grey; a faint whitish transverse line from ¾ costa; cilia whitish, apices and a median line grey.

Queensland: Charleville in September; one specimen.

Diadexia parodes Turn.

Proc. Roy. Soc. Q. xix. p. 56 (1905)—

Catancyla brunnea Hmps. Ann. Mag. Nat. Hist. (9) iv. p. 140 (1919).—The male antennae are bipectinate.

North-West Australia: Roeburne; Kimberley.

Talis dichospila n. sp.

διχοσπιλος, double-spotted—

♀ 25 mm. Head and thorax brownish-fuscous. Palpi 6; grey, beneath whitish. Antennae fuscous. Abdomen grey. Legs fuscous. Forewings narrow, dilated, costa straight, apex pointed, termen straight, slightly oblique; brownish-fuscous, paler towards base; a fuscous costal streak from base to ⅗, suffusedly edged with whitish, which extends on costa to ⅘; a small fuscous transverse mark in disc at ⅓, another larger at ⅔; a very slender white line inwardly oblique from costa before apex, soon curved outwards and sinuate to tornus; a white apical spot preceded by a fuscous costal spot; a pair of blackish-edged white spots on termen above tornus; a slender blackish terminal line; cilia grey with a slender white basal line. Hindwings with termen slightly sinuate; pale grey; cilia whitish.

Western Australia: Perth; one specimen received from Mr. W. H. Matthews.

Talis radialis Hmps.

Ann. Mag. Nat. Hist. (9) iv. p. 147 (1919)—

T. diargyra Turn. Trans. Roy. Soc. S. Aust. 1925 p. 42 is a synonym.

Talis crypsichroa Low.

T. discilunalis Hmps. is a synonym.

New South Wales: Broken Hill, Victoria; Birchip, Melbourne; Gisborne, South Australia; Adelaide, Mount Lofty.

Fam. SCHOENOBIADAE.

Scirpophaga haplosticha n. sp.

ἁπλοστιχος, with simple lines—

♂ 14–16 mm. Head, thorax, abdomen, and legs white. Labial palpi 2¼; white. Antennae grey; in male shortly laminate with moderate ciliations (1). Forewings elongate-triangular, costa nearly straight, apex pointed, termen obliquely rounded; white with extremely pale fuscous markings; a straight line from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum; a discal mark beyond middle, touching a sinuate line from $\frac{3}{4}$ costa to $\frac{3}{4}$ dorsum; a faint subterminal line; cilia white. Hindwings over 1, elongate, termen gently rounded; white; cilia white.

North Queensland: Cape York in April; two specimens received from Mr. W. B. Barnard, who has the type.

Fam. PYRALIDAE.

Anemosa polyrrhoda.

Polyterpnes polyrrhoda Turn., Trans. Roy. Soc., S.A., 1932, p. 188—

I was mistaken in referring this species to the *Crambidae*. There is no cubital pecten in the hindwings, but some long hairs between the bases of the cubital and first anal may be easily mistaken for one. The forewings are narrower than in *A. isadalis* Wlk., but it agrees with this species in all essential structural points. The facial projection is formed by a long tuft of hairs. In both species 6 of forewings may be connate or short-stalked, and 7 of hindwing may anastomose at a point or for some distance. In one example of *A. isadalis* this vein is merely closely approximated.

North Australia: Mary R. (Campbell) in June. North Queensland: Cape York in June (Barnard). North-West Australia: Wyndham (Campbell) in January.

Gen. *Blechrophanes* nov.

βληχροφανης, weak-looking—

Tongue strong. Palpi ascending, recurved, appressed to face, reaching vertex; second joint thickened with smooth scales; terminal joint short, pointed. Maxillary palpi short, filiform. Antennae in male simple. Forewings with 4 and 5 stalked, 6 separate, 7, 8, 9, 10, 11 stalked. Hindwings with 4 and 5 connate, diverging.

Blechrophanes crocoptila n. sp.

κροκοπτιλος, saffron-winged—

♂♀ 14–16 mm. Head, thorax, and abdomen orange. Palpi whitish. Antennae grey-whitish. Legs ochreous-whitish. Forewings elongate-triangular, costa straight to $\frac{3}{4}$, thence arched, apex rounded, termen slightly rounded, not oblique; orange, median area sometimes paler; two nearly straight pale yellow transverse lines; first at $\frac{1}{3}$; second at $\frac{2}{3}$, narrowly edged with brown posteriorly; cilia orange. Hindwings with termen slightly rounded; as forewings.

North Queensland: Banks Island in May; Cape York in June and November; five specimens received from Mr. W. B. Barnard, who has the type.

Endotricha microphylla n. sp.

μικροφυλλος, small-winged—

♂♀ 15–16 mm. Head and thorax dull crimson, in female ochreous-grey. Palpi grey. Antennae ochreous-grey; ciliations in male $2\frac{1}{2}$. Legs whitish-ochreous; anterior pair fuscous. Forewings elongate-triangular, costa straight to $\frac{2}{3}$, thence arched, apex pointed, termen straight, oblique; dull crimson, in female purple-grey; an undulating fuscous line from

$\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum; another from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, edged posteriorly by a pale line; costal edge between these lines strigulated with fuscous and whitish-ochreous; a fuscous median subcostal dot; cilia fuscous, apices in male dull crimson or whitish-ochreous. Hindwings triangular, termen straight, tornus prominent; as forewings.

North Queensland: Cape York in October and November; seven specimens received from Mr. W. B. Barnard, who has the type.

Endotricha dinosticha n. sp.

δινοστιχος, with curved line—

♂♀ 16–17 mm. Head and palpi dark fuscous. Antennae pale grey; in male with fasciles of long cilia (3). Thorax including tegulae grey-brown; patagia fuscous. Legs brown-whitish partly suffused with fuscous; posterior pair mostly whitish. Forewings triangular, costa sinuate, nearly straight to $\frac{3}{4}$, apex pointed, termen nearly straight, oblique; fuscous-brown; basal area edged by a slender whitish outwardly curved line, from $\frac{2}{5}$ costa to $\frac{2}{5}$ dorsum; beyond this is a pale suffusion, and some fuscous and whitish costal strigulae; a whitish line from costa at $\frac{5}{6}$, at first outwardly oblique, then angled and strongly curved inwards, finally becoming submarginal and ending on tornus, edged on both sides with fuscous; a short doubly toothed whitish line follows this above its upper angle; cilia fuscous with a white basal line; but mostly white beneath apex and above tornus. Hindwings with termen rounded; fuscous; a paler fascia before middle, edged by whitish lines, which in their turn are edged with fuscous; cilia as forewings, but mostly whitish on and beneath apex.

Near *E. puncticostalis* and *E. scioessa*, best distinguished by the peculiarly formed subterminal line of forewings.

North Queensland: Cape York in October; five specimens received from Mr. W. B. Barnard, who has the type.

Endotricha periphaea n. sp.

περιφαιος, dark-edged—

♀ 22–26 mm. Head, palpi, antennae, and thorax ochreous-grey. Abdomen and legs ochreous-grey lightly sprinkled with fuscous. Forewings elongate-triangular, costa straight almost to apex, apex pointed, termen gently rounded, moderately oblique; 4 and 5 stalked or closely approximated for some distance; ochreous-grey lightly sprinkled with fuscous, on termen purplish-tinged; a series of pale costal dots; a darker basal patch edged by a slender curved whitish line from $\frac{1}{3}$ costa to $\frac{2}{5}$ dorsum; a slender curved whitish line from costa near apex running close to termen, partly edged with fuscous; an interrupted blackish terminal line; cilia fuscous, bases pale, apices whitish. Hindwings with termen strongly rounded, less so towards tornus; 4 and 5 closely approximated at base; purple-fuscous; a paler median band edged by whitish lines; first line curved at $\frac{1}{3}$, second straighter, fuscous-edged on both sides; terminal line and cilia as forewings.

Near *E. mesenterialis*, but differing in colour and especially in cilia. That species has 4 and 5 of both wings long-stalked.

Queensland: Noosa in October; three specimens.

Scenidiopis heterozyga n. sp.

ἑτερόζυγος, unequally mated—

♂ 17–18 mm. Head reddish-brown. Palpi fuscous-brown. Antennae grey; ciliations in male 4. Thorax brown, more or less mixed with ochreous. Abdomen brown; tuft partly ochreous. Legs fuscous; posterior tibiae and tarsi whitish. Forewings triangular, costa straight to beyond middle, thence sinuate, apex round-pointed, termen slightly rounded, oblique; purple-fuscous; transverse lines whitish, obscure, partly obsolete, wavy; first from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum; second from $\frac{4}{5}$ costa to before tornus, well-marked on costa; a terminal series of blackish dots; cilia purple-grey. Hindwings with termen gently rounded; colour, terminal dots, and cilia as forewings; transverse lines much more distinct, outwardly curved, finely dentate, at about $\frac{2}{5}$ and $\frac{3}{5}$.

♀ 20 mm. Head, thorax, and abdomen ochreous-grey. Forewings with termen straight to near apex; ochreous-grey partly sprinkled with fuscous; lines slender, edged suffusedly on both sides with fuscous. Hindwings as forewings, but terminal area suffused with dull crimson.

North Queensland: Cape York in October and April; four specimens received from Mr. W. B. Barnard, who has the type.

Petta alternata Warr.

Ann. Mag. Nat. Hist. (6), xvi., p. 469; Hmps. Moths. Ind., iv., p. 138.

Auchmophoba tynnuta Turn, Proc. Roy. Soc. Q. 1912, p. 142, is a synonym.

North Queensland: Kuranda. Queensland: Stradbroke Island, Coolangatta. Also from the Archipelago and India.

Cangetta minuscula n. sp.

minusculus, small—

♂ 12 mm. Head, palpi, thorax, and abdomen whitish. Antennae whitish; in male shortly ciliated ($\frac{1}{2}$). Legs whitish; anterior pair fuscous. Forewings elongate, narrow, slightly dilated, costa nearly straight, apex pointed, termen sinuate, slightly oblique; whitish with slight grey suffusion towards costa and termen; markings fuscous; a very slender line from $\frac{1}{3}$ costa to $\frac{1}{4}$ dorsum, strongly angled outward below middle; a median subcostal discal dot; a costal dot at $\frac{3}{4}$; postmedian line double, sinuate from $\frac{3}{4}$ costa to $\frac{3}{4}$ dorsum; a distinct terminal line; cilia whitish with a fuscous median line. Hindwings with termen bisinuate; as forewings; antemedian line obsolete towards costa; discal dot at $\frac{1}{3}$, larger; a double transverse wavy postmedian line; terminal line indistinct; a dot on termen at $\frac{1}{3}$.

Queensland: Montville (1,500 ft.), near Nambour, in March; one specimen.

Cardamyla hercophora Meyr.

Trans. Ent. Soc. 1884, p. 281. Correctly referred here.

North Australia: Darwin.

Cardamyla eurycroca n. sp.

εὐρύκροκος, broadly saffron-tinged—

♂♀ 26–36 mm. Head yellow; face whitish with a pair of fuscous dots. Palpi reaching middle of face; fuscous-whitish. Antennae fuscous; in male minutely ciliated. Thorax whitish with some yellow suffusion; patagia, apices of tegulae, an interrupted transverse median line, and a posterior spot, fuscous. Abdomen whitish more or less tinged with yellow towards apex; transverse fuscous bars, often interrupted, on apices of segments. Legs fuscous with whitish rings. Forewings triangular, costa straight to $\frac{2}{3}$, apex round-pointed, termen slightly rounded, slightly oblique; fuscous with whitish markings; a transverse fascia at $\frac{1}{5}$, sometimes broad, sometimes reduced to a dentate line; a costal or subcostal blotch containing a fuscous median discal dot, variably prolonged towards or to dorsum, sometimes partly confluent with sub-basal fascia; a dentate line from $\frac{3}{4}$ costa, strongly sinuate to $\frac{3}{4}$ dorsum, often partly yellow, sometimes partly obsolete; sometimes a fine submarginal line connected by fine streaks with termen; cilia fuscous or grey sometimes indistinctly barred with whitish. Hindwings with termen very slightly rounded; mostly yellow, in parts whitish; a subdorsal fuscous spot towards base; a fuscous median fascia not reaching costa; a terminal fuscous band; subterminal line and cilia as forewings.

Near *C. didymalis* Wlk., but the ground-colour is fuscous not greenish-grey, and the markings differ in detail.

North Queensland: Stannary Hills, near Herberton. Queensland: Clermont, Eidsvold; Gayndah; Brisbane in February; Bunya Mountains in January. New South Wales: Scone in November and March; twelve specimens. Larvae on leaves of *Celastrus cunninghamii* (Dr. T. Bancroft), and on *Alphitonia excelsa* (H. Nicholas).

Catamola funerea Wlk.

In his valuable publication, Exot. Micro. v., p. 1 (1936), Mr. Meyrick has proposed a new generic name, *Elaphernis,* for this species. This name cannot stand, because *funerea* is the type of Meyrick's genus *Catamola,* Trans. Ent. Soc. 1883, p. 62. Of the three species there referred to *Catamola,* for which no type was indicated, only *funerea* strictly corresponds to Meyrick's description, in that vein 6 of hindwings anastomoses strongly with 7. In *thyridalis* these veins may be either closely approximated, or anastomose at a point, or for a very short distance only. Of *xanthomelalis* I have only one example, and in that those veins are only approximated.

In case this may not be convincing, I must state that I fixed *funerea* as the type of *Catamola* in the Proc. Roy. Soc. Q., 1905, p. 60.

Gen. *Agastophanes* nov.

ἀγαστοφανης, admirable—

Tongue present. Labial palpi ascending, appressed to face, reaching vertex; second joint long, slightly thickened, nearly smooth, with a small posterior tuft at apex; terminal joint short, acute. Maxillary palpi in male, with a strong terminal pencil of long hairs. Antennae in male moderately ciliated, with a short but strong dorsal process from basal joint, ending in a triangularly dilated tuft. Forewings with tufts of raised scales; 2 from near angle, 3 from angle approximated to 4, 5, which are connate but diverging, 6 from upper angle connate with stalk of 7, 8, 9, 10, and 11 stalked. Hindwings with 4 and 5 connate and diverging, 7 anastomosing with 12.

Nearest Titanoceros Meyr.

Agastophanes zophoxysta n. sp.

ζοφοξυστος, darkly polished—

♂♀ 20–24 mm. Head, thorax, and abdomen dark fuscous, in male reddish-tinged. Palpi dark fuscous; maxillary hair pencil in male reddish. Antennae fuscous; dorsal process of male not reaching beyond patagia, ciliations 1. Legs reddish-fuscous in male, dark fuscous in female; tarsi with slender white rings; posterior pair mostly whitish-ochreous. Forewings triangular, costa straight, slightly concave before apex, apex pointed, termen strongly sinuate, not oblique; reddish-fuscous in male, dark fuscous in female, with lustrous reflections in both; a rounded spot beneath costa before middle, and a reniform spot after middle, the latter with a process running almost to apex, pale green; some whitish irroration before termen; cilia grey-whitish with a darker sub-basal line. Hindwings with termen rounded; pale ochreous-reddish; veins and a large tornal suffusion deep red; a suffused fuscous streak on vein 4; cilia as forewings, but interrupted by a fuscous bar opposite median streak.

North Queensland: Cape York in October and November; four specimens received from Mr. W. B. Barnard, who has the type.

Gen. *Diastrophica* nov.

διαστροφικος, distorted—

Tongue strongly developed. Palpi long, very slender, appressed to face, reaching vertex; second joint very long; terminal joint minute, acute. Maxillary palpi very short, filiform, ending in a short pencil of hairs. Antennae in male with a moderately long, densely scaled dorsal process from base. Legs not hairy. Forewings with raised scales; in male with a small costal fovea beneath before middle, edged anteriorly with raised scales; cell open; 4 and 5 apparently stalked, radial veins in male distorted. Hindwings with 4 and 5 connate or stalked, 3 closely approximated at base, 7 anastomosing at a point with 12.

It does not seem possible to refer the following little species to any received genus, but further material is necessary for full understanding of its structure.

Diastrophica tephrophanes n. sp.

τεφροφανης, like ashes—

♂ 15–16 mm. Head, palpi, antennae, and thorax blackish. Antennae of male slightly laminate and shortly ciliated ($\frac{2}{3}$); dorsal process nearly reaching mid thorax. Abdomen grey-whitish sprinkled with fuscous. Legs fuscous sparsely sprinkled with whitish. Forewings elongate-triangular, costa moderately arched, apex round-pointed, termen obliquely rounded; fuscous, towards base blackish; median area suffused with whitish; cilia fuscous. Hindwings with termen scarcely rounded; fuscous; cilia fuscous.

Queensland: Banana in March (Mrs. Hobler); Chinchilla in October; two specimens.

Gen. *Oncobela* nov.

ὀγκοβελος, with swollen palpi—

Palpi in male with third joint immensely swollen with a terminal brush of hairs. Antennae in male without dorsal process.

The corresponding joint in the male of Hetrobela is minute and smooth-scaled; otherwise the two genera are similar.

Oncobela philobrya n. sp.

φιλοβυος, moss-loving—

♂♀ 30–35 mm. Head and thorax green with some brownish scales. Palpi green; terminal joint in female slender, moderately long (½), fuscous, extreme apex whitish. Antennae pale grey; ciliations in male ½. Abdomen ochreous-whitish slightly greenish-tinged, dorsum sprinkled with reddish-brown. Legs fuscous with reddish irroration and green or whitish rings; anterior coxae reddish; posterior tibiae mostly whitish. Forewings elongate-triangular, costa almost straight, apex rounded, termen rounded, slightly oblique; green with fuscous and reddish markings; a basal dot; a suffused fascia from ⅛ costa to ⅓ dorsum, broad on costa narrowing towards dorsum; fine wavy interrupted transverse lines, from ⅓ costa to ⅖ dorsum and from ⅔ costa to ⅘ dorsum; an irregular reddish-fuscous median blotch with a median process towards base; sometimes an interrupted subcostal line beyond middle and a spot on ⅔ dorsum reddish; a subterminal fuscous line touching small reddish fuscous blotches above and below middle; a terminal series of dots; cilia whitish, reddish-tinged, with a basal series of blackish bars. Hindwings with termen rounded; fuscous; cilia as forewings.

North Queensland: Cape York in November; three specimens received from Mr. W. B. Barnard, who has the type.

Heterobela nubilalis Hmps.

Ill. Het. ix., p. 157, pl. 172, f. 9.

Moths Ind., iv., p. 112—

North Queensland: Cape York; Palm Island; Townsville. Also from Ceylon and India.

Macalla nephelodes Turn.

North Queensland: Cairns; Townsville. Queensland; Yeppoon; Tweed Heads; Toowoomba.

Macalla cholica Meyr.

Epipaschia lygropa Turn. is a synonym.

Queensland: Duaringa; Brisbane; Toowoomba. New South Wales: Sydney. Victoria: Melbourne; Gisborne.

Macalla ebenina Turn.

North Queensland: Herberton; Mount Mulligan. Queensland: Brisbane; Tweed Heads; Toowoomba; Charleville; Adavale. Tasmania: Ross; Launceston.

Larvae feeding in spun-together shoots of sapling *Eucalyptus*.

Macalla glyceropa n. sp.

γλυκερωπος, delightful—

♂ 28 mm. Head, thorax, and abdomen ochreous-green. Palpi fuscous-green. Antennae grey; in male serrate, ciliations 1, dorsal process stout, not reaching midthorax, fuscous-green. Legs ochreous-whitish sprinkled with reddish and ringed with fuscous; posterior pair mostly ochreous-whitish. Forewings elongate-triangular, costa straight to ⅔, thence gently arched, apex round-pointed, termen slightly rounded, slightly oblique; ochreous-green with patchy reddish suffusion and fuscous markings; a triangular fuscous suffusion on costa near base; antemedian line illdefined, represented by a very slender outwardly oblique line from $\frac{2}{5}$ costa, obsolete in disc, inwardly oblique and dark fuscous near dorsum, ending on $\frac{1}{3}$; a short longitudinal dark fuscous line in disc above middle, preceded by some raised scales, before this line; postmedian from $\frac{3}{5}$ costa very obliquely outwards, forming a rounded prominence in middle, thence inwards and slightly dentate, strongly indented inwards above dorsum, on which it ends at $\frac{3}{4}$; included area mostly reddish, with a minute fuscous discal dot beyond middle preceded by some raised scales; a broad dark fuscous streak from postmedian line to termen above middle, edged beneath by a pale spot; some fuscous terminal dots above this, and some reddish tornal suffusion, cilia reddish with fuscous bars, apices paler. Hindwings with termen slightly rounded; fuscous; cilia fuscous, apices whitish.

Queensland: Brisbane in March; one specimen.

Epipaschia polypsamma n. sp.

πολυψαμμος, sand-coloured—

♂ 33 mm. Head and thorax brown. Palpi whitish-ochreous sprinkled with fuscous and brown. Antennae fuscous; ciliations in male 1, dorsal process greatly expanded, not reaching midthorax, brown. Abdomen pale brown. Legs brown; tarsi fuscous with whitish-ochreous rings. Forewings elongate-triangular, costa gently arched, apex rounded, termen slightly rounded, oblique; ochreous-whitish sprinkled with brown; markings dark brown; a basal patch sharply defined by a pale line from $\frac{1}{3}$ costa to $\frac{1}{4}$ dorsum; a costal dot immediately beyond and another in middle; a spot on mid-dorsum; an apical blotch continuous with a terminal fascia, edged anteriorly by a pale line from $\frac{2}{3}$ costa obliquely outwards, becoming transverse above middle and acutely and finely dentate to $\frac{3}{4}$ dorsum; cilia brown-whitish with fuscous bars. Hindwings with termen slightly rounded; fuscous, paler towards base; cilia as forewings.

North Queensland: Kuranda; one specimen received from Mr. F. P. Dodd.

Epipaschia hicanodes n. sp.

ἱκανωδης, comely—

♂ 35–36 m.m. Head brown sprinkled with fuscous. Palpi pale grey. Antennae grey; in male serrate with tufts of cilia ($1\frac{1}{2}$); dorsal process dilated, brown sprinkled with fuscous, not reaching midthorax. Thorax brown-whitish; patagia brown sprinkled with fuscous. Abdomen grey-whitish. Legs fuscous with whitish rings; posterior pair mostly whitish. Forewings elongate-triangular, costa nearly straight, apex round-pointed, termen slightly rounded, slightly oblique; whitish mostly suffused with brown; markings distinct; a darker basal patch to antemedian line; antemedian from $\frac{1}{3}$ costa to mid-dorsum, slender, fuscous, angled inwards beneath costa, edged anteriorly by a pale line; a slender transverse brown median discal mark; a finely serrated fuscous line from $\frac{3}{4}$ costa to before tornus, obtusely angled outwards in middle, thence incurved, edged posteriorly by a pale line; this is followed by a brown shade containing some fuscous wedges; an interrupted fuscous terminal line; cilia brown mixed with whitish and barred with fuscous. Hindwings with termen rounded; grey, paler towards base; a dentate grey postmedian line; cilia as forewings.

West Australia: Denmark in April; five specimens received from Mr. W. B. Barnard, who has the type.

Epipaschia loxophaea n. sp.

λοξοφαιος, obliquely dark—

♂♀ 22–28 mm. Head, thorax, and palpi whitish sprinkled with fuscous. Antennae whitish-grey; in male serrate with tufts of cilia (1), dorsal process much dilated, not reaching midthorax, whitish sprinkled with fuscous. Abdomen ochreous-whitish. Legs fuscous with whitish rings. Forewings narrow, costa straight to $\frac{2}{3}$, thence arched, apex round-pointed, termen slightly rounded, slightly oblique; white with fuscous irroration and markings; a spot on base of dorsum; a broadly suffused line from $\frac{1}{3}$ costa to tornus, in female slender or obsolete; costal dots at middle and $\frac{3}{4}$; from the latter a slender dentate line outwardly oblique to middle of wing, thence incurved to tornus; a broad interrupted subterminal shade; a terminal series of dots; cilia white mixed with pale reddish, bases barred with fuscous. Hindwings with termen slightly rounded; grey, paler towards base; cilia white, bases barred with fuscous.

North Queensland: Cape York in November; Kuranda in February and June; five specimens received from Mr. W. B. Barnard, who has the type.

Epipaschia peratophaea n. sp.

περατοφαιος, dark at the apex—

♂♀ 22–26 mm. Head, thorax, and abdomen whitish-brown. Palpi pale brown; in female fuscous. Antennae grey; ciliations in male 1, dorsal process short, not reaching beyond patagia. Legs ochreous-whitish sprinkled with brown; tarsi fuscous with whitish rings. Forewings elongate-triangular, costa straight to $\frac{2}{3}$, thence arched, apex rounded; termen slightly rounded, slightly oblique; ochreous-whitish with fuscous and brown irroration and markings; some basal irroration in male; an interrupted costal streak from base to $\frac{1}{3}$; a short slender fuscous line from base surrounded by more or less brown suffusion; a dentate line from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum, not always developed; a subcostal discal dot at $\frac{2}{5}$; a line from $\frac{2}{3}$ costa obliquely outwards to middle, there angled inwards to $\frac{3}{4}$ dorsum, often cutting through a large dorsal blotch extending from middle to tornus; a well-defined apical blotch, darker in female; some fuscous terminal dots; cilia whitish tinged with red, sometimes with fuscous basal bars. Hindwings with termen gently rounded; fuscous, paler towards base; cilia as forewings.

North Queensland: Cape York in October and November; Kuranda in January. Queensland: Stradbroke Island in March; Tweed Heads in January; fourteen specimens.

Epipaschia basiochra n. sp.

βασιωχρος, pale at the base—

♀ 23–25 mm. Head, thorax, and abdomen pale brown. Palpi fuscous. Antennae grey. Legs ochreous-whitish sprinkled with fuscous; tarsi fuscous with whitish rings. Forewings elongate-triangular, costa straight to $\frac{2}{3}$, thence arched, apex rounded, termen slightly rounded, slightly oblique; ochreous-whitish with fuscous and brown irroration and markings; an indistinct transverse line at $\frac{1}{3}$; a suffused dark fuscous line from $\frac{1}{3}$ costa to $\frac{2}{5}$ dorsum; a finely dentate dark fuscous line from before $\frac{2}{3}$ costa to before tornus, bent outwards above and inwards below middle, edged posteriorly by a pale line; area between lines fuscous, beyond second line pale fuscous; an interrupted terminal line; cilia fuscous with indistinct pale bars. Hindwings with termen gently rounded; pale fuscous; a terminal series of whitish-ochreous dots; cilia brown-whitish with a darker sub-basal line.

North Queensland: Cape York in October and November; five specimens received from Mr. W. B. Barnard, who has the type.

Fam. PYRAUSTIDAE.

Araeomorpha limnophila n. sp.

λιμνοφιλος, loving marshes—

♂♀ 21–30 mm. Head, palpi, thorax, abdomen, and legs fuscous. Antennae fuscous; in male thickened, ciliations minute. Forewings narrow, moderately dilated, costa straight to $\frac{2}{3}$, apex rounded, termen obliquely rounded; fuscous; markings whitish-grey; obscure; a sub-basal fascia; a discal dot at $\frac{2}{5}$, preceded and followed by a blackish dot; a suffused outwardly curved line, sometimes obsolete, from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum; sometimes a submarginal line interrupted on veins; cilia grey, apices paler. Hindwings broad, termen rounded; grey; cilia as forewings.

Larger than *A. atmota* Turn., and with postmedian line of forewings differently formed.

North Queensland: Kuranda in September and June; six specimens.

Gen. *Blechroglossa* nov.

βλεχρογλοssos, weak-tongued—

Tongue weakly developed, rudimentary. Labial palpi recurved, ascending, reaching middle of face; second joint thickened with rough scales; terminal joint short, stout, obtuse. Antennae in male minutely ciliated. Tibiae with outer spurs about $\frac{1}{2}$ inner. Forewings with 2 from near angle, 3, 4, 5 approximated from angle, 8, 9, 10 stalked. Hindwings with 3, 4, 5 approximated from angle, 6 from upper angle, 7 anastomosing with 12 to near its apex.

Blechroglossa pelochyta n. sp.

πηλοχυτος, muddy—

♂ 22 mm. Head and thorax pale brown. Palpi ochreous-whitish; second joint sprinkled with fuscous. Antennae grey. Abdomen dark grey. Legs fuscous. Forewings narrow, dilated, costa straight to $\frac{3}{5}$, thence strongly arched, apex rounded, termen obliquely rounded; pale brown sprinkled with fuscous; a pale spot beneath $\frac{2}{3}$ costa, surrounded by fuscous; cilia grey. Hindwings with apex broadly rounded; termen only slightly rounded; grey; cilia grey.

Queensland: Charleville in August; one specimen.

Cataclysta polyrrapha n. sp.

πολυρραφος, highly wrought—

♂ 14–18 mm. ♀ 16–22 mm. Head and thorax white. Palpi grey. Antennae whitish; in male thickened and very shortly ciliated ($\frac{1}{4}$). Abdomen grey, sometimes partly white; first two segments white with paired fuscous dots. Legs white; anterior tibiae and tarsi broadly ringed with fuscous. Forewings elongate-triangular, costa straight to $\frac{2}{3}$, thence arched, apex round-pointed, termen obliquely rounded; white; an oblong fuscous patch on base of costa, containing a sub-basal ochreous dot; an ochreous line edged with fuscous from $\frac{1}{3}$ costa to $\frac{2}{5}$ dorsum, strongly indented inwards beneath costa; an inwardly oblique fuscous fascia from $\frac{2}{3}$ costa to mid-dorsum; an outwardly oblique ochreous line edged with fuscous from $\frac{2}{3}$ costa nearly to termen below middle, there acutely angled, thence slender and curved to before tornus; a simular line from $\frac{5}{6}$ costa to termen beneath apex, and another along termen, the latter interrupted above and below middle; cilia fuscous with several white bars. Hindwings with termen slightly rounded; white; a round central fuscous blotch containing an incomplete ochreous ring; a narrow terminal fascia a crenulate ochreous line, a terminal series of ochreous dots, and a series of silvery dots between these two; cilia as forewings.

North Queensland: Cape York in April, May, and June; nine specimens received from Mr. W. B. Barnard, who has the type.

Cataclysta haematera n. sp.

αἱματηρος, blood-stained—

♂ 15–16 mm. Head white; side-tufts and face grey. Palpi white. Antennae grey-whitish with slender incomplete fuscous annulations. Thorax white, with a median fuscous transverse bar. Abdomen grey; first two segments, apices of remaining segments, and tuft, white. Legs white; anterior tibiae and tarsi with fuscous rings; mid-tibiae fuscous on basal half of dorsum. Forewings elongate-triangular, costa straight to $\frac{3}{4}$, thence arched, apex round-pointed, termen slightly rounded, slightly oblique; white with fuscous markings; a basal costal dot; a transverse fascia at $\frac{1}{4}$; a broad antemedian fascia with irregular edges, sometimes interrupted; a transverse line from $\frac{2}{3}$ costa, bent slightly inwards below middle, thence transverse to $\frac{3}{4}$ dorsum; this is followed by a broad ochreous-reddish suffusion, leaving extreme terminal area white; three dark fuscous marks on termen beneath apex; cilia white, with a fuscous median line, often restricted to subapical area. Hindwings with termen rounded; dull reddish; a small apical fuscous blotch; costal area before middle, and a subapical spot prolonged on terminal edge toward tornus, white; cilia as forewings.

North Queensland: Cape York in October and November; five specimens received from Mr. W. B. Barnard, who has the type.

Cataclysta argyrilinalis.

Oligostigma argryrilinale Hmps. Trans. Ent. Soc. 1897, p. 168—

Hampson distinguishes *Oligostigma* Gn. by the hindwing being excised beneath apex, but this excision is often very slight, and the distinction does not seem to me natural or reliable. I regard the genus as a synonym of *Nymphula*. *Cataclysta* is distinguished from that genus by the smooth-scaled acute filiform maxillary palpi, and the longer outer tibial spurs (about $\frac{3}{4}$). In *Nymphula* the maxillary palpi are loose-haired and obtuse, and the outer tibial spurs about $\frac{1}{2}$.

North Queensland: Cooktown; Cardwell.

Cataclysta marginipuncta n. sp. /

marginipunctus, with marginal dots—

♂ 16 mm. Head, palpi, thorax, abdomen, and legs white. Antennae annulate; white; in male minutely ciliated. Forewings triangular, costa straight almost to apex, apex pointed, termen slightly sinuate, oblique; white, suffused with pale-yellow beneath costa; a short perpendicular streak on costa at $\frac{2}{5}$; a suffused line from costa at $\frac{3}{4}$, at first perpendicular, forming a rounded angle above middle, thence sinuate to $\frac{2}{5}$ dorsum, pale-yellow, towards costa mixed with fuscous; a pale-yellow subterminal line from before apex to tornus; a pale-yellow terminal line edged anteriorly with fuscous; cilia fuscous, apices white. Hindwings with termen gently rounded; white, suffused with pale-yellow before middle and on a broad terminal band, but leaving apex white; a submarginal series of six circular blackish dots; cilia as forewings.

North Queensland: Cape York in October; one specimen received from Mr. W. B. Barnard.

Gen. *Trigonophylla* nov.

τριγονοφυλλος, with triangular wings—

Tongue present. Palpi curved, ascending, appressed to face, considerably thickened, anterior edge rough; terminal joint short, obtuse. Forewings with cell $\frac{1}{2}$, 2 from $\frac{2}{3}$, 3 from before angle, 4 and 5 approximated from angle, 6 from middle of cell, 7 from upper angle, 8, 9, 10 stalked, 11 free. Hindwings with cell $\frac{1}{2}$, 2 from $\frac{4}{5}$, 4 absent, 3 and 5 connate from angle, widely diverging.

Allied to *Aulacodes,* but differs in structure of hindwings.

Trigonophylla trichroma n. sp.

τριχρωμος, three-coloured—

♂ 20 mm. Head white; crown ochreous-tinged. Palpi white. Antennae pale-grey; in male minutely ciliated. Thorax yellow; sides and a posterior spot white. Abdomen white sprinkled with fuscous; first three segments yellow on dorsum; last two segments and tuft with fuscous apices. Legs white; anterior pair yellow with white rings. Forewings elongate-triangular, costa straight to $\frac{3}{4}$, thence arched, apex rectangular, termen slightly rounded, slightly oblique; white; a yellow basal patch, short on costa, on dorsum extending to $\frac{1}{3}$; a small fuscous tornal patch containing two white dots; a yellow spot on $\frac{1}{3}$ costa; four converging costal streaks; first outwardly oblique from before middle, fuscous but yellow on costa, very slender, sometimes running into second; second from mid-costa, similar but longer, reaching beyond middle of wing; third from $\frac{2}{3}$, less oblique, mostly yellow; fourth broadly wedge-shaped, from costa before apex, yellow, connected with termen beneath apex; a broad yellow line on lower half of termen; cilia white, bases yellow, on tornus fuscous. Hindwings broadly triangular, termen nearly straight; white; a broad fuscous terminal band extending inwards on veins 2 and 3; dorsal edge fuscous; terminal edge and an apical spot white; cilia white with a yellow basal line, which becomes fuscous towards tornus, on dorsum fuscous.

North Queensland: Cape York in April and June; two specimens received from Mr. W. B. Barnard, who has the type.

Strepsinoma repititalis Warr.

Ann. Mag. Nat. Hist. (6) xvii., p. 205—

♂ 20 mm. Head and palpi pale-yellow. Antennae pale-grey. Thorax pale-yellow with three posterior fuscous spots. Abdomen pale-yellow; first segment and tuft whitish; second segment and apices of those following fuscous. Legs ochreous-whitish; anterior coxae of male with a broad internal tuft of fuscous hairs at apex. Forewings narrow, costa gently arched, apex pointed, termen obliquely rounded; an elongate triangular fovea in cell beneath; 2, 3, 4, 5 closely approximated at origin, 11 stalked or approximated; basal part pale-yellow; a fuscous sub-basal median fuscous spot; a large triangle extending on dorsum from $\frac{1}{4}$ to $\frac{3}{4}$, its apex reaching above middle, coarsely irrorated with blackish, and edged with fuscous; an oblique fuscous wedge from mid-costa to above tornus; beyond this a broad obtuse transverse white wedge; a broad yellow fuscous-edged fascia from $\frac{3}{4}$ costa, at first transverse, then narrower and curved inwards ending on tornus, but sending a process along outer edge of dorsal triangle; a yellow terminal line edged with fuscous; space between last two markings white towards costa, becoming fuscous and narrow towards tornus; a terminal series of fuscous dots, that one beneath apex larger; cilia pale fuscous. Hindwings with termen only slightly rounded; whitish, towards dorsum suffused with yellow; four blackish spots, edged for the most part with orange, on middle portion of termen; these are enclosed in a curved blackish line containing three silvery dots; above these markings a curved yellow line edged with fuscous and preceded by fuscous irroration; an orange apical spot; cilia fuscous, on dorsum whitish-ochreous.

North Australia: Melville I. North Queensland: Cairns; Innisfail; Herberton; Ingham. Queensland: Yeppoon.

Strepsinoma foveata n. sp.

foveatus, with conspicuous fovea—

♂ 23 mm. Head, palpi, and thorax pale-yellow. Antennae pale-grey. Abdomen pale-yellow; apices of segments whitish. Legs whitish; anterior femora and tibiae fuscous. Forewings elongate-triangular, costa slightly arched, apex rounded, termen slightly rounded, slightly oblique; on upper surface a triangular fovea in cell preceded by an angular raised edge; on lower surface a large fovea occupying whole of cell, with three swollen transverse corrugations; fuscous with yellow streaks and lines; a slender median streak from base to tornus; a broader dorsal streak to $\frac{2}{3}$; a white wedge at $\frac{3}{4}$, its base not touching costa, its apex rounded above tornus, its posterior edge indented; this is edged with fuscous and surrounded with yellow, broadly on sides, narrowly around apex; a broad yellow terminal line edged on both sides with fuscous; cilia fuscous. Hindwings with termen rounded, sinuate beneath apex; whitish; a transverse yellow fuscous-edged postmedian line not touching costa and dorsum; four blackish spots on median portion of termen, each containing a central white dot, separated by yellow streaks; some fuscous irroration between these and postmedian line; a yellow fuscous-edged line on apex and another on termen between central spots and tornus; cilia fuscous, on tornus and dorsum whitish.

New South Wales: Casino in March; one specimen.

Gen. *Sericophylla* nov.

σερικοφυλλος, with silken wings—

Face smooth, not projecting. Tongue well developed. Labial palpi ascending, curved, appressed to face, not reaching vertex; second joint moderately thickened with appressed scales, rough anteriorly; terminal joint very short, obtuse. Maxillary palpi filiform. Antennae not annulate; in male thickened with moderately long ciliations. Tibiae with outer spurs ½ or less. Forewings with cell ½, 2 from ¾, 3 from near angle, 4 and 5 connate, 6 from above middle, 7 from upper angle, 8, 9, 10 stalked, 11 free. Hindwings with cell nearly ½, 2 from near angle, 3 from angle connate with 4, 5, which are short-stalked, 7 anastomosing with 12 to ¾ of wing.

This genus approximates in structure to *Diathraustodes* Hmps.

Sericophylla

~~*Sericophora*~~ *nivalis* n. sp.

nivalis, snowy—

♂♀ 16–18 mm. Head, palpi, thorax, abdomen, and legs white. Antennae white; ciliations in male 1½. Forewings elongate-triangular, costa slightly arched, apex rounded, termen slightly rounded, oblique; white with grey markings; an outwardly curved line from ¼ costa to ⅓ dorsum; a median discal dot; a line from ⅔ costa, strongly curved outwards, bent below middle, thence transverse to ⅔ dorsum; cilia white, bases pale-grey. Hindwings with termen rounded; colour and cilia as forewings; a slender postmedian line curved outwards in costal half.

North Queensland: Cape York in October and November; seven specimens received from Mr. W. B. Barnard, who has the type.

Gen. *Cissachroa* nov.

κισσαχρωος, coloured like a magpie—

Head smooth, not projecting. Tongue well developed. Labial palpi short, curved, ascending, not reaching middle of face; second joint moderately thickened, rough anteriorly; terminal joint very short, obtuse. Maxillary palpi short, filiform, concealed. Antennae of male with moderately long ciliations. Posterior tibiae with outer spurs half inner or less. Forewings with cell ½, 2 from shortly before angle, 3, 4, 5 approximated at origin, 6 from above middle, 7 from upper angle, 8, 9, 10 stalked, 11 free. Hindwings with cell short (about ⅓) and open, 2 from ⅔, 3, 4, 5 approximated, 7 anastomosing with 12 to ¾ of wing.

The maxillary palpi can be seen only after removal of the labial palpi.

Cissachroa callischema n. sp.

καλλισχημος, prettily patterned—

♂♀ 12–16 mm. Head blackish; face white. Palpi white, base more or less fuscous. Antennae whitish-grey; ciliations in male 1½. Thorax white with a posterior blackish spot. Abdomen fuscous with some white rings; terminal segment white. Legs white; anterior pair fuscous. Forewings elongate-triangular, costa straight almost to apex, apex pointed, termen straight, rounded beneath, oblique; white with blackish markings; a moderate basal fascia; a costal streak to ⅗; a narrow fascia from mid-costa curved outwards to tornus; this is joined by a fascia from ¾ costa, at first narrow and sometimes interrupted, dilated in middle of wing, at the point of junction is a short obtuse inward process; an oblong apical blotch extending to mid-termen, prolonged slightly on terminal edge; cilia white with a fuscous median line, on apex and tornus fuscous. Hindwings with termen sinuate; white; a large triangular apical blackish blotch; a terminal line from tornus to ⅓ termen; cilia as forewings, on dorsum wholly white.

North Queensland: Cape York in October, November, and May; nine specimens received from Mr. E. J. Dumigan and Mr. W. B. Barnard.

Gen. *Streptobela* nov.

στρεπτοβελος, with bent palpi—

Tongue strong. Face smooth, not projecting. Labial palpi with second joint obliquely ascending, clothed with long hairs anteriorly; terminal joint long, smooth, acute, strongly bent downwards. Maxillary palpi short, filiform. Antennae of male with moderately long ciliations. Tibiae with outer spurs nearly as long as inner. Forewings with 2 from $\frac{3}{4}$, 7 well separate, 8, 9, 10 stalked. Hindwings with cell open, short ($\frac{1}{3}$), oblique, 2 from $\frac{3}{4}$, 3, 4, 5 diverging, 7 anastomosing strongly with 12.

Probably nearest *Margarochroma* Warr.

Streptobela crocobaphes n. sp.

κροκοβαφης· saffron-dyed—

♂♀ 16 mm. Head and thorax orange-yellow. Palpi whitish, terminal joint and a median bar on second joint orange-yellow. Antennae pale-grey; ciliations in male 2. Abdomen whitish broadly barred with orange-yellow on dorsum. Legs whitish; anterior tibiae and part of tarsi ochreous-grey. Forewings elongate-triangular, costa straight to $\frac{2}{3}$, thence gently arched, apex rounded, termen rounded, slightly oblique; basal area orange-yellow; postmedian area except a strip along costa and another on termen pale fuscous; two slender fuscous transverse lines; first slightly dentate, from mid-costa to dorsum beyond middle; second from $\frac{3}{4}$ costa, outwardly curved to below middle, where it ceases abruptly; cilia pale-yellow. Hindwings with costa gently rounded; fuscous; costal area whitish; basal hairs and a terminal strip not reaching apex orange-yellow; cilia as forewings.

North Queensland: Kuranda in June; two specimens.

Tabidia marmarodes n. sp.

μαμαρωδης, like marble—

♂♀ 22 mm. Head whitish. Palpi white. Antennae fuscous Thorax white; shoulders and a broad longitudinal median stripe dark fuscous. Abdomen fuscous with broad basal and sub-basal bars, a narrow terminal bar, and underside white; tuft in male grey-whitish. Legs white with dark fuscous rings; posterior pair almost wholly white. Forewings elongate-triangular, costa straight to $\frac{3}{4}$, thence arched, apex subrectangular, termen gently rounded, moderately oblique; fuscous with white markings; a basal spot; an erect sub-basal dorsal mark; a narrow fascia from $\frac{1}{3}$ costa to mid-dorsum, angled outwards below middle, but sometimes interrupted; an incomplete fascia from $\frac{2}{3}$ costa to below middle, dilated in disc; an oblong costal subapical spot, from which arises a slender acutely dentate line to dorsum beyond middle, sometimes joining lower end of first fascia; a tornal spot; cilia white. Hindwings with termen sinuate; white with fuscous markings; a slender line from near base of costa to tornus; a large antemedian spot; an S-shaped line from $\frac{2}{3}$ costa to tornus; a terminal band containing two submarginal white spots towards tornus; cilia white, on tornus fuscous.

North Queensland: Mossman and Tully in June; two specimens.

Tatobotys ceramochra Meyr.

Trans. Ent. Soc. 1885, p. 443—

Considerably smaller than *T. janapalis* Wlk., the forewings narrower and less rounded at apex, more brightly coloured, without sub-basal line, subcostal spots darker and more distinct, dentations of postmedian line much smaller and sharper.

North Australia: Darwin; Brock's Creek. North Queensland: Mossman; Cairns; Innisfail. Queensland: Duaringa.

Sylepta ocellifera n. sp.

ocellifer with eyed spots—

♂♀ 22–30 mm. Head pale-brown; face whitish. Palpi fuscous; base whitish. Antennae pale-grey; ciliations in male $\frac{1}{2}$. Thorax whitish partly suffused with grey; tegulae long, with central brown or fuscous stripe. Abdomen whitish sometimes partly ochreous-tinged; apices of segments sometimes fuscous; tuft in male dark fuscous. Legs pale-grey; posterior tibiae whitish. Forewings elongate-triangular, costa straight to $\frac{3}{4}$, thence strongly arched, apex rounded, termen slightly rounded, slightly oblique; 7 not curved at base; white with purple reflections; markings pale-ochreous edged with fuscous; a subcostal fuscous line from base to $\frac{2}{3}$; costal and dorsal sub-basal spots in a fuscous suffusion; an oblique line from $\frac{1}{4}$ costa (in female $\frac{1}{6}$) to $\frac{2}{5}$ dorsum (in female $\frac{1}{3}$) with a posterior spur below middle; a large longitudinally oval subcostal blackish spot beyond middle, broadly edged with pale ochreous and outside this with fuscous, with a minute central whitish dot; a sinuate line from $\frac{3}{4}$ costa to dorsum before tornus; a narrow terminal band containing a suffused fuscous spot above middle; cilia white, on apex and terminal spot fuscous. Hindwings triangular, termen nearly straight; colour as forewings; a small discal circle connected by a line with costa at $\frac{1}{3}$ fuscous; a sinuate fuscous subterminal line; a fuscous terminal spot; a pale ochreous fuscous-edged terminal line; cilia white, on apex fuscous.

North Queensland: Cape York and Cooktown in October, November, and December; seven specimens received from Mr. W. B. Barnard, who has the type.

Sylepta argillitis n. sp.

ἀργιλλιτις, clay-coloured—

♀ 22–24 mm. Head and palpi fuscous. Antennae grey, towards base fuscous. Thorax ochreous-brown; anteriorly broadly fuscous. Legs grey; anterior tibiae fuscous; tarsi fuscous with pale rings. Forewings elongate-triangular, costa straight to $\frac{3}{4}$, thence arched, apex rounded, termen slightly rounded, oblique; ochreous-brown with fuscous markings; a broad suffused costal streak to beyond middle; a slender line from $\frac{1}{5}$ costa to $\frac{1}{3}$ dorsum; discal spot before middle, broadly edged anteriorly and posteriorly, open above and beneath; postmedian from $\frac{3}{4}$ costa, slender, finely and irregularly waved, deflected above tornus to beneath discal spot, thence to $\frac{2}{3}$ dorsum; submarginal and terminal series of dots; cilia grey with a fuscous sub-basal line. Hindwings with termen slightly rounded; ochreous-brown, paler towards base and costa; a slender discal mark at $\frac{1}{3}$; postmedian slender, wavy, its median portion approximated to termen; marginal dots and cilia as forewings.

North Queensland: Cooktown in April; Tully, near Innisfail, in June and July; three specimens.

Sylepta cyclotypa n. sp.

κυκλοτυπος, with rounded markings—

♀ 30–32 mm. Head pale ochreous; face and palpi pale fuscous. Antennae grey. Thorax fuscous mixed with pale ochreous. Abdomen ochreous-whitish; dorsum barred with pale fuscous. Legs fuscous. Forewings elongate-triangular, costa straight to $\frac{3}{4}$, thence arched, apex rounded, termen rounded, slightly oblique; whitish-ochreous with fuscous markings; a short subcostal streak from base joined at its apex by a streak from base of dorsum; a transverse line at $\frac{1}{4}$, with posterior projections from middle and on dorsum; a small oval subcostal spot beyond this; a much larger oval spot beneath mid-costa; a dentate line from $\frac{2}{3}$ costa to $\frac{3}{5}$ dorsum; a large apical and a small tornal blotch; these are connected by three dots in a curved transverse line; a terminal series of minute whitish-ochreous interneural dots; cilia with a whitish-ochreous bar on tornus and another shortly above. Hindwings with termen slightly rounded; colours as forewings; veins outlined with fuscous; a dentate transverse line at $\frac{1}{3}$; small apical and tornal blotches; connected by a line of three dots; terminal dots and cilia as forewings.

In coloration very similar to *Rhimphalea sceletalis* Wlk., but differing in detail of pattern and in structure of antennae and palpi.

North Queensland: Kuranda in April; two specimens received from Mr. F. P. Dodd.

Bocchoris zophophanes n. sp.

ζοφοφανης, dusky—

♂ 25–26 mm. Head and thorax fuscous-brown. Palpi fuscous-brown; basal half white. Abdomen and legs brown. Forewings triangular, costa straight to near apex, apex round-pointed, termen slightly rounded, slightly oblique; fuscous-brown; markings fuscous; a line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum; a pale-centred narrow median discal spot; postmedian finely dentate from $\frac{5}{6}$ costa, indented inwards above middle, beneath middle bent inwards to beneath discal spot, thence transverse to $\frac{2}{3}$ dorsum; a terminal series of dots; cilia pale-brown. Hindwings with termen rounded; colour as forewings; postmedian from $\frac{2}{3}$ costa, angled inwards or interrupted beyond middle, thence transverse to tornus; terminal dots and cilia as forewings.

Queensland: Bunya Mountains (3,000 ft.) in January; two specimens.

Nausinoe euronalis Swin.

Polythlipta euroalis Swin. Proc. Zool. Soc. 1889, p. 420, Pl. 44, f. 12.

Phalangiodes rivulalis Snel. Trans. Ent. Soc. 1890, p. 637, Pl. 20, f. 1.

North Queensland: Cape York in May, June, and October (W. B. Barnard). Also from Java, Sumatra, and India.

Margaronia actorionalis Wlk.

Cat. Brit. Mus. xvii., p. 498, Moore. Lep. Ceyl. iii., Pl. 180, f. 1.

Glyphodes zelleri Led. Wien. Ent. Mon. 1863, p. 478, Pl. 14, f. 8.

Glyphodes conclusalis Wlk. xxxiv., p. 1354.

Glyphodes tumidalis Warr. Ann. Mag. Nat. Hist. (6) xviii., p. 118.

Glyphodes violalis Warr. Ann. Mag. Nat. Hist. (6) xviii., p. 118.

Lypotigris jovialis Feld. Reise Nov., Pl. 136, f. 25.

North Queensland: Cape York in June (W. B. Barnard). Also from Archipelago, Ceylon, and India.

Margaronia basiferalis Hmps.

Proc. Zool. Soc. 1898, p. 743, Pl. 50, f. 16—

♂ 28 mm. Head and thorax whitish-grey-ochreous. Palpi grey; beneath sharply white towards base. Antennae grey-whitish; ciliations in male minute. Abdomen whitish-grey. Legs whitish; anterior pair except coxae ochreous. Forewings triangular, costa straight to $\frac{2}{3}$, thence arched, apex round-pointed, termen slightly rounded, slightly oblique; ochreous-whitish, thinly scaled; markings pale-brown; a straight oblique line from $\frac{1}{5}$ cost to $\frac{1}{3}$ dorsum, preceded by two slender lines; a fascia from mid-costa to $\frac{2}{3}$ dorsum, moderately broad on costa, gradually narrowing, containing a fine whitish central streak beneath costa; a straight line from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum, immediately followed by a darker line; terminal area grey with a suffused line from apex; cilia whitish with a dark fuscous basal line towards apex. Hindwings broad, termen nearly straight to near tornus; colour as forewings; median and subdorsal longitudinal streaks in basal area; terminal band as forewings but not reaching tornus; cilia whitish with a dark fuscous sub-basal line towards tornus.

North Queensland: Cape York in November; one specimen (W. B. Barnard). The locality ''Bathurst'' given by Hampson for this species is quite impossible. Probably the real locality is Bathurst Island, North Australia.

Archernis mitis n. sp.

mitis, mild, gentle—

♂♀ 38–40 mm. Head and thorax pale ochreous-brown. Palpi 2, porrect; second joint dilated with scales towards apex; terminal joint short, obtuse; ochreous-brown, sharply white towards base beneath. Antennae pale-grey; ciliations in male 1. Abdomen pale-brown, beneath white. Legs white; anterior pair mostly grey. Forewings elongate-triangular, costa gently arched, apex pointed, termen slightly rounded, oblique; pale ochreous-brown, markings faintly darker; traces of a transverse line at $\frac{1}{4}$; a faint discal dot at $\frac{2}{5}$; a slightly dentate line from $\frac{2}{3}$ costa, at first slightly oblique, below middle bent inwards and upwards to beneath discal dot, then downwards to mid-dorsum; cilia grey. Hindwings with termen gently rounded; grey; cilia whitish-grey.

North Queensland: Townsville in February; two specimens received from Mr. F. P. Dodd. Queensland: Yeppoon.

Metallarcha umbrifera n. sp.

umbriferus, shaded—

♂♀ 16–18 mm. Head whitish-ochreous; face with rounded prominence. Palpi $2\frac{1}{2}$; dark fuscous, sharply white towards base beneath. Antennae fuscous; ciliations in male $\frac{1}{2}$. Thorax fuscous. Abdomen fuscous apices of segments whitish. Legs fuscous; middle and posterior tibiae and all tarsi fuscous-whitish. Forewings elongate-triangular, costa straight almost to apex, apex round-pointed, termen slightly rounded, moderately oblique; fuscous sprinkled with whitish, appearing grey; a moderate pale ochreous-tinged fascia edged with fuscous from before mid-dorsum narrowing to a point beneath costa before middle; a second similar fascia from $\frac{3}{4}$ costa, ending in a rounded extremity well above tornus, constricted in middle; a fine pale terminal line; cilia fuscous. Hindwings with termen rounded; orange; a subcostal spot at $\frac{1}{4}$, a broad apical patch narrowly prolonged to tornus, and dorsal edge, blackish; cilia fuscous.

Near *M. diplochrysa* Meyr., but lacking the clear orange markings and basal patch on forewings.

West Australia: Albany and Busselton in February; four specimens received from Mr. W. B. Barnard, who has the type.

Metasia polytima Turn.

M. nyctichroa Turn. is a synonym.

North Australia: Darwin; Melville Island. North Queensland: Herberton; Townsville. Queensland: Yeppoon; Bundaberg; Nambour; Killarney.

Noorda pyrsodes n. sp.

πυρσωδης, fiery—

♀ 18 mm. Head yellow. Palpi 3; reddish-orange, sharply white towards base beneath. Maxillary palpi dilated; reddish-orange. Antennae pale ochreous-grey. Thorax yellow; shoulders and an interrupted postmedian line red. Abdomen yellow, partly suffused with red on dorsum; apices of segments and underside white; two posterior segments purple. Legs white; anterior pair yellow with red tibiae. Forewings triangular, costa straight to near apex, apex pointed, termen obtusely bowed on vein 3; 8, 9, 10 stalked; yellow reticulated with red; narrow sub-basal and antemedian red fasciae; fine red streaks on veins; costal edge fuscous; a finely-dentate line from $\frac{3}{4}$ costa, curved inwards above middle, thence to $\frac{2}{3}$ dorsum, upper half reddish-fuscous. lower half red; a yellow line follows this; terminal area suffused with reddish-fuscous; cilia reddish-fuscous, apices white, but fuscous on apex, angle, and tornus. Hindwings with termen gently rounded; yellow; a moderate purple terminal band ceasing at tornus; cilia as forewings, on dorsum pale-yellow.

North Queensland: Cape York in May; one specimen received from Mr. W. B. Barnard, who has the type.

Noorda miltosoma n. sp.

μιλτοσωμος, red-bodied—

♀ 22 mm. Head red on crown; face fuscous. Labial palpi dark fuscous; at base beneath white, reddish-tinged. Antennae fuscous. Thorax dark fuscous with a large anterior red spot. Abdomen bright red; dark fuscous beneath. Legs dark fuscous with white rings; posterior tibiae and tarsi mostly white. Forewings triangular, costa straight to $\frac{3}{4}$, thence gently arched, apex pointed, termen slightly rounded, moderately oblique; dark fuscous sparsely sprinkled with minute whitish scales; cilia fuscous. Hindwings with termen rounded; dark fuscous; cilia fuscous.

A species of singular colouration. Queensland: Eidsvold in October; one specimen.

Pitacanda spilosomoides Moore.

Lep. Ceyl. iii., p. 334, Pl. 183, f. 10—

North Queensland: Cape York in October and November (W. B. Barnard). Also from Ceylon and India.

Gen. *Nyctiplanes* nov.

νυκτιπλανης, wandering by night—

Tongue present. Face smooth, rounded, not projecting. Palpi moderately long, porrect; second joint shortly rough-haired above and beneath; terminal joint moderate, obtuse. Maxillary palpi stout with a short forwardly directed apical tuft. Tibiae with outer spurs about ½ inner. Forewings with 3 from well before angle, 7 straight, 8, 9, 10 stalked, or 10 closely approximated. Hindwings with cell ⅖, 4 and 5 approximated at origin, immediately diverging, 7 anastomosing with 12 for some distance.

Probably near *Noorda*, but the palpi are much shorter. The male antennal ciliations are an additional character.

Nyctiplanes polypenthes n. sp.

πολυπενθης, very mournful—

♂ 24–25 mm. Head and thorax dark fuscous. Palpi 2; dark fuscous, beneath whitish-brown. Antennae fuscous; ciliations in male 1. Abdomen fuscous; tuft and underside grey-whitish; dorsum of second segment whitish-ochreous. Legs fuscous; posterior tibiae and all tarsi grey-whitish; the latter with fuscous rings. Forewings elongate-triangular, costa slightly arched, apex rectangular, termen obtusely bowed on vein 3, not oblique; fuscous, darker towards base; a small whitish-ochreous triangle on costa just before middle; a whitish-ochreous spot on ⅚ costa; a dark fuscous crenulate line cuts through this and curving outwards and then inwards ends on tornus, obscurely edged with whitish posteriorly; an oblong whitish-ochreous spot on termen before apex, and a much smaller spot above tornus; cilia fuscous barred with whitish-ochreous. Hindwings with termen rounded; fuscous; an obscure darker subterminal line obscurely whitish-edged; a whitish dot well above tornus; cilia as forewings.

North Queensland: Cape York in June; two specimens received from Mr. W. B. Barnard, who has the type.

Gen. *Ectadiosoma* nov.

ἐκταδιοσωμος, long-bodied—

Tongue strong. Face smooth, not projecting. Labial palpi moderately long, porrect, triangularly scaled; terminal joint concealed. Maxillary palpi slightly dilated at apex. Antennae about ⅘; annulated towards apex; ciliations in male minute. Tibiae with outer spurs less than half inner. Abdomen slender and very elongate, projecting far behind hindwings. Forewings with 2 from ⅔, 3, 4, 5 approximated from angle, 7 slightly curved, 10 closely approximated to 8, 9. Hindwings with cell about ⅖, 3, 4, 5 approximated at origin, thence diverging, 7 anastomosing strongly with 12.

Near *Hyalobathra*. Differs in the very long slender abdomen and shorter cell of hindwings.

Ectadiosoma pleurocapna n. sp.

πλευροκαπνος, with smoky costa—

♂ 27–30 mm. Head ochreous-grey. Palpi 2¼; beneath sharply white. Antennae pale-grey. Thorax pale-yellow; anterior margin fuscous. Abdomen brownish-fuscous; towards base pale-yellow. Legs whitish; anterior pair partly pale-grey. Forewings elongate-triangular, slightly arched near apex, apex pointed, termen straight, oblique; pale-yellow with some grey suffusion towards termen; a median pair of blackish dots at each angle of cell; a broad fuscous costal streak from base to $\frac{3}{4}$; a fine fuscous transverse line at $\frac{1}{5}$; a fuscous line from $\frac{4}{5}$ costa slightly outwardly curved to $\frac{2}{3}$ dorsum, indented below middle; cilia whitish-grey. Hindwings with termen rounded; pale-grey; a blackish dot in disc at $\frac{1}{3}$; a curved fuscous transverse line at $\frac{4}{5}$ not reaching dorsum, cilia as forewings.

North Queensland: Townsville in September. Queensland: Brisbane and Toowoomba in March. Three specimens; I have also seen one from Yeppoon in October.

Hyalobathra rhodoplecta n. sp.

ῥοδοπλεκτος, rosy-braided—

♂♀ 25–28 mm. Head and thorax crimson mixed with pale-yellow. Palpi pale-yellow with basal, median, and apical crimson bars. Antennae grey, towards base crimson-tinged; ciliations in male 1. Abdomen pale-yellow with dorsal crimson bars. Legs crimson; tarsi whitish-ochreous; anterior tarsi with crimson bars. Forewings elongate-triangular, costa straight to $\frac{3}{4}$, thence arched, apex rounded, termen slightly rounded, slightly oblique; pale-yellow with coarse crimson lines and streaks; a costal streak to middle; dentate transverse lines near base and at $\frac{1}{5}$; a line from $\frac{3}{5}$ costa outwardly oblique, strongly curved outwards, retracted below middle, sinuate and dentate to mid-dorsum, connected by a short dentate line with $\frac{2}{5}$ costa; a finely-dentate line at $\frac{4}{5}$ connected with termen by streaks on veins; cilia crimson. Hindwings with termen rounded; pale-yellow becoming whitish towards costa; a sinuate crimson line from $\frac{2}{3}$ dorsum, not reaching costa; subterminal and terminal crimson lines; cilia crimson.

North Queensland: Kuranda in December, May, and July; five specimens.

Gen. *Phenacodes* nov.

φενακωδης, like an impostor—

Tongue strongly developed. Face smooth, not projecting. Labial palpi short, stout, porrect, thickened with appressed scales, but rough beneath towards base; terminal joint short, stout, obtusely truncate. Maxillary palpi widely dilated with scales at apex. Antennae in male without basal process, minutely ciliated. Forewings with raised scales; 2 from $\frac{3}{4}$, 3 from before angle, 4 and 5 rather approximated at origin, 6 separate, 7 separate from near upper angle, 8 and 9 stalked, 10 from well before angle, 11 from $\frac{3}{4}$. Hindwings with 2 from $\frac{4}{5}$, 3, 4, 5 approximated from angle, 6 from upper angle connate with 7, which anastomoses with 12.

This is an anomalous genus. By strictness of definition is must be referred to the *Pyraustidae,* but its shape, raised scales, pattern and coloration of forewings, suggest the *Pyralidae,* to some of which it is closely similar. On the other hand its short palpi with very short obtuse terminal joint support the evidence furnished by the neuration.

Phenacodes aleuropa Low.

Trans. Roy. Soc. S.A., 1903, p. 59—

North Queensland: Atherton; Mackay. Queensland: Brisbane; Toowoomba; Mount Tambourine. New South Wales: Lismore; Murrurundi. Mr. A. R. Brimblecombe has bred this species from larvae feeding on *Platycerium alcicorne,* the Elkhorn fern. They have also been noted to feed on other ferns. The larva shelters during the day in a tunnel within the peat, and emerges at night to feed on the fronds, or it chews off a piece and consumes it at the entrance of the tunnel, in which it pupates.

Heliothela floricola Turn.

Pros. Roy. Soc. Q. 1912, p. 159—

When I described this species I confused it with the following, thinking the two forms sexes. This was an error, for I have both sexes of each, and actually the type of *H. floricola* is a female. From the other Australian species it may be readily distinguished by its smaller size (♂♀ 10–12 mm.) and the presence of a white spot on the hindwings, but it is extremely similar to the New Zealand *H. atra* Butl.

New South Wales: Mount Kosciusko (5,000 to 6,000 ft). Tasmania: Cradle Mountain (3,000 ft.). I have received two examples labelled "Altona" (near Melbourne?) but doubt this locality.

Heliothela aterrima n. sp.

aterrimus, very black—

♂♀ 14–18 mm. Head and thorax blackish with a few white scales. Palpi $3\frac{1}{2}$; blackish with some white scales, wholly white towards base beneath. Antennae blackish. Abdomen blackish with few white scales on apices of segments and in tuft. Legs blackish; tarsi with white rings. Forewings elongate-triangular, costa straight, apex rounded, termen slightly rounded, slightly oblique; blackish with few scattered white scales; three obscure black transverse lines; first sub-basal; second at $\frac{1}{4}$, slightly waved; third median, sinuate; an obliquely elongate white spot beyond middle, touching costa, edged posteriorly by a black line, which runs inwards beneath spot into third line; beyond this a line of white scales from costa ending in a white dot on tornus; cilia fuscous, on apex with white apices. Hindwings broad, termen rounded; blackish; cilia fuscous with white apices.

New South Wales: Mount Kosciusko (5,000 to 6,000 feet) in January (4 males) and in March (3 females).

Fam. PTEROPHORIDAE.

Platyptilia brachymorpha Meyr.

Mr. A. Brimblecombe has found the larvae of this species feeding in lantana berries. Though this cannot be its native host, the fact is of interest and suggests that the species may be somewhat of a general feeder.

Notes on Australian Cyperaceae I.

By S. T. Blake, M.Sc., Walter and Eliza Hall Fellow in Economic Biology, University of Queensland.

(*Read before the Royal Society of Queensland, 30th November, 1936.*)

PLATES II. AND III.

Tribe RYNCHOSPOREAE.

Trachystylis S. T. Blake gen. nov.; affinis *Actinoschoeno* Benth. et *Arthrostylidi* R. Br. sed planta foliosa, spiculis umbellatis, stylo bifido superne hispido, staminibus 2 differt.

Spiculae umbellatae bisexuales plerumque uniflorae, glumae undique imbricatae, suprema vacua, 1-2 succedentes hermaphroditae, ceterae (plures) vacuae. *Setae hypogynae* nullae. *Stamina* 2. *Stylus* elongatus hispidus, basin versus conico-dilatatus glaber in nuce articulatus, facillime deciduus; rami 2 longi hispidi. *Nux* magna complanata cellulis extimis minutis hexagono-rotundis.

Rhizoma horizontale, culmi caespitosi, basin versus dense foliati, inflorescentia umbellata; internodus inter flores elongatus, alatus, ceteri brevissimi.

Species unica, Queenslandiae australis incola.

T. foliosa S. T. Blake sp. nov. *Rhizoma* breve. *Culmi* dense caespitosi, 1-4 dm. alti, graciles, triquetri, sulcati, angulis antrorsim plus minusve scabridae. *Folia* 4-6, internodis brevissimis; vaginae scariosae, albae vel pallide brunneae; laminae ad 2 dm. longae, 0·4-0·5 mm. latae, rigidae, erectae vel interdum curvatae, concavae, tenuiter nervosae, marginibus nerviformibus scabridis exceptis laeves, apicem obtusam versus plus minusve triquetrae. *Bracteae* perpaucae, ima ca. 1 cm. vel raro ad 3·5 cm. longa, foliis subsimilis, superiores brevissimae. *Umbella* simplex vel subcomposita, raro ad unicam spiculam redacta; radii usque ad 8 subaequales ad 1 cm. longi, graciles, campressi, interdum 1-2 divisi; bracteolae squamiformes. *Spiculae* in radiis radiolisque solitariae, pallidae vel pallide brunneae, ovato-lanceolatae, acuminatae, aliquantum compressae saepissime uniflorae, ca. 5 mm. longae, 2-2.5 mm. latae. *Glumae* 6-7, dorso virides carinatae, lateribus tenuiter coriaceae, pallidae vel pallide brunneae vel subhyalinae, marginibus integerrimis glaberrimae (mucronibus hispidis exceptis); gluma suprema vacua oblongo-elliptica vel oblanceolata, obtusa, mutica, 2.8-3 mm. longa, 1-2 succedentes hermaphroditae maximae, lanceolatae, obtusae, apicem versus involutae, inferne sub-5-nerves cum mucrone dorsali brevissima 4.5-5 mm. longae; inferiores gradatim breviores, cum mucrone terminali hispida longiore; glumae 1-2 infimae deltoideo-ovatae obtusae, cum mucrone 0.5 mm. longa 1.8-2.0 mm. longae quasi bracteolaeformes. *Internodus* inter flores (in spiculis bifloris) elongatus, curvatus, late alatus ad 1.1 mm. longus, ceteri brevissimi. *Stamina* 2 antherae lineares aristatae. *Stylus* 3.5 mm. longus, tenuior, superne teretiusculus, plus minusve antrorsim dense hispidus, basi anguste compresso-conicus glabrescens; rami 2 dense hispidi, 3 mm. longi exserti. *Nux* aliquantum opaca pallida vel cinerascens vel fuscescens, late elliptico-obovata vel suborbicularis admodum asymmetrica, minute stipitata, biconvexa sed compressa, marginibus obtusis, 2.0-2.2 mm. longa 1.5-1.75 mm. lata; cellulae extimae minutae, sed conspicuae, subrotundae.

QUEENSLAND.—Burnett District: Bustard Head *Keys* 6. Moreton District: Bribie Island *C. T. White* Easter 1914; on loose sand in mixed open forest near sea-level, 5. VI. 1933, *S. T. Blake* 4830; sandridges in lightly timbered country, 25. IX. 1934, *S. T. Blake* 7057; Stradbroke Island, *C. T. White* V. 1915, hillsides on sand in mixed open forest, 5. XII. 1934, *S. T. Blake* 7110 (type).

A distinctive and interesting plant. Its 1-2 flowered spikelets with several empty glumes place it in the *Rynchosporeae,* and the style dilated at its base and articulate on the ovary and nut suggest its affinity with *Actinoschoenus* and *Arthrostylis.* But its densely leafy habit, umbellate inflorescence and bifid style differentiate it sharply. In many characters it is not unlike *Fimbristylis* of the *Scirpeae,* but apart from the tribal characters, the characters of the style and nut are rather different.

The spikelet is *almost always* one flowered. Of the material cited above, all of White's specimens and *Blake* 4830, 7057, comprising a very large number of specimens, carry 1-flowered spikelets only. Key's specimens are few and carry a few 2-flowered spikelets. In *Blake* 7110, among a large number of specimens, about five 2-flowered spikelets occur, though at the time of collection such spikelets were diligently sought for. It would thus appear that this state is very exceptional.

Tribe SCIRPEAE.

Scirpus congruus, S. T. Blake comb. nov. *Isolepis congrua* Nees in Pl. Preiss II. 75 (1846-47). *I. castanea* F. Muell. MS. in Herb. Melb. *Scirpus Kochii* Maiden and Betche in Proc. Linn. Soc. N.S.W. XXXIII., 318 (1908).

WEST AUSTRALIA.—Swan River: *Preiss* 1747 type of *I. congrua* Nees!; Cowcowing *M. Koch* 1239 type of *S. Kochii!;* between Esperance Bay and Fraser Range, *Dempster* in 1876; Northampton, *Spalding* in 1883; basaltic valleys north of Stirling Range, Oct. 1867, *F. Mueller*; west from Kangaroo Hill, XI. 1891 *Helms* (Elder Expedition).

SOUTH AUSTRALIA.—In collibus siccis Bethaniae prope Gawlertown, Sept. 16, 1848, *F. Mueller.*

This distinctive little species is readily recognised by its extremely hyaline prominently fenestrate glumes and its minute (about 0·5 mm. long and broad), acutely triquetrous, silver grey nut. It is most nearly allied to *S. stellatus* C. B. Clarke, which has thicker glumes and a different nut, as well as a coarser habit. With *S. cartilagineus* Spreng. (= *S. antarcticus* Linn.) with which the authors of *S. Kochii* compare their plant, the species has little in common beyond the possession of a trifid style and somewhat similarly shaped glumes.

Boeckeler, according to Bentham, Fl. Austr. VII. 328, treated *I. congrua* as conspecific with *S. riparius* (*S. cernuus* Vahl), but it is just as distinct from this species as it is from *S. antarcticus.*

The type collection of *I. congrua,* Preiss 1747, is represented in the Melbourne Herbarium by a single stem, bearing a spikelet from which the lower glumes have fallen away. Though a poor specimen, there is no doubt that the above cited collections are conspecific with it. The type collection of *S. Kochii* includes some taller plants than the others, some stems bearing up to four spikelets instead of the usual 2-3.

The Section *Isolepis* is richly developed in southern Australia, where a bewildering variety of forms occurs. It is hoped that a complete revision of these will be completed in the near future.

On *Scirpus sterilis* Maiden and Betche Proc. Linn. Soc. N.S.W. XXXIII., 315 (1908). An examination of the type collection of this species (Narrabri, *J. Boorman*, VIII. 1907 in Herb. Sydney) shows it to be identical with *Bulbostylis barbata* Kunth (*Stenophyllus barbatus* Cooke, *Fimbristylis barbata* Benth., *Scirpus barbatus* Rottb., *Isolepis barbata* R. Br.). The writer has frequently noticed the abortion of ovules in many species of *Cyperaceae* and *Gramineae* from the drier areas.

Fimbristylis humilis, S. T. Blake sp. nov.; affinis *F. setaceae* R. Br. et *F. nutanti* R. Br., sed ab illa (quoad habitu approximat) spiculae forma coloreque, glumis brevioribus obtusissimis et nuce minore, ab hac habitu et in omni parte multo minore differt.

Annua parva caespitosa, viridis vel glaucescens, glaberrima; *culmi* vel obliqui vel erecti vel arcuati, anguloso-striati, ad 10 cm. alti., 0·3-0·35 mm. diam. *Foliorum* vaginae 2 laxiusculae, in dorso tenuiter herbaceae, plurinervesque in marginibus scariosae insuper glanduloso-striatae, apice vel ovatae vel lanceolatae vel superior laminifera : lamina rarissime ad 4 cm. longa, fere plana, ca. 0·4 mm. lata, 3-5 nervis. *Spicula* unica ebracteata, terminalis, erecta vel obliqua, ovoidea subobtusa densiflora, brunnea, 4-5 mm. longa 1·7-2 mm. lata. *Glumae* facile deciduae, rhachilla alata, concavae, late ovatae, obtusissimae, 1·5 mm. longae 1·2 mm. latae, carina lata 3-nervi breviter excurrente, lateribus rigidiusculae nitide castaneo-brunneae enerves, in marginibus auguste hyalinae integerrimae; ima sterilis brevior rigidor minus obtusa, bracteiformis. *Stamen* 1, anthera lineari-oblonga, acutiuscula vix apiculata ca. 0·4 mm. longa. *Stylus* latiusculus, complanatus, in marginibus angustissime hyalino-alatus parce ciliatus, inferne admodum dilatatus, 0·75-0·8 mm. longus, 0·3-0·35 mm. latus. *Stigmata* 2 cum stylo aequilonga. *Nux* obovata plus minusve cuneata, obtusa, biconvexa ca. 0·8 mm. longa, 0·55 mm. lata, nitide albida, manifeste transversim 4-costata, cellulis extimis obscuris.

QUEENSLAND.—Cook District: Wyaaba River, 16° 45′S. 142° 0′E., in swampy patch 18.VIII.1936, *S. T. Blake* 12622; Cairns in *Melaleuca* swamp near sea-level 14.VI.1935, *S. T. Blake* 9354 (type). Burke District: Normanton, depression in mixed forest 25.V.1935, *S. T. Blake* 9171; Gulliver in 1876; Glenore near Normanton on edge of waterhole 22.V.1935, *S. T. Blake* 9135; Croydon, in depressions and on stream beds and banks on whitish sand 350 ft., 22.V.1935, *S. T. Blake* 9080. North Kennedy District: Pentland on dry sandy stream bed 1,300 ft. 12.VI. 1934, *S. T. Blake* 6153.

CENTRAL AUSTRALIA: Macdonnell Range: *Tietkens* in 1889.

This distinctive little species is easily recognised by its dwarf annual habit, the solitary small brown obtuse spikelet either erect or oblique on different stems of the same plant, and the small biconvex 4-wrinkled nut. Tietkens's plant is referred by Tate in Horn Expedn. III. 181 (1896) to *F. acuminata* Vahl.

Fimbristylis rara R. Br. Prodr. 227 (1810); Benth. Fl. Austr. VII. 316 (1878) as to Brown's specimens only; F. Muell. First Census 126 (1882), Sec. Census 212 (1889); C. B. Clarke in Kew Bull. Add. Ser. VIII. 108 (1908), Ewart and White Fl. North. Terr. 61 (1907) (as to Brown's specimens); Domin. in Bibliot. Bot. XX. Heft. 85, 461 (1915). *F. obtusangula* F. Muell. Fragm. I. 198 (1859), First Census 126 (1883), Sec. Census 212 (1889), Benth. Fl. Austr. VII. 315 (1878). F. M. Bail. Syn. Queens. Fl. 599 (1883), Catal. Plants Queensl. 53 (1890), Queens.

Fl. VI. 1765 (1902), Compreh. Catal. 595 (1913), Ewart and White Fl. North. Terr. 61 (1917). *F. miliacea* F. Muell. Fragm. IX. 12 (1875), partly not of Vahl. *F. rara* var. *obtusangula* Domin in Bibliot. Bot. XX. Heft. 85, 461, Fig. 102 (1915).

NORTH AUSTRALIA.—North Coast *R. Brown* Iter Australiense 5950 (type); Dépôt Creek *F. Mueller* IV. 1856 (type of *F. obtusangula*).

QUEENSLAND.—Burke District: Normanton on low sandy flat 18.V.1935, *S. T. Blake* 8984; Normanton on open slightly saline swampy ground 7.VIII.1936, *S. T. Blake* 12490. Mitchell District: Bowen Downs, *Birch*. North Kennedy District: Pentland *Domin* (ex Domin loc. cit. n.v.).

Brown's specimens in Herb. Melbourne are immature, 1-2 dm. high with very narrow leaves and few spikelets in the inflorescence. Through the courtesy of the Director a better developed spikelet from the same collection was obtained from the Herbarium of the Royal Botanic Gardens at Kew, though it also was immature. Mueller's specimens are mature, taller, and with coarser more numerous leaves (up to 4 per stem) and more numerous spikelets. It probably represents one extreme form, while the other is represented by *Blake* 8984, which consists chiefly of depauperate specimens with mostly 1-2 spikelets per stem. *Blake* 12490, however, exhibits a complete series of forms from those depauperate ones to the extreme *F. obtusangula* form. Brown's specimens can be exactly matched by some of the incompletely developed stems, while frequently in the same tuft other stems bear inflorescences exactly matching those of Mueller's plats. Birch's specimens consist almost entirely of inflorescences.

The affinities of the species are with *F. Allenii* Turrill and *F. miliacea,* Vahl. It differs from both in foliage and in the much larger nut (0·9 mm. long, 0·7 mm. wide). It further differs from *F. Allenii* in the broader, more obtuse spikelets, and the white or glassy character of the nut, and from *F. miliacea* in the usually fewer but larger spikelets, glumes frequently ciliate at the edges, and the nut comparatively broader with the external cells rounded, not oblong. From *F. trachycarya* F. Muell., from which Bentham's description of *F. rara* is drawn, it is much further removed (see below).

Fimbristylis trachycarya F. Muell. Fragm. I. 199 (1859). *F. rara* Benth. Fl. Austr. VII. 316 (1878) *as to descript. and Mueller's specimens. F. miliacea* F. Muell. Fragm. IX. 12 (1875) and Domin Bibliot. Bot. XX. Heft 85, 769 (1915) *in small part* not of Vahl. *F. salbundia* C. B. Clarke ex Domin. loc. cit. 463 not of Kunth.

NORTH AUSTRALIA.—Upper Victoria River *F. Mueller* IV. 1856 (type); XII. 1855; Victoria River *F. Mueller* V. 1856.

A great deal of confusion has arisen about this species which is to be recognised by the keeled obtuse glumes with broad hyaline margins, the ragged rhachilla of the spikelet, the oblong obovate trigonous tuberculate nut with transversely oblong external cells, and by the leaves with thickened nerve-like margins and prominent midrib. It is very close to *F. salbundia* Kunth, *F. miliacea* Vahl, and *F. quinquangularis* Kunth. The glumes are very similar to those of the Indian *F. salbundia* but smaller, the nut very similar to that of the two latter species. From *F. miliacea* it differs in the more distinctly angled spikelets, the glumes more acutely keeled with broad hyaline margins, the ragged rhachilla, and very sharply in the foliage. From *F. quinquangularis* it differs in the more obtuse spikelet, the non-apiculate glumes with broad hyaline margins and the more prominent midrib to the leaves. It really has no very close affinity with *F. rara,* from which it differs in nearly every character except in the possession of a trifid style and a trigonous nut.

Fimbristylis microcarya F. Muell. Fragm. I. 200 (1859), First Census 126 (1882), Sec. Census **212** (1889); Benth. Fl. Austr. VII. 316 (1878); F. M. Bail. Syn. Queensl. Fl. 599 (1883), Catal. Plants Queensland 53 (1890), Queensl. Fl. VI. 1765 (1902), Compreh. Catal. 595 (1913), Ewart and White Fl. North. Territ. 61 (1917). *F. cyperoides* F. Muell. Fragm. IX. 11 (1875) not of R. Br. *F. tenera* Boeck. in Flora LVIII. (1875) in part, not of R. and S. *F. complanata* Link var. *microcarya* C. B. Clarke in Hook. f. Fl. Brit. Ind. VI. 646 (1893) (*"microcarpa"*); Domin. Bibliot. Bot. XX. Heft. 85, 462 (1915). *F. autumnalis* R. and S. var. *microcarya* Kuek. in Herb. Sydney.

Widely distributed in North Australia (whence the type: Depôt Creek IV. 1856 *F. Mueller* in Herb. Melbourne), Queensland (except in the extreme south and south-west), the East Indies, and Eastern Asia.

The species is certainly related to the widespread *F. complanata* Link. and the American *F. autumnalis* R. and S., but is as sharply defined as most members of this genus are. In its slender strictly annual habit and very small spikelets, it is very similar to *F. autumnalis.* The nuts, however, are quite different, those of the latter species beng acutely triquetrous with concave sides and quadrate external cells, while those of *F. microcarya* are trigonous and 3-ribbed with convex, mostly tuberculated sides with the external cells transversely linear-oblong arranged in about four vertical rows on each face. The nut of *F. complanata* is very much larger with the external cells much shorter, shortly oblong or almost quadrate, arranged in many vertical rows on each face. This species is further distinguished by the broad flat almost praemorse leaves and bracts, usually broad and very flat stem and coarser inflorescence with larger spikelets.

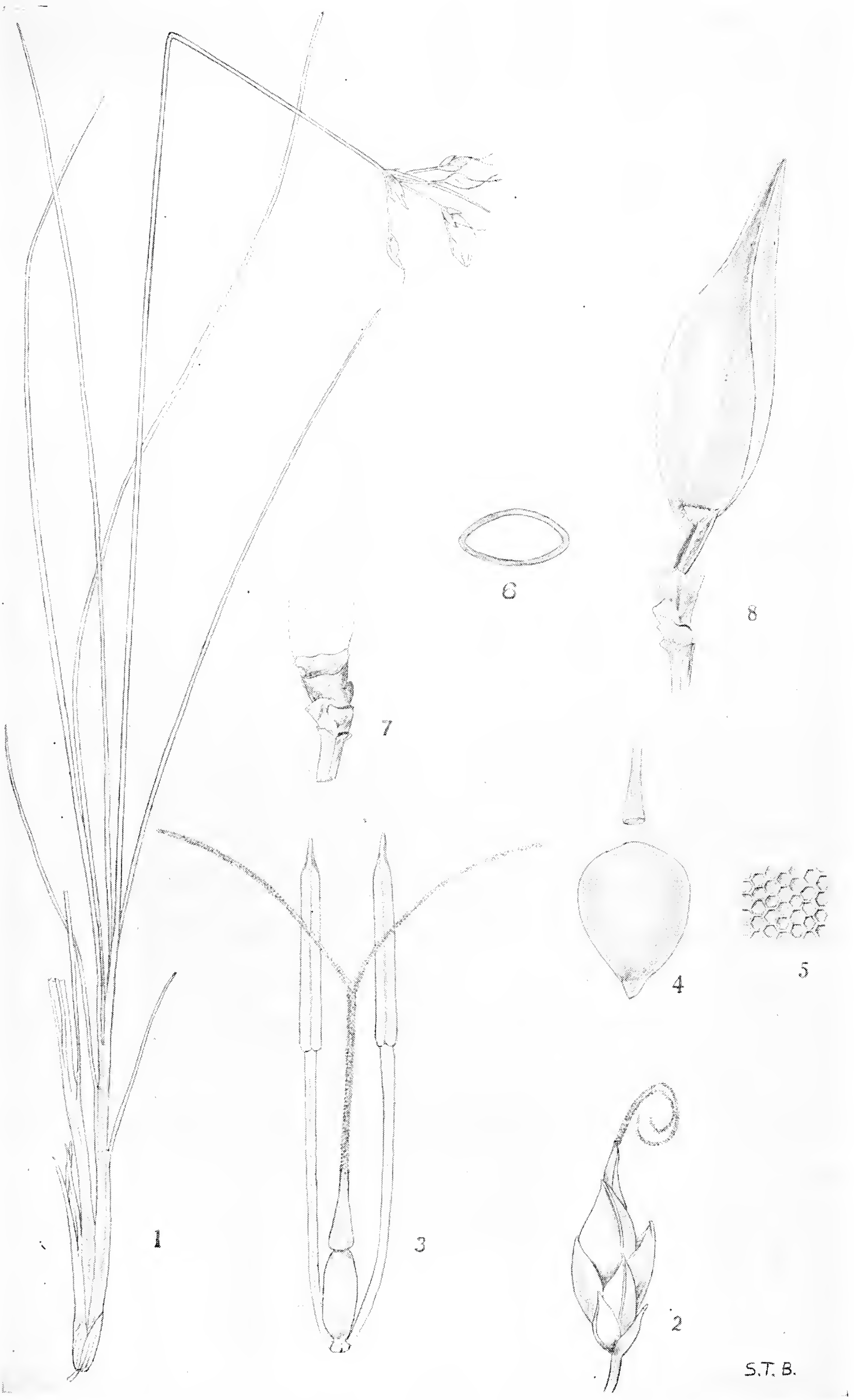
F. complanata var. *macrocarya* Domin loc. cit. 463 (*F. macrocarya* Domin loc. cit. in note) is said to be characterised by the broad obtuse leaves, the elongated involucral bracts, the contracted inflorescence, and the nut. The type (North Australia: Chillagoe *Domin* II. 1910) has not been seen, but *Blake* 8691 (Queensland: Burke District:—Gregory River, Riversleigh, approximately 19° 0′ S., 138° 45′ E. at water's edge shaded by *Pandanus* and *Melaleuca* 20.IV.1935) agrees with the description perfectly. Some nuts are not quite so densely tuberculate as most, and these differ in no way from those of *F. complanata* Link. sens. strict., while the other characters of leaf and bracts are exactly those of this species. The absolute length of the bracts is much the same, but owing to the looser inflorescence of the typical form, they are there relatively shorter. There thus remains nothing to separate var. *macrocarya* from *F. complanata* besides a contracted inflorescence. In *Blake* 8691, which consists of a large number of plants, the umbel rays of some plants show a strong tendency to lengthen, and those plants are very similar to the typical form.

On the evidence offering, it seems advisable to treat *F. complanata* var. *macrocarya* Domin (*F. macrocarya* Domin) as a mere synonym of *F. complanata* Link.

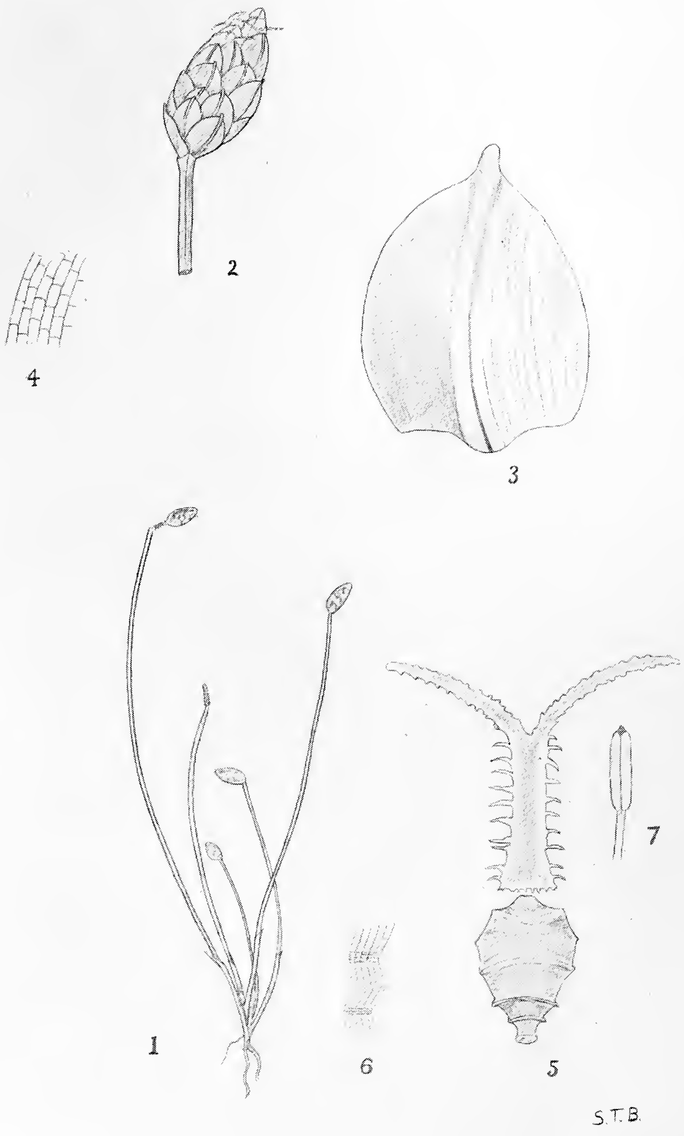
EXPLANATION OF PLATES.

PLATE II.—*Trachystylis foliosa* S. T. Blake (from Blake 7110). Fig. 1, portion of plant, *natural size*; 2, spikelet x 5; 3, flower x 10; 4, nut x 10; 5 surface of nut x 45; 6, transverse section of nut; 7, rhachilla of spikelet (all glumes fallen) x 10: dotted lines indicate position of topmost (empty) glume; 8, rhachilla of 2-flowered spikelet with all glumes except upper fertile one removed to show prolongation of rhachilla, x 10.

PLATE III.—*Fimbristylis humilis* S. T. Blake (from Blake 9354). Fig. 1, plant, *natural size;* 2, spikelet x 5; 3, glume x 25; 4, surface of glume x 50; 5, nut and style x 25; 6, surface of nut x 50; 7, anther x 25.



Trachystylis foliosa S. T. Blake.



Fimbristylis humilis S. T. Blake.

Queensland Assets.

By His Excellency Sir Leslie Wilson.

(An Address Delivered Before the Royal Society of Queensland, 12th October, 1936.)

I fear that I made a rash promise when I accepted your kind invitation to give an address to the Royal Society of Queensland, nor did I appreciate how rash that promise was till I read a volume of the Proceedings of the Royal Society, and gathered that the usual papers read before you were on very deep and erudite subjects.

When I read these theses—much of which I failed to understand at all—I very nearly wrote and said that I could not come, more particularly as in another rash moment, I remembered I had said that I would speak to you on " Queensland Assets "—a subject on which many may hold the most varying opinions.

On my way out to Queensland over four years ago, I met a man who told me something about this State, and, among other things, he informed me that I should have to make innumerable speeches. I asked, " What on "? He said, " On every occasion," and he spoke very truly. I then asked, " What about "? He replied that the main theme of Governors seemed to be on " the potentialities of Queensland." I said that I could not possibly talk for five years (and now it seems that I have to talk for ten) on Queensland's potentialities, and in fact, since I have arrived, I have always avoided the words " potentialities " or " possibilities," and when I speak of the future of this State, I allude always to the undoubted assets which Queensland possesses. I had this in my mind when I wrote to your Hon. Secretary, and, in response to his urgent request for a title of my address, said that it would be " Queensland's Assets."

I doubt much if I can say anything to you which you do not know already. It may be that I have travelled through a greater part of this State than most of you during the last four and a-half years. If one measures in mileage my travels, perhaps I have done so, for I am approaching 70,000 miles, and I have seen nearly every district except those somewhat distant areas around Birdsville and Boulia.

The only justification for my attempting to speak on this subject is that I view Queensland with an outlook which is not influenced by a life spent in the State, or by any preconceived ideas, but by views based on the knowledge of many other countries in the world, which may not be so present to those who have lived most or all of their lives in Australia. I have no other justification whatever.

Only shortly before I came here, I had lived for five years in a high administrative capacity in India—a country three times as large as Queensland, but with a population thirty-five times as great, and when I came here, and had travelled through the rich coastal districts, over the great fertile Downs, and in other parts, I confess to a feeling of amazement that Queensland, with all its assets, had less than 1,000,000 people, compared with the 350,000,000 in India, who live and have their being on land which cannot be compared, as regards fertility and climate, to this great State.

As I believe that my address is not private, I am handicapped in what I should like to say, and I must not enter into any controversial subjects, and it might be that, in any comparison between India and Queensland, I trend on the question of a White Australia; but, believe me, I have no intention of even suggesting that this question comes into my argument or comparison between these two great continents.

The fact remains that Queensland is far richer than India in agricultural soil, in minerals, in marine wealth, and its healthy climate, in the practical non-existence of tropical disease, and in that most important question—the total absence of destructive and dangerous wild animals. Yet Queensland has less than 1,000,000 people, whereas, even if conditions were equal, and not weighted as they are in Queensland's favour as regards India, she ought to have a third of India's population, but even so, allowing for that great part of Queensland, suitable only for cattle or sheep, and allowing also for a higher standard of living, to put the comparison at a very low figure, say, one-thirtieth—which would give Queensland a population of some 10,000,000 people

I am not here to-night to tell you what you know yourselves—to quote you a mass of statistics about our output of butter, our sugar, our cheese, our maize, our minerals, our wool or our chilled beef. Anyone can read those figures, but the fact remains that, year by year, the quality and quantity of what Queensland produces is increasing and, year by year, more land, especially in the great fertile North on the Coast and Tablelands, is producing more wealth, and in the Gulf and Cape York Peninsula, where hitherto unknown mineral wealth is being found from month to month to an ever increasing degree.

Then may I say a word about that part of Queensland known as the Gulf Country? Few go there, and few know it and few have the very haziest idea about it, except that there are large cattle stations there, where the areas are only known in miles and not acres, and where, in days gone by, gold was at one time found. Here certainly is one of the assets of Queensland. Even the people living there, living so far apart as they do (for I believe that in the Shire of Bourke, about 17,000 square miles in area, there are only some 300 men, women and children), even they know little about it, only their own part.

Glance yourselves at a map of Australia, and you will see that the Gulf of Carpentaria itself offers a natural port to a sea outlet of thousands of square miles of well watered country—not perhaps very rich to-day, but watered by great rivers such as the Bynoe, the Flinders, the Leichhardt, the Gregory, and about ten others, with all their tributaries, the waters of which are all now allowed to run to waste into the seas of the Gulf. Are there no undeveloped assets here, and I ask myself again, thinking of India—would all this land, fertile but for water, be allowed to remain unfertile and this great gift of nature—water—allowed to be wasted if we realised the value of this asset. The 350,000,000 in India would starve if they did not conserve the water of the rains and their rivers.

Again, we think, or ought to think, of fresh markets. I am always thinking of them, as I know that, if Queensland is to prosper, she must find new markets for her exportable surplus of primary produce, and is not this great Gulf country far nearer to the populous centres of the East than any other?

Those who know not the Gulf country cannot talk of the climate. Often I have heard it said it is not a white man's climate, but I doubt if between April and September you will find a finer or more healthy climate in the world, and even between October and March—hot as those months are—you have only to go there to see the people and children, and then you will realize that, with the practical total absence of any tropical disease, there are very many worse places in the world where white men and women live and prosper.

I do claim that, apart from all the well known parts of Queensland, of which I need not speak for you know them well, here is this great Gulf country, populated now with some 10,000 people, about one to every 20 square miles, Queensland has a great and undeveloped asset—how great no one knows.

I have, however, never been one of those who has pinned his faith to the development of Queensland by the spasmodic discovery of gold or some rich mineral. It is true that, in the past, practically every one of our coastal towns has owed its origin to the discovery of gold; in fact, one might say every one from Gympie to Townsville, with the possible exception of Mackay, but the wealth of Queensland will only be, in my opinion, fully discovered when the settlement of the distant parts of the State becomes an accomplished fact. In the past, you have had gold rushes to this North—Croydon and Cooktown are outstanding examples—to-day of little importance and of very small population, but I consulted many eminent mineralogists who told me that there was no doubt that, under present metallurgical processes, the ore yet untouched could be made a paying proposition, which also applied to other fields only yet scratched, while, on the Gilbert and other rivers, there was alluvial gold, tin, and other rare and valuable metals, the value and extent of which were entirely unknown.

The assets of Queensland! I myself believe their magnitude is unknown. I have spoken of the Gulf country. I have not touched on those you know yourself much closer to Brisbane, or our coastal district, of the fertile areas around Cooktown, or those rich and healthy tablelands above Cairns, many of which are only partially developed. Perhaps I am biassed too much about the value of water from my life in India, but it certainly does hurt one to see so much of the water in Queensland going to the sea in waste when, in so many parts of the State, the most simple and economic dams could be constructed to conserve it for irrigation purposes. I am not thinking of great irrigation schemes such as the unbuilt Nathan Dam at Theodore, but of just simple dams on the innumerable rivers and creeks which flow throughout the State—so often quite dry, but where the very cheap dam could hold the water when the rain comes for the immense benefit of the land when the rains do not come. Divine Providence seems to have gifted Queensland with great opportunity in this direction by the formation of the land, and yet what use do we take of this?

Opportunities are seldom labelled—we have to look for them and take them—and here, in Queensland, we do not seem to have looked for them to develop these great assets of ours. We do not seem to realise, except in a very few cases, such as the hydro-electric scheme in Cairns, how we could use our water for power and light. We set up local electric supplies, when, by the use of hydraulic power, we could light our towns and give our industries power from water at a far cheaper cost. We are not, and here again I hesitate for fear I am indulging in controversial subjects, making the best use of the assets of the State, provided by most beneficent natural gifts. I could ask you and myself many other questions, for instance, as to why others—not of our own race—succeed in intensive cultivation—some of our best citizens in Queensland, and yet we do not.

Another important question is why we do not think of the vital necessity of realising that the development of our wide spaces, particularly in the North, is so bound up with the question of defence of our land, why we will not appreciate the fact that the world is far closer to us by air and the advance of science in so many ways than it ever was before, and why it is not of the greatest importance to appreciate that fact, more particularly in view of the land hunger of the crowded nations of the world? The days of "splendid isolation" are gone—science has seen to that. We have assets here which, perhaps, no other part of the British Empire or the world has. Providence has been more than kind to Queensland—Providence provides for the provident, and for the provident only. Let us, therefore, be foreseeing. It is not too late, and certainly it is not too early, to take all the steps in our favour to develop all those great assets which have been given to us as a very favoured people.

Just one other point. I think we ought to ask ourselves two more questions. One—whether we are doing all in our power to develop these assets to the best advantage of Queensland and its people, and, secondly, whether, if we are not, what further steps we can take in this all important matter? Here, again, I have no political thought in my mind, and nothing I say has anything to do with any action or lack of action by Governments, past or present.

We have these definite assets—in land, water, and minerals. We have the man power—we have a splendid young generation growing up under ideal conditions of climate and instruction, to take the place of the present generation. Here is another great asset. In time to come, and even now, we shall need more man power—a larger population, but I have no intention of touching on the question of migration this evening.

The practical, as well as the academic instruction of our younger generation improves every year, and we have laid sound foundations for the future in such valuable institutions as the Queensland Agricultural College and High School at Gatton, and in our Technical Colleges, in our young University, and in many other ways. We must, however, remember that we are very young as a State.

I agree that the progress that has been made in the seventy-seven years of the State's existence as a self-governed State is remarkable, but any effort to a real appreciation of our assets began a comparatively few years ago.

The best school of all is undoubtedly experience—experience teaches slowly at the cost of mistakes. Of course, mistakes have been made in other countries, but I often think that many mistakes could have been avoided and more progress made if we, here in Australia, had availed ourselves more of the experience and mistakes of the older world. For instance, I have spoken of irrigation and water conservation. I suppose there has been no more valuable work done in the world in this matter, not even in Egypt or America, than that done by the European engineer officers working in India, and the experience gained in the great irrigation schemes there, which keep the huge population of India alive, and without which there would be famine, is beyond value. Could we not utilize to good advantage, some of that knowledge which is the outcome of centuries of practical experience, for certainly many of the problems which confront the development of the North are very similar, in practically every way, to those of India, both as regards its climate and its monsoonal rains, and very much the same argument applies to a great deal of Queensland. We have in Queensland some very valuable and highly efficient irrigation officers, and I have often wondered whether it would not be a very wise step to make an exchange of a few of our irrigation officers here with a few of those in India. This, I believe, would benefit both India and Queensland. Our officers going there would, no doubt, bring the fresh ideas of a new country to an old one, and those from India would bring that practical experience gained over many centuries to the progress of a young State. The world is so much closer to-day than it ever was, that I honestly believe that, in this matter of irrigation and in many other matters affecting the full use of our assets in Queensland, there would be a reciprocal advantage if we sent more of our representatives, versed in all highly technical questions, to the older countries, and they sent us some in return. The cost would be infinitesimal, and the advantage to both must be great.

Gentlemen, I have nearly finished. I have said perhaps little which is not prominent in your own minds, nor have I given you, as you are accustomed to, an address on natural or applied sciences, or any learned argument on research. There is, of course, much more one could say, if I had time, and particularly if I were not handicapped to some extent, as I must necessarily be, by the position I hold, but I am one of those who feel that there is much that can and will be done in this State of Queensland if all give to the work of development, the determination to undertake a task which means so much for the future, not only of this State and Continent, but of the British Empire.

One word more. Let us not forget how young we are, and the old Latin motto: *Festina lente*. Let us "hasten slowly," and lay our foundations well.

The Royal Society of Queensland.

Report of Council for 1935.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its report for the year 1935.

Nine original papers were accepted for publication in the Proceedings, and seven of these were actually read at ordinary meetings of the Society.

During the year the following lectures were delivered:—Dr. M. White on "Some Modern Aspects of Nutrition"; Professor Cumbrae Stewart, D.C.L., on "The Origin of the Alphabet"; Dr. J. Baum on "The Habits and Biology of Spiders"; Dr. F. G. Holdaway on "Standard Laboratory Colonies of Termites for Testing Timber for Termite Resistance"; Mr. J. S. Just on "The New Gaseous Discharge Electric Lamp"; and Mr. J. J. Broe on "Wool as a Textile Fibre."

One evening was devoted entirely to exhibits, and as usual proved to be most interesting and attractive.

Your Council takes this opportunity of thanking those who assisted in the above phases of the Society's work; those who provided the numerous exhibits which were displayed for the interest of members; the University of Queensland for housing the library and providing accommodation for meetings; and the Assistant Librarian of the University, Miss McIver, for superintending the lending of periodicals from the Library.

Realising that the time is rapidly approaching when the Society will be compelled to provide a home of its own, your Council has founded a trust fund as a step in this direction. It is hoped that members, who are in a position to do so, will aid the Council in this worthy objective. Donations, however small, will assist materially in building up a fund which will enable the Society, either alone, or in conjunction with other scientific societies, to provide a central meeting place, and suitable library accommodation.

On the death of His Majesty, King George V., a message of sympathy was sent by the President, on behalf of the Society, to His Excellency the Governor. A reply has been received stating that the message has been forwarded to the Secretary of State for Dominion Affairs, for transmission to His Majesty the King.

The membership roll consists of 3 honorary life members, 7 life members, 4 corresponding members, 170 ordinary members, and 2 associate members. During the year there were 6 resignations, 14 names were removed from the list under Rule 15, and 11 new members were elected. It is with deep regret that the death is reported of two of the older members of the Society: Messrs. A. G. Jackson and E. R. Gross.

There were ten meetings of the Council during the year, the attendance being as follows:—L. S. Bagster, 8; E. W. Bick, 9; W. H. Bryan, 9; D. A. Herbert, 10; J. S. Just, 6; H. A. Longman, 3; E. O. Marks, 9; J. K. Murray, 2; E. O. O'Connor, 6; F. A. Perkins, 10; R. Veitch, 9; J. Vickery, 7; C. T. White, 5.

In terms of Rule 19, Mr. C. T. White, Senior Member of the Council, automatically retires, but will be eligible for re-election in 1937.

R. VEITCH, President.

F. A. PERKINS, Hon. Secretary.

THE ROYAL SOCIETY OF QUEENSLAND.

STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDED 31ST DECEMBER, 1935.

Cr. **Dr.**

RECEIPTS.

	£	s.	d.
Balance at Commonwealth Bank, 31st December, 1934 ..	115	18	10
Subscriptions	179	18	0
Sales, Reprints, and Volumes	5	10	6
C.S.I.R., Subsidy on Cost Dr. Dorothy Hill's Paper, "The Lower Carboniferous Corals of Australia (1933)"	30	18	3
Refund of Sales Tax, Commonwealth Taxation Department, per H. Pole and Co., Ltd.	14	9	11
Bank Interest	2	17	1
Exchanges	0	2	5
Cheque, Outstanding, 1934, Cashed 22nd January, 1935 ..	0	14	0
	£350	9	0

EXPENDITURE.

	£	s.	d.
Government Printer, Stationery	6	13	3
Government Printer—Volume and Abstracts Printing ..	151	8	6
Hon. Secretary (Postages)	11	0	0
Hon. Treasurer (Postages)	1	0	0
Lanternist	1	0	0
Half-Cost Lettering Tablet in Leichhardt Street Quarry	1	19	6
State Government Insurance (Library)	0	10	7
Commonwealth Loan, £70, at Cost	69	16	6
Balance in Commonwealth Bank	107	0	8
	£350	9	0

Audited and found correct.

A. J. M. STONEY, B.E.E., Hon. Auditor.

E. W. BICK, Hon. Treasurer.

Abstract of Proceedings, 30th March, 1936.

The Annual Meeting of the Society was held in the Geology Department of the University at 8 p.m. on Monday, 30th March. The President, Mr. R. Veitch, occupied the chair, and about forty members and visitors were present. Apologies were received from His Excellency the Governor and Messrs. Kyle and Wells. The minutes of the previous annual meeting were read and confirmed. Professor Helmore and Messrs. J. J. Broe and W. L. Haenke were unanimously elected members of the Society. The following were proposed for Ordinary Membership:—Mr. R. Bambrick by Messrs. Blake and Perkins, Mr. B. Jones by Drs. Bryan and Whitehouse, Mr. H. J. Sparks by Dr. Herbert and Mr. Hines, Mr. C. Schindler, M.A., by Messrs. Perkins and Kyle, Dr. F. H. Roberts by Mr. Perkins and Mr. Veitch, and Mr. Edmiston by Prof. Bagster and Dr. Jones.

The Annual Report and Balance-sheet were adopted.

The following officers were elected for 1936:—President, Prof. J. K. Murray; Vice-Presidents, Mr. R. Veitch and Prof. L. S. Bagster; Hon. Treasurer, Mr. E. W. Bick; Hon. Secretary, Mr. F. A. Perkins; Hon. Librarian, Mr. F. Bennett; Hon. Editors, Dr. D. A. Herbert and Mr. H. A. Longman; Members of the Council, Dr. E. O. Marks, Mr. J. S. Just, Dr. F. Whitehouse, Mr. W. F. Wells, and Mr. W. W. Bryan; Hon. Auditor, Mr. A. Stoney.

Mr. Veitch, the retiring president, then delivered his presidential address, the first portion thereof consisting of a general review of outstanding events of importance in Queensland scientific circles during the year 1935. The Society's attention was also drawn to the fact that consideration might soon have to be given to obtaining other accommodation for the holding of meetings when the transfer of the University to the new St. Lucia site eventuates.

The second portion of the presidential address was devoted to a review of "The Development of Applied Entomology in Queensland."

It was first pointed out that the absence of adequate quarantine precautions in the early days of settlement in Australia had led to the introduction of a considerable number of pests, some of which might not yet otherwise have become established in Australia. The efficiency of the existing overseas quarantine organisation was emphasized, and attention was directed to added dangers arising out of the institution of a weekly air mail service passing through the Dutch East Indies. The value of local quarantine measures was exemplified by the success achieved in stemming the progress of the buffalo fly, and reference was made to such achievements as the eradication of the Mediterranean fruit fly in Florida. It was pointed out, however, that the eradication of an introduced insect pest once it had bred through a few generations was generally regarded as being impracticable.

The remaining section of this portion of the presidential address was devoted to a consideration of the various lines of investigation adopted in the case of the Queensland fruit fly, the woolly apple aphis, the cattle-poisoning sawfly, the pinhole borer of North Queensland cabinet woods, and the paspalum white grub.

Particular attention was devoted to a consideration of the evidence on which it was finally concluded that the annual reinfestation of the Stanthorpe district by the Queensland fruit fly was due to migration.

The woolly apple aphis was considered as a problem in which success had been achieved by the use of resistent root stocks and by the introduction of a natural enemy supplemented by the occasional use of sprays.

The cattle-poisoning sawfly was selected for discussion on account of the peculiar nature of the problem and of the unusual methods adopted in an attempt at solution—i.e., an endeavour to determine the cause of the dietetic deficiency responsible for the depraved appetite displayed in eating the putrid masses of dead sawfly larvæ and counteracting this dietetic deficiency by the use of suitable licks.

The pinhole borer of North Queensland cabinet woods was submitted as an illustration of the successful elucidation of a difficult forest entomological problem, the solution in this case being dependent on an accurate knowledge of temperature relationships of the insect and its reaction to chemical stimuli.

The paspalum white grub problem of North Queensland was discussed as one in which no definite entomological control was possible, its solution being dependent on a change in farming practices in the infested area.

A vote of thanks, moved by Dr. Hamlyn Harris, supported by Messrs. A. P. Dodd and F. Bennett, was carried by acclamation.

Abstract of Proceedings, 27th April, 1936.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University, at 8 p.m., on Monday, 27th April. The President, Professor J. K. Murray, occupied the chair, and about seventy members and visitors were present. Apologies were received from Drs. Bryan and Whitehouse and Mr. C. T. White. The minutes of the previous meeting were read and confirmed. Messrs. R. Bambrick, B. Jones, H. Sparks, C. Schindler, and E. S. Edmiston, and Dr. F. H. S. Roberts were unanimously elected ordinary members of the Society. The following were proposed for membership:—Ordinary membership: Professor H. R. Seddon by Mr. Perkins and Professor L. S. Bagster and Miss K. Watson, B.A.; Associate membership: Messrs. S. Everist and McMahon by Mr. Perkins and Dr. Herbert, and Miss A. W. Newman by Messrs. Perkins and Hines.

A paper entitled "Notes on Australian Muscoidea, ii. Subfamily Muscinae," by G. H. Hardy, was laid on the table. The subfamily Muscinae is poorly represented in the Australian region, but most of the species are very common and widely distributed. In the past most of the species have been confused. In this paper satisfactory keys are provided for all the known genera and species, together with notes on distribution and synonymy.

A paper entitled "The Analysis of Co-variance and its Use in Correcting for Irregularities of Stand in Yield Trials," by L. G. Miles and W. W. Bryan, was laid on the table. Irregularities in stand have proved a frequent source of trouble in agricultural field trials for yield. To overcome these irregularities arbitrary methods of correction, implying unity correlation between yield and the figures taken to represent stand, have been used in the past. The method of "Co-variance" of Fisher offers the most logical and reasonable method of adjusting yields on a basis of stand. In this the actual correlation found to exist in any trial between yield and stand is used in correcting yields. The paper dealt with the application of this method to a maize variety trial conducted at the Queensland Agricultural College in 1934-35. The trial was thereby raised from one on which little reliability could be placed on account of stand discrepancies, to one of considerable value in the varietal trial series.

The main business of the evening was a very interesting lecture on "The Story of the Brisbane River Bridge," by Dr. J. J. C. Bradfield. The lecture was illustrated by a very fine set of lantern slides and dealt very fully with the site, the preliminary work on the foundations, the nature of the underlying rock formations, and the result of the boring operations which preceded the work. Excellent pictures were shown of the methods adopted in testing all the materials to be used in the construction of the bridge, and of the preparation of such materials.

A vote of thanks, moved by Mr. Longman, and supported by Dr. Marks and Mr. Bennett, was carried by acclamation.

Abstract of Proceedings, 25th May, 1936.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 25th May. The President, Professor J. K. Murray, occupied the chair, and about forty members and visitors were present. Apologies were received from Messrs. Kemp, Just, Longman, Bradfield, Perkins, Bryan, Richards, Whitehouse. The minutes of the previous meeting were read and confirmed. The following were unanimously elected members of the Society:—Ordinary members—Professor H. R. Seddon and Miss K. Watson, B.A.; Associate members—Miss A. W. Newman, Mr. McMahon, Mr. S. Everist. The following were proposed for ordinary membership:—Dr. F. G. Booth, Dr. N. M. Gutteridge, Mr. T. B. Paltridge, B.Sc., and Professor Wilkinson.

The main business of the evening was a series of short addresses on the history, geology, botany, and agriculture of South-Western Queensland.

Professor J. K. Murray dealt briefly with the different types of agriculture practised in South-Western Queensland.

Mr. C. Ogilvie gave a very interesting account of the origin, distribution, and utilisation of artesian water in Queensland.

Professor F. W. Cumbrae-Stewart dealt with the early history of South-Western Queensland.

The first Europeans to enter South Western Queensland were the party under Captain Charles Sturt, 39th Regiment. The Expedition was organised in South Australia for the purpose of examining the country to the north of Lake Torrens. At that time it was supposed that an inland sea existed, and from observations of the flight of birds it was thought that Central Waters would be found west of the Darling and near the 29th parallel. Sturt, however, found nothing but an arid desert, although he reached Eyre Creek, now called the Mulligan, in September, 1845, crossing the present site of Birdsville and the lower course of the Diamantina, at the time a dry, stony desert. He then returned and discovered and examined Cooper's Creek 3rd November, 1845. At the extreme point of his discoveries he was but 150 miles from the centre of the Continent.

In 1847 Kennedy followed down the supposed Victoria River and Mitchell (really the Barcoo) until he was satisfied that it was Sturt's Cooper's Creek.

In 1858 A. C. Gregory, in search of Leichhardt, discovered the Thomson, and followed it down to Cooper's Creek. He descended Cooper's Creek to the junction of Hizlecki Creek, and from thence reached Adelaide.

The expedition of discovery of Burke and Wills (1860-1) led to the opening up of all Western Queensland south of the Selwyn Range which divides the Gulf waters from those flowing into South Australia. Burke and Wills went north from Cooper's Creek and, crossing the waters, had reached the Gulf of Carpentaria. On their return to the Cooper they became lost, and relief expeditions were sent out. Dr. Howith's search disclosed their fate. McKinlay went in the direction which the lost explorers had taken as far as the Gulf and returned by way of Bowen. Landsborough went by sea to the Gulf, and after examining the Barkly Tableland crossed the Divide on to the head waters of the Thomson, and from the Thomson reached the head of the Warrego. Descending the Warrego, he reached Melbourne by way of the Darling.

By 1861 pastoral occupation of South-Western Queensland had begun. In this work John Costello and Patrick Durack were among the earliest run holders in what are now the Pastoral Districts of North and South Gregory. Shortly afterwards the head of the Thomson and its tributaries were occupied.

In 1866 Landsborough and George Phillips, on their way to Swan Island, in the Gulf, went west from Bowen and definitely fixed and named the Diamantina, the lower course of which had been discovered by Sturt, and later by McKinlay.

In 1873 the Eyre Creek and Mulligan Waters were examined by W. O. Hodgkinson in charge of a Government expedition.

The work of the regular explorers was devoted to establishing the broad outline of the area and the larger watercourses. It was supplemented by private persons in search of pastoral country. By their journeys and hardships the unknown land of a century ago has become a province of Queensland, extraordinarily fertile in wet seasons but a dry and arid land in time of drought.

Dr. Herbert read a paper prepared by Mr. C. T. White entitled, "The Plants of South-Western Queensland."

The flora of South-Western Queensland is a definitely xerophytic one, and the perennial plants that live there mostly as trees or shrubs possess special qualifications to withstand long periods of drought. Following summer rains there is always a good crop of grasses, though some of these may be ephemeral in character, seeding and completing their life cycle almost within a few weeks. One of the most widely spread of these and quickest growing is *Tripogon loliiformis*, familiarly known on this account as Five Minute Grass.

Succulent plants are represented mostly by members of the Portulacaceae, Aizoaceae, and Chenopodiaceae.

The area has been the subject of two published papers—one, by Mr. J. F. Bailey, on the "Plants of Rabbit-infested Country, Bulloo River," published in the "Proceedings of the Australasian Association for the Advancement of Science," 1898, and the other, more recently, by Mr. W. D. Francis, being observations of the plants of Charleville, published in the "Queensland Agricultural Journal" in December, 1925.

The most outstanding tree of the South-West, as in many other parts of Inland Australia, is the Mulga (*Acacia aneura*). This tree is the standby of stockowners over long periods. The peculiarities of Mulga, particularly the various races and their relative palatability, the response of the adult trees to different methods of lopping, and the natural regeneration of the species, is a matter worthy of attention.

Trees associated with the Mulga are the Poplar Box (*Eucalyptus populifolia*), Moreton Bay Ash (*Eucalyptus tessellaris*), Cypress Pine (*Callitris glauca*), Apple Tree (*Angophora melanoxylon*), and one or two species of Hakea, familiarly known as Needle Bushes or Cork Trees. In some parts, where the Mulga has been cut out, the country is overrun by a large-growing Cassia (*Cassia pleurocarpa*) familiarly known in the South-West as Acacia.

Apart from the Poplar Box the most important Eucalypts are *E. coolibar* and the River Red Gum (*E. rostrata*). Two Eucalypts, both known as Yapunyah or Napunyah, are common in parts of the district—one, a small-fruited form, *E. thozetiana*, is common on hillsides, the other, a larger-fruited one, *E. ochrophloia*, is much less widely distributed, and is mostly found along creek banks.

The Chenopodiaceae or Salt Bush family is well represented, and it is one of the few localities in Queensland where the Old Man Salt Bush (*Atriplex nummularia*) is found growing wild.

From an economic point of view the outstanding grasses of the South-West are the Mitchell Grasses of the Mitchell Grass Plains. Four kinds of Mitchell Grasses are known in Australia, and all four are found in the South-Western area of Queensland. In addition to the Mitchell Grasses, mostly associated with them, but sometimes forming almost pure stands, is the Flinders Grass (*Iseilema membranaceum*).

Two of the most important grasses of the Mulga country are the so-called Mulga Mitchell (*Neurachne Mitchelliana*) and a species of Danthonia. Very characteristic features of the South-West are the large claypans. On these a particular grass grows which is quite a feature of the landscape. This is *Leptochloa subdigitata*, commonly known as Cane Grass. Mr. Bailey, in his account of the plants of the Bulloo River, mentions that the claypans are composed of hard, white, grain-like soil in which the cane grass is found growing. Though to all appearances dead after a long period of dry weather, following a shower of rain all the apparently dead stems soon produce tufts of green shoots from the nodes.

Other features of the landscape are the Lignum swamps, the characteristic plant of these areas being the Lignum Bushes (*Muehlenbeckia Cunninghamii*), a plant growing mostly round the edges of swamps, along creek banks, &c., with a definite xerophytic structure, perhaps due to periods of dry weather.

The following took part in the discussion which followed:—Messrs. Gunn, Herbert, Gipps, and Bennett.

Abstract of Proceedings, 30th June, 1936.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on Tuesday, 30th June. The President, Professor J. K. Murray, occupied the chair, and about forty members and visitors were present. Apologies were received from Messrs. Wells, Veitch, Roberts, Richards, Bryan, Whitehouse, and W. W. Bryan. The minutes of the previous meeting were read and confirmed. The following were proposed for membership:—Ordinary membership—Professor D. H. Lee, by Mr. Hines and Prof. Bagster; and Miss G. Ferguson, B.Sc., by Drs. Bryan and Whitehouse; Associate membership—Mr. Connah and Miss M. Whitehouse, by Drs. Bryan and Whitehouse. The following were unanimously elected ordinary members of the Society:—Professor Wilkinson, Dr. F. G. Booth, Dr. N. M. Gutteridge, and Mr. T. B. Paltridge.

Mr. C. T. White exhibited fruits of *Trichosanthes pentaphylla*, a climber of North Queensland with handsome red globose fruits.

Dr. D. A. Herbert exhibited specimens of the following Myxomycetes hitherto unrecorded from Queensland:—*Physarum nucleatum* Rox., *Physarum melleum* Mass., *Physarum nutans* Pers., and *Diderma trevelyoni* Fr. *Physarum nutans* was collected on Tambourine Mountain, the other species in Brisbane. He also exhibited the fasciated apex of a hoop pine, *Araucaria Cunninghamii,* 2 feet across at the broadest part and showing very marked convolutions. The specimen came from the Upper Brisbane Valley.

The main business of the evening was a very interesting address by Dr. E. Hirschfeld entitled, "Some Biological Problems of Western Queensland." Following the address a discussion took place in which Messrs. White, Gipps, Herbert, Fraser, Christian, and the President participated. A vote of thanks moved by Mr. C. T. White was carried by acclamation.

Abstract of Proceedings, 27th July, 1936.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 27th July. The President, Professor J. K. Murray, occupied the chair, and about eighty members and visitors were present. Apologies were received from Dr. Robertson and Messrs. Just, Edmiston, and

Watkins. The minutes of the previous meeting were read and confirmed. Mr. R. G. Bahr was proposed for ordinary membership by Messrs. Watkins and Perkins. The following were unanimously elected members of the Society:—Ordinary Membership—Professor H. D. Lee and Miss G. Ferguson, B.Sc.; Associate Membership—Mr. T. L. Connah and Miss M. Whitehouse. The President mentioned the death of one of our older members, Mr. P. Sylow, and a motion of condolence was carried by the members standing in silence for one minute.

The main business of the evening was a very interesting address by Professor H. C. Richards, D.Sc. The title of the address was "Research, Ways and Means." A vote of thanks moved by Professor Bagster and seconded by Mr. Veitch was carried by acclamation.

Abstract of Proceedings, 31st August, 1936.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 31st August. The President, Professor J. K. Murray, occupied the chair, and about forty members and visitors were present. Apologies were received from Prof. D. H. K. Lee, Dr. J. J. Bradfield, and Mr. Kemp. The minutes of the previous meeting were read and confirmed. Mr. R. G. Bahr was unanimously elected an Ordinary Member of the Society.

Mr. F. A. Perkins read a paper by Dr. R. J. Tillyard, F.R.S., entitled "A Small Collection of Fossil Cockroach Remains from Mount Crosby, Queensland." This collection contains nine specimens from Mount Crosby. Queensland, the age of the beds being unknown. All the specimens are remains of cockroach tegmina, seven being fragmentary, and two nearly complete and in good preservation. These are shown to belong to the upper Triassic genus *Triassoblatta Till.*, so that the age of the beds is thereby determined as either Upper Triassic or very close to to it. A key to the four known species of *Triassoblatta*, is given, the genotype and one other species being from Ipswich Q. *Triassoblatta denmeadi* n.sp.: T. jonesi n.sp. Messrs. Whitehouse, Denmead, O. Jones, and Perkins commented on this paper.

A paper, "Essential Oils from the Queensland Flora," Part IX., by T. G. H. Jones and W. L. Haenke, was read by the former. Two varieties of *Melaleuca viridiflora* (the broad leaf Melaleuca) have been found to exist growing together in various localities and the essential oil from one of these varieties has been examined. The main constituents were found to be the two alcohols, linalol and nerolidol (melaleucol), and in view of the high linalol content was considered to be of economic value.

Professor Bagster showed the rotation or twisting of a beam of polarised light when passing through a column of sugar solution. The beam was made visible by addition of a small amount of colloidal suspension of rosin particles.

Mr. H. A. Longman exhibited:—(1) Fossils—fragments of *Trionyx australiensis,* a fresh-water tortoise; fragment of a crocodile jaw with a tooth, and a claw of an unknown animal. These Pleistocene fossils had been discovered by Mr. R. O. Cooper on the southern slope of Boat Mountain, seven miles east of Murgon, after a land slide, the result of heavy rain. (2) Nests of an arboreal trapdoor spider found on "box-trees" at Thursday Island, and sent to the Queensland Museum by Mr. H. Hockings, with associated spiders, which had been identified by Miss K. Watson as *Conothele* sp. The nests were somewhat similar to those of *C. arboricola,* figured by Pocock in Willey's "Zoological Results" (1902), Plate X., fig. 3a. (3) A large living specimen of *Phyllurus platurus*, from Glenapp, S.E.Q., collected by Mr. B. Keats. A study of cranial characters shows the distinction of *Phyllurus* from *Gymnodactylus*, in which genus this species was usually placed.

Mr. J. H. Simmonds exhibited on behalf of Mr. R. S. Mitchell culture of three strains of *Thielaviopsis paradoxa* (De Seyn) Hoehn isolated respectively from banana, pineapple, and sugar-cane. The results of inoculating these strains into banana fruit and cane was illustrated, and it was evident that, while the banana isolation was strongly parasitic on the banana and not on cane, the pineapple and cane strains exhibited the opposite tendency. Temperature relationships also suggested that the banana organism was a strain distinct from the more common pineapple and cane pathogens.

Mr. C. T. White exhibited several imported species of *Chloris* grasses, including *C. distichophylla,* which has recently been given prominence in the Agricultural Press as Winter Growing Rhodes Grass. Like some others of the genus it is cosmopolitan.

Dr. M. White exhibited two ox bones—(*a*) Showing extensive coral-like proliferation of the periostium after injury from a stricture by wire; and (*b*) a broken femur showing great thickening and fore shortening. He also showed the fore leg of a pig with eight toes.

Mr. W. T. Robertson exhibited some bacterial plates demonstrating the effect of filtration and chlorination on the percentage bacterial reduction in water supply purification. Also some broths showing reaction to putrefactive bacteria (chiefly the *B. coli ærogenes* group) in water supply.

Dr. E. O. Marks exhibited an old microscope which had been in the possession of his family for seventy years. It was manufactured before the discovery of the achromatic lens, which took place in 1829, and, consequently, was more than 100 years old. It had no fine adjustment, and focussing was done by moving the stage.

Mr. F. Bennett showed some rocks from the Mackay breakwater. Originally the contract price was 3s. 6d. per cubic yard, but in practice it was found to cost nearer 8s. per yard. It was contended that the increase in cost was due to the fact that the rock was more siliceous and brittle than was expected, resulting in quick blunting of drills and inability to blast the rock in large pieces.

Dr. D. A. Herbert exhibited a living specimen of *Myrmecodia echinata,* an ant plant of North Queensland. A similar specimen had been grown in his bush house in Brisbane for several years in the absence of ants. During that time it had flowered freely.

The above exhibits were discussed by Messrs. Herbert, Denmead, Bennett, M. White, C. T. White, Vickery, and Longman.

Abstract of Proceedings, 28th September, 1936.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 28th September. The President, Professor J. K. Murray, occupied the chair and about thirty-five members and visitors were present. Apologies were received from Professor Bagster, Dr. Bryan, and Messrs. Wells, Longman, and Watkins. The minutes of the previous meeting were read and confirmed. The President, on behalf of the Council, proposed Mr. J. B. Henderson for Honorary Life Membership.

The business of the evening was a symposium on "Concretions."

Dr. F. W. Whitehouse exhibited a large series of concretions from Queensland rocks. He showed a group of concentric limonitic structures due to percolation of solutions towards the kernels of jointed blocks, and stressed the factor of the liesegang type of precipitation in the production of such forms. Exhibited with these were analagous weathering structures (spheroidally weathered basalt, &c.). In contrast there were displayed several series of concretions formed by accretionary processes. Some of these had originated in free media (air or water) others within the rocks. Growth factors were discussed (normal crystal accretion, colloidal features, the occasional effect of algae and bacteria, the presence of open structures in the rock, and so on). Special reference was made to spiral concretions, particularly the giant forms of Western Queensland. A few striking abnormal types of concretions were also shown, including some circular calcareous discs 4 inches across but only $\frac{1}{8}$ inch thick (from Jurassic coal measures), and some eddy-like structures in Cambrian cherts. Some notes were given about the distribution of such forms in stratigraphical horizons (early palaeozoic stromatoliths, horizons of cone-in-cone limestones, the concretionary sequence in the Cretaceous deposits of Queensland, and so on).

Professor H. R. Seddon dealt with the subject from the veterinary aspect, and pointed out that in animals concretions were of three kinds, and exhibited specimens of many of the following types:—

1. *Calculi.*—Various body fluids, such as bile, urine, saliva, &c., contain organic and inorganic substances, which are liable to be deposited. In all such cases the deposition occurs around some central nucleus, and on section calculi thus show a laminated appearance. Analogy of pearl, which is, in fact, a concretion. Calculi seen in old rather than young animals.

Urinary Calculi.—May form in kidney, ureter, bladder, or urethra. Most cases seen in females. Reason—Size and shape very variable—when single, spherical to ovoid, but may be irregular, or in the case of renal calculi may follow the form of the renal pelvis; if multiple, often angular or facetted. Cause cannot be stated definitely, but evidently related to diet, though local inflammatory conditions (due to diet or local presence of bacteria) often predisposing cause. Nucleus often a small mass of cells..

Dog and Cat—common—may lead to death.

Composition—Urates.

Sheep—common, especially in rams and wethers, where small shot-like calculi may block urethra near filiform appendage and cause death; believed often associated with bore water, and certain feeding, such as turnips.

Composition—Ammonium magnesium phosphate.

Another type composed of Xanthin.

Pig—Not so common. Ammonium magnesium phosphate.

Horse and Ox—relatively rare, but cystic calculi may attain very large size. Composition, carbonates. In horse may also see amorphous calcium carbonate in bladder—sometimes large quantity of this sabulous material.

Note.—Renal pelvis of horse commonly contains granules of calcium carbonate, lying in thick mucus; normal.

Salivary Calculi.—Seen especially in Stenson's duct in horse. Shape typically cylindrical, but may be broken into two or three pieces. Seen chiefly in districts where much lime in the drinking water.

Biliary Calculi.—Two types.—

(*a*) Largely inspissated—bile and bile salts.

(*b*) Result purely of salt deposition. Salts chiefly carbonates and phosphates. Commonest in ox and pig (Horse no gall bladder). Dog rare.

Pancreatic Calculi.—Sometimes seen in ox.

Enteroliths.—

(*a*) Stoneballs—colon, horse. Nucleus, pebble or nail, with deposition of ammonium magnesium phosphate and calcium carbonate. Supposed to result from high phosphorous diet—bran—millers' horses.

(*b*) Oat-hair Calculi—Result from deposition of ammonium magnesium phosphate along with fine hairs from oats; therefore, a mixed type.

2. *Animal and Vegetable Tissue Concretions.*—

Note.—Oat-hair calculus a mixed type of true calculus and vegetable tissue concretion.

(*a*) *Hairballs*—common. Single large mass—spherical or ovoid—sometimes irregular; sometimes covered with thin layer of salts on the outside, forming thin plate-like covering. Seen commonly in calves and pigs—result of licking themselves or one another. Therefore, animal may contain hairball of hair foreign to it—pigs, stomach; calves, rumen, abomasum (especially).

(*b*) *Wool-balls*—Generally not so well formed, and often small and irregularly flattened; seen especially in lambs.

(*c*) *Butter-fat Concretions*—Seen in galactocysts. Can actually get lacteal calculi of phosphatic material, but such are rare.

(*d*) *Vegetable Fibre Concretions*—Plant hairs, often downy spicules from plant leaves, felt together forming single or multiple masses; multiple usually facetted (cubical or pyramidal). Seen in sheep and cattle (rumen and abomasum); scrub feeding.

3. *Mineral Deposition in Tissues.*—

Either *in* or *on* the tissues.—

(*a*) *Inflammatory tissues,* e.g., tissue killed by toxin of tubercle bacilli get calcium depositions; also with other microbes. As deposition generally occurs first in the central part and extends peripherally may get some lamination, though often merely amorphous depositions and not lamella formation.

(*b*) *Around Dead Parasites* and perhaps replacing them, e.g., degenerated measles; cysticerci; hydatids; strongylus in liver of horse.

(*c*) *Lining vessels,* e.g., blood vessels in atheroma. Bile ducts of ox in case of liver fluke (not in sheep).

(*d*) *Putty Brisket.*

(*e*) *Tartar, "Gold" on Sheep's Teeth*—Mica.

Dr. Noel M. Gutteridge dealt with the subject of concretions from the standpoint of human pathology. Just as in geological concretions, in which the nucleus could be formed by organisms such as algae, so in the human gall-bladder or kidney a concretion could form around a clump of bacteria as a nucleus. Human gall-stones usually consist of either cholesterin or calcium bilirubinate or a mixture of these two substances arranged in concentric laminations.

With regard to concretions in the urinary tract, students of history will remember that Samuel Pepys underwent the operation of "cutting for the stone."

Recent work has suggested that the formation of concretions in this situation had a nutritional basis coupled with a too great concentration of the renal secretion.

Dr. Herbert gave an account of the deposition of organic and inorganic substances in plant tissues. He exhibited a specimen of a stone fungus, *Polyporus tumulosus,* which produces a subterranean mycelial mass containing pebbles and soil.

Dr. W. H. Bryan exhibited and described a number of concretionary structures found within the soil, and produced as a result of soil-forming processes. These showed a considerable variety in shape, size, colour, and chemical composition, and each occupied a significant position in the soil in which it was found. But not all of these bodies were concretions in the literal sense. On the contrary, some were to be regarded as residuals of an originally continuous material that had become progressively smaller and rounder. Dr. Bryan suggested that some simply descriptive term, such as "soil nodules," would cover both the true concretions and these other structures that simulate them.

The President, on behalf of the members present, thanked the speakers for their contributions, and the meeting closed at 9.55 p.m.

Abstract of Proceedings, 12th October, 1936.

A Special Meeting was held in the Geology Lecture Theatre of the University, at 8 p.m., when His Excellency the Governor Sir Leslie Orme Wilson delivered an address entitled "Queensland Assets." (These Proceedings, pp. 95-99.) The President, Professor J. K. Murray, occupied the chair, and there was a large and representative attendance. A vote of thanks was tendered to His Excellency on the motion of Professor H. C. Richards, Mr. J. B. Bridgen seconding.

Abstract of Proceedings, 26th October, 1936.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 26th October, 1936. The President, Professor J. K. Murray, occupied the chair, and about thirty members and visitors were present. Apologies were received from Messrs. J. S. Just, A. Trist, and W. W. Bryan. The minutes of the previous meeting were read and confirmed. Mr. J. B. Henderson was unanimously elected an Honorary Life Member of the Society. The motion was carried by acclamation.

A film prepared by Professor Douglas H. K. Lee, Dr. F. J. Booth, and Mr. G. H. Tommerup was shown by Professor Lee.

The film illustrates observations made upon a man who, for surgical reasons, had had the left naso-orbital tissues almost completely removed, and in whom on this account the movements of the soft palate could be seen during normal speech and other activity. The film demonstrates the following points:—

(i.) The palate rises to different heights with different pure vowel sounds.

(ii.) The attachment of nasal consonants to vowels reduces the height to which the palate rises, while the association of an explosive consonant neutralises any nasal reduction.

(iii.) Singing does not modify pure vowel actions.

(iv.) Yawning, swallowing, and coughing produce marked palatal action in which almost the whole of the naso-pharynx is covered.

(v.) Forced respiration is accompanied by some palatal movement, snoring by a little, quiet respiration by none.

Mr. McGrath read a paper by Mr. A. R. Trist, M.Sc., entitled "Some Silvicultural Research Problems in Queensland."

The definition of the forest types having a good representation of commercial species and capable of the production of utilisable wood is the primary consideration, and from that viewpoint the State is resolved into five major divisions.

In the attack of the problem presented by any particular research region two basic facts require early realisation, viz., that although Queensland forestry "may profit materially from European silvicultural experience it must develop cultural methods to meet the requirements of its own complexes," and secondly that the fundamental approach is impracticable. Consequently, broad observational experiments on a large scale are adopted up to the point where a clear conception is gained of the correct line of silvicultural procedure. From that point research is concentrated on securing answers to points of recognised practical difficulty. The underlying principle of the detailed research has been simplicity and concentration on the variation of the factor being investigated, and no other factor. The methods employed in this connection take into account the necessity of statistical analyses of results, and wherever possible balanced experimental layout is adopted. The paper touches on merely a few of the main points which have received attention, but of main interest is the theory underlying the adopted practices regarding pruning and thinning of plantations.

The regions recognised and the main research problems encountered in each of them are outlined as follows:—

1. *The Hoop Pine Rain Forest Formation.*—This region is recognised as the most important silvical unit of the State almost solely on account of the occurrence of the main dominant, Hoop Pine, the source of the majority of the State's softwood requirements. The volume of associated species is relatively negligible, and the problem concerns the perpetuation of the diminishing resources of the conifer. The history of the observational experiments leading to the formulation of the policy of open plantation establishment is briefly reviewed, and from that point detailed research on individual problems of nursery and plantation technique is outlined. Geographical strain experiments, season of planting, method of tending, pruning, and yield experiments are touched on as illustrating the type of work being carried out, and the observations regarding open plantation effect on site quality are indicated.

2. *The Northern Rain Forest Formation.*—The decidedly different composition of this forest type presents the more complex problem of perpetuating the wide variety of cabinet-wood species which occur. Large-scale experiments on natural regeneration methods have for the time being been abandoned. Instead, a thorough understanding of the silvicultural requirements of the constituent species is aimed at by establishing them as individual sections in open plantations. Thus, while the technique of open plantations is being worked out information is being obtained for later employment in natural regeneration experiments proper.

3. *The Coastal Hardwood Formation.*—Generally the type has a good representation of the younger age classes, and research is directed towards methods of improving the specific composition, and cultural methods aiming at the production of the best-quality timber in the shortest time. In other cases, however, the problem of obtaining satisfactory regeneration is a necessary prelude. In any work in this type of forest the main difficulty is to obtain comparable experimental plots, and the criteria of comparability is discussed.

4. *The Cypress Pine Hardwood Formation.*—The main value of the formation lies in its extent and the ease with which simple and effective silvicultural treatment can be applied. The problem here concerns primarily cultural treatments, and of particular interest are the results already obtained from thinning experiments.

5. *The Exotic Areas.*—"Exotics are utilised in Queensland only in so far as it is necessary to supplement the planting of the main indigenous softwoods." Thus exotics are being employed to produce commercial forests on areas carrying species of little or no value, viz., at Beerwah, Pechey, and Paschendaele. The problem concerns the choice of species, their nursery and plantation treatment, and particularly is research directed to the pathological and entomological difficulties which are encountered.

The paper was discussed by Dr. Herbert and Messrs. White, Bennett, and Blake, and a vote of thanks moved from the Chair was carried by acclamation.

ABSTRACT OF PROCEEDINGS, 30TH NOVEMBER, 1936.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 30th November. The President, Professor J. K. Murray, occupied the chair, and about thirty members and visitors were present. Apologies were received from Dr. Whitehouse and Messrs. Wells and Perkins. Mr. R. J. Carroll was proposed for Ordinary Membership by Professor R. Hawken and Professor L. S. Bagster.

The following papers were either read in part or tabled:—

(1) "New Australian Pyraloidea (Lepidoptera)," by A. Jefferis Turner, M.D., F.R.E.S.; (2) "Essential Oils from the Queensland Flora, Part X., Melaleuca linariifolia," by T. G. H. Jones, D.Sc., A.A.C.I.; (3) "Erinosis, a Disease of Laportea," by D. A. Herbert, D.Sc.; (4) "New Genera of Oriental and Australian Dacinae (Trypaneidae)," by F. A. Perkins, B.Sc.Agr.; (5) "Notes on Australian Cyperaceae, Part 1," by S. T. Blake, M.Sc.

The papers were discussed by Messrs. Bennett, White, and Longman.

Publications are being received from the following Institutions, Societies, etc., and are hereby gratefully acknowledged:—

ALGERIA—
Societe de Geographie et d'Archaeologie d'Oran.

ARGENTINE—
Universidad Nacional de la Plata.

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Brown, Jas., B.A., M.D., Ch.B. (Edin.), D.Ph. (Cambridge)	"Widmoorene," Margaret Street, Toowoomba

*Members who have contributed papers to the Society.

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PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

QUEENSLAND

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Volume XLIX.

VOL. XLIX., No. 1.

Proceedings of the Royal Society of Queensland.

Presidential Address.

AGRICULTURE AND MIGRATION IN QUEENSLAND.

By Professor J. K. Murray, B.A., B.Sc.Agr.

(Delivered before the Royal Society of Queensland, 30th March, 1937.)

The Annual Report discloses that the year has been a successful one. The membership is higher than at any previous time in the history of the Society, and the papers to be printed in the Year's Proceedings reveal that the society's task of encouraging research has been fulfilled.

The Society was honoured during the year by an address from the Patron, His Excellency the Governor, the Right Honourable Sir Leslie Orme Wilson, on "Queensland's Assets." His Excellency has been pleased to signify his intention of being present at this evening's Annual Meeting. The Society and its Council wish to express their appreciation of His Excellency's interest in pure and applied research, an interest which has characterised His Excellency's period of office as Governor of this State.

I regret to have to record the death of Dr. R. J. Tillyard, F.R.S., who contributed several valuable papers to the Proceedings.

Mr. J. B. Henderson, who was an active member of the Society for over forty years and its President on three occasions, was elected a life member of the Society during the past year. Mr. Henderson had a very distinguished career, commencing with research work on the gravimetric composition of water. He was an original member of the Prickly Pear Board, first President of the Queensland Branch of the Australian Chemical Institute, and a member of the Munitions Board during the war, for which he was made an Officer of the Order of the British Empire. Mr. Henderson was a member of the Senate of the University from its foundation.

INTRODUCTORY.

The title of this address has been selected because of the many somewhat ill-considered statements of persons, including bishops and movie managing directors, who have more than insinuated that the Australian attitude towards immigration has "a dog in the manger" component, its agriculture is less efficient than that of Britain, and that the position is provocative of offensive measures by overcrowded nations to obtain for their nationals "a place in the sun" and, for their countries, supplies of raw materials, food, and clothing.

The possibilities of absorption of migrants involve, of course, consideration of the absorptive capacity for migration in primary, secondary, and what Fisher has called tertiary production.[1] With regard to the last two I am interested only in so far as their expansion will increase the demand for agricultural products and thus enhance the ability of producers already on the land to stay there (despite the increasing productivity per human unit), or to add to their number.

With regard to the primary industries, agriculture in the broad sense is the section to which I wish to devote attention, but it is not intended to include afforestation as an agricultural process.

The problem demands a perspective and thorough going attention which it cannot receive in the scope of this address. In an attempt, admittedly inadequate, to contribute something to the consideration of the problems raised we may commence with migration, and follow with agriculture and markets and then the inter-relationship of the three.

A. MIGRATION.

The desirability of migration to Australia has been argued from many points of view. Adequate utilization of the world's resources is one of them; defence problems of the British Empire (and Australia in particular) another; the attainment of an optimum population at an optimum immigration rate a third; the betterment of the lot of migrants moving from the depressed industry and lower living standard areas of various countries to the higher living standard here; the market which a greater Australian population would make for British products of the secondary and tertiary industries; the market which an increased population will make for all Australian industries; and so on.

Adequate Utilization of the World's Resources.

There has been much confused thinking in connection with this aspect. People have been impressed by the size of the Australian continent and by the exaggeration of Australian possibilities by Australians and others. A corrective was the work of Griffith Taylor, and, of recent years, the work of many economists—this year's meetings of the Australian and New Zealand Association for the Advancement of Science in Auckland and the Australian Institute of Political Science at Canberra are cases in point.

Some Climatic Considerations.

With regard to Australia, it is frequently forgotten that it is possible to travel from Thargomindah to the vicinity of Port Hedland without passing through an area of any size with an average rainfall of as much as 10 inches per annum or, probably, an evaporation rate from a water surface of less than six times this amount. On the other hand it is impossible to consider that the maximum productivity has been obtained from Commonwealth resources and, of all the States with potential increases in agricultural production, Queensland in my view has most promise. There has been little sympathy and less understanding of the Australian problem in agricultural production. Agriculture in Australia is a very different problem from that of North-Western Europe.

[1] Present Large Scale Migration Policy by Professor A. G. B. Fisher, A.N.Z.A.A.S. Meeting, Auckland, 1937.

Many people have almost consistently considered annual rainfalls in Australia without cognisance of the limitations of rainfall values imposed by distribution and evaporation. In connection with this matter the following figures are presented by courtesy of T. Rimmer[2]:—

SOME MEAN ANNUAL VALUES OF EVAPORATION AND RAINFALLS AT SELECTED STATIONS.

Station.	Evaporation.	No. of Years.	Rainfall.	P/E.
	Inch.		Inch.	
Queensland—				
Blackall	86·2	(24)	20·8	0·241
Brisbane	59·0	(17)	45·3	0·768
Boulia	123	(?)	10·2	0·083
Charleville	82·1	(9)	19·7	0·240
Home Hill (Inkerman)..	72·7	(16)	31·4	0·432
Rockhampton	52·6	(16)	39·7	0·755
St. George	71·3	(10)	20·0	0·280
Taroom	66·4	(15)	27·0	0·406
Warwick	56·5	(15)	27·5	0·487
Winton	97·6	(16)	15·6	0·160
Tasmania—				
Hobart	32	(?)	24	0·75
South Australia—				
Adelaide	55	(?)	21	0·38
Great Britain—				
Harrogate	18·9	(18)	29·5	1·56
Stoney Hill	16·5	(8)	40	2·4

It will be noted that in some cases the rainfall (precipitation) is greater than the evaporation during the year, in other cases that the evaporation is a multiple of the precipitation. For instance even in Brisbane, which is quite close to the coast, the evaporation considerably exceeds the rainfall; while at Stoneyhill in the environs of Edinburgh and near the Firth of Forth, the rainfall is getting on for two and a-half times the evaporation. At Boulia the evaporation is eleven times the rainfall, at Winton six times the rainfall, at Blackall and Charleville four times the rainfall, at St. George three and a-half times the rainfall, and Home Hill, Warwick, and Taroom over twice the rainfall, whereas in Harrogate in mid-England, about 15 miles north of Leeds, the evaporation is two-thirds of the rainfall. At Rothamsted Agricultural Experiment Station, Harpenden, Herefordshire, the evaporation from the soil surface over an average of sixty years is 14·5 inches and the rainfall 29·4 inches.[3] Facts such as these have been ignored by well-intentioned people who have chidingly criticised the Australian wheat yield per acre when compared with that of North European countries and New Zealand. It is safe to say that, given equal skill and working knowledge of the climatic and other farming conditions, good European or New Zealand farmers would not obtain higher yields under Australian conditions than a good Australian farmer.

[2] Lecturer in Meteorology, University of Queensland.

[3] Soil Conditions and Plant Growth by Sir John Russell, page 453.

The Merino Industry.

As a counter to the limitations associated with crop-growing under low P/E ratios, there has been the development of the merino sheep industry. Australia has the greatest number of sheep, 113 millions,[4] a figure 10 millions greater than that of the sum of the sheep of the next two nations, the United States of America and the Union of the Socialist Soviet Republics. In wool, too, the 1,015[5] million pounds of Australia (expressed as "greasy") is 176 million pounds more than the production of the next two countries, the United States of America and the Argentine.

The merino sheep industry does not employ a big population in relation to its production; the small numbers per square mile in Australian sheep country are a direct consequence of the climatic and pasture conditions which have favoured the merino and the production of the finest wool at a low cost in units of human labour.

THE WHEAT INDUSTRY.*

Wheat Yields.

Country.	Average 1931-1933.
Denmark	42·60
Netherlands	42·23
Belgium	38·84
United Kingdom	33·16
Germany	32·62
Sweden	32·45
Switzerland	31·65
New Zealand	31·11
Yugoslavia	16·32
Argentine Republic	14·40
Manchuria	14·15
United States of America	13·60
Spain	13·57
Rumania	13·27
Canada	13·20
AUSTRALIA	12·81
Uruguay	9·75
Soviet Union	9·73
Union of South Africa	8·05
Algeria	7·64
Tunis	6·63

It will be noted from the world's yields that countries like Argentina, Australia, and the United States of America with extensive farming conditions have comparatively low yields. It shows a poor appraisal of the relative farming conditions to expect that the Australian average should approach closely the average yield for Denmark, Great Britain, or New Zealand.

Agricultural scientists have sound ground for pride in achievements of the Australian wheatgrower and the agricultural machinery inventor.

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[4] Official Year Book of the Commonwealth of Australia, 1936, page 63.

[5] Official Year Book of the Commonwealth of Australia, 1936, page 639.

* Official Year Book of the Commonwealth of Australia, 1936, pages 657-8.

The Open Door to Australian Farming.

No ban has been placed in the migration of European farmers to Australia. If a potential migrant with farming experience really considers that his good farming and resources applied to Australian conditions would make a ready fortune for him, there is no Australian restriction which prevents his undertaking such work. Indeed, recent attempts have been made in the Commonwealth to settle migrants permanently in agricultural areas and often at very great cost. For instance, in the West Australian group settlement 1,700 settlers may be regarded as having been permanently settled at a cost of some nine million pounds; there is, of course, subsidiary industry serving these settlers. It will be remembered that the Development and Migration Commission with thirty-four million pounds available mainly for migration purposes found itself unable to recommend many schemes which would justify considerable expenditure from this amount. The most productive lands, have, of course, mostly been settled for farming or pastoral purposes except in those cases where they have been reserved for forestry purposes or are very remote, or are small areas and remote.

The newcomers have to make good as pioneers of country which is marginal or else be provided with or possess sufficient capital to enable them to buy into areas of greater safety and production. This latter procedure cannot be justified unless the output from the area is increased in proportion to the capital expended. Mere replacement of individuals has only problematical economic value. The world has, as yet, no solution to the problem of large scale settlement of Northern Australia which will permit of an approximation to the present Australian standard of living.

Defence Problems of the British Empire and Australia in Particular.

Migration to Australia has been discussed as a means of improving the defence of the Empire, it being considered a strengthening of the present position to move rapidly people from Britain, with a surplus population over available employment, to another component of the Empire like Australia where it is considered that there is ample opportunity for the British unemployed to work and live under better conditions. Were the case as stated, it would be unanswerable. There is, however, the cross demand of considerable numbers of unemployed in Australia, the absorption by armament requirements in Britain of many of the men who would be useful in Australian secondary industries and, moreover, the agricultural development policy of the British Government would appear to be holding people with agricultural interests in Britain and also decreasing the market for Australian exports. Unemployed men from, for instance, the Welsh coalfields present a similar sort of problem to that already existent in Australia in the Queensland and New South Wales coalfields as a consequence of the development of crude oil and its derivatives for transportation and stationary power purposes. Unemployment in the coal industry would, of course, be alleviated by successful commercial use of methods for the hydrogenation of coal which would also partly solve the Empire's oil fuel problem.

It has been pointed out by H. Burton[6] that the greatest net immigration (all ages) to Australia of recent decades was 261,000 for 1922 to 1933 and that this was only about one-fourth of the figure due to

[6] Australian Migration Policy Since the War. A.N.Z.A.A.S., Auckland, 1937.

natural increase. Even in the 'fifties, during the gold rushes, the immigration increase was but 50,000 per annum. If the defence problem were an immediate one and we were able to induce as satisfactory net immigration rates as those of 1922 to 1931, which were higher than at any period since the 'eighties, this increase in the Australian population could not be regarded as a significant defence factor. From the point of view of long time effect the result would be valuable, but the addition of 100,000 (all ages) within four years to a population of six and a-half millions, supposing that any blow to be struck did not occur during this period, could not be expected to have a decisive effect. From the psychological and place maintenance points of view greater encouragement of migrants from Germany and Italy might help to satisfy the demand for a place for excess population. W. B. Reddaway, in "Migration from the British Point of View," puts this aspect in this way, "If we really want to base a case for migration to the Dominions on the defence argument, we must favour migration not from Britain but from the dissatisfied countries."

If "The jealous eyes of more crowded countries are focussed upon Australia,"[7] it is partly due to a belief that the unoccupied or lightly-occupied areas are on lands much more potentially productive than we know them to be. Some of these lands, like the poor forested lands of coastal Queensland, may be capable of flowing with milk and honey and of supporting a large population at a reasonable standard of comfort, but we do not know the answer to their grassland problems yet; and it is true that we have not made a research effort in quality or quantity commensurate with this problem.

Fisher† quotes Adam Smith, "Defence is more important than opulence"—a consideration which may cause some hesitancy at present in affirming that living standards must be kept where they are in the face of a threat to the existence of anything like their present level. A lively imagination may picture an impact of modern war on a people generally lacking the purpose to do something to lessen the chance of it.

An Optimum Population at an Optimum Immigration Rate.

In a paper on "Absorption of Immigrants in New Zealand," by Professor A. B. Tocker[8] he discussed the optimum population from the point of view of the increasing return for labour with increasing population to a culminating point, followed by the operation of the law of diminishing returns as further increments of population were absorbed.

For any one set of conditions there may be an optimum population and also an optimum rate at which it may be increased, but the problem is a constantly changing one and the optimum in each case will not be a fixed quantity from year to year. There are general considerations which dictate that steps to increase the population of any country by immigration require a measure of consideration, investigation, and planning that has rarely been given. One such consideration is that the general result should not be such as to reduce permanently the high standards of living in countries (such as have attained them) simply as a consequence of the pressure of countries deliberately producing a surplus population

[7] Lord Huntingfield; quoted by A. S. B. Fisher. A.N.Z.A.A.S. Meeting, Auckland, 1937. The defence aspect of production of fuel alcohol from sub-tropical crops is discussed under Agriculture (Industrial Alcohol).

† See earlier reference.

[8] A.N.Z.A.A.S. Meeting, Auckland, 1937.

by encouragement of numbers of children beyond the capacity of the family or State to care for adequately. With the adoption of steps similar to those suggested in the section under agriculture, the optimum population for Queensland will be very much higher than it is now. The actual optimum rate of increase in our present population will depend much on markets, and the solution of the many problems concerning more efficient use of the large areas of (at present) low productive country, having favourable rainfall, which we more than any other Australian State, possess. The sub-tropical and tropical problems involved have not yet been solved elsewhere. It might again be mentioned that there is no bar to the migration of people from Europe to the Commonwealth now, provided that it is reasonably certain that they will not become a charge upon Government revenues.

The Betterment of the Lot of Migrants Moving from the Depressed and Low Living Standard Areas of Various Countries to a Higher Standard.

The migrant of whom large numbers might be expected from Britain, in the face of the schemes for the training of young workers of initiative in new vocations, is not likely to be a type which will have a reasonable prospect of succeeding on the land when there are large numbers of young Australians with Australian farming experience who find it difficult to obtain areas to meet their needs. There may, however, be the desirability of obtaining farming stock particularly from Germany; the experience of Queensland and South Australia is that these German farmers are hard working folk who have established themselves under Australian conditions and that their children may possess an Australian outlook. Queensland has, of course, absorbed more Italians of recent years than any other State in the Commonwealth and continues to absorb them. The absorption of Asiatic people would be in conflict with the policy of Australia since Federation; it is questionable whether anything internationally useful could be done in Australia to cope with the single problem of the Japanese annual increase of one million people. Moreover the sometimes accepted view that North Australia might be a Mecca for Japanese migration seems somewhat in conflict with climatic facts. The major portion of the Japanese Empire, with the exception of Formosa, lies between 49° and 33° of north latitude, whereas the whole of Queensland lies between 29° and 10° of south latitude. It would appear then that New Zealand, lying between 34° and 47° of south latitude and Southern Australia, lying between 29° and 44° south might be much more attractive. It is hardly likely that, were the whole of Australasia open to Japan, they would choose to settle on those portions of it most dissimilar from the climatic and crop experience of the main portion of their own Empire—unless there were political factors forcing such a decision.

No doubt the Japanese could make a success of New Zealand and South Australian settlement at least as easily, if not more easily, than that of Australia "North of Twenty Eight."

The Market which a greater Australian Population would make for the Products of the British Industries.

It has been argued that migration from Great Britain to Australia would increase the market for British export products while easing the strain on the foodstuffs required for the population of the United Kingdom. This would, of course, be the case were the migrants of a type which could satisfactorily place themselves in Australian industries, produce things of which there is not a surplus already in view, and increase Australian purchasing power. It does not, of course, follow that persons newly settled in Australia will consume the same quantity of products of British secondary industries as before; many such products consumed will be the produce of Australia. A most satisfactory form of migration might be of organised industrial units producing something in Australia which is at present a matter of importation and for which the Australian demand is sufficient to guarantee the economic stability of the industrial unit. Such a transfer would call for adjustments in Britain since the purchasing power of such people in British subsidiary industries would have been lost.

The Market which an Increased Population will make for all Australian Industries.

Provided that an increment in population finds no difficulty in selling its products within the Commonwealth or outside, this increment will add by its own needs to the demand for materials produced in the Commonwealth. If, however, a thousand additional farmers by producing additional foodstuffs and raw material for clothing increase the supply of products for which the demand is stationary or actually weakening, they may lower returns for farmers and make average returns approximate to the lower ones which their ingress has brought about.

Ability to market produce at satisfactory rates, or lower the cost of production by greater efficiency, are of first rate importance. Whereas in pre-war years there appeared to be the likelihood of an insufficient supply of foodstuffs to meet the European demand, the major trouble at the moment is to find markets for the increased production of the nations exporting foodstuffs and raw materials for clothing. There is, of course, nothing like a real world excess of food and clothing, but a country like China needing much, lacks purchasing power per family; still other nations direct purchasing power along other channels than those supplying family needs.

In the encouragment of migration it would appear that young men will have a better chance of establishing themselves than older ones. They have fewer cares and responsibilities and can afford to take lower rates of pay while gaining their experience of farming conditions and do their subsequent pioneering of undeveloped areas with hardships of a similar degree but of a different kind from those experienced by earlier groups of pioneers.

AGRICULTURE.

A permanent system of agriculture depends on the conservation of land capital which generally means the conservation of the surface soil and its fertility. The recent emphasis on the prevention of erosion is not before its time. It is possible in a trip from Gatton to Brisbane to see paddocks in which the subsoil is exposed, the surface soil has been transported to lower levels. The worst of these results may develop within a lifetime on steep slopes, but on the gentler slopes where herbage protection has been removed, the process may take longer but nevertheless occupy a short time in the history of the State. Every bale of greasy wool, each bushel of wheat, and each hundredweight of cheese exported, represents removal from the soil of ingredients which older agricultural systems find it necessary to replenish. We are at present working on soil, more or less virgin, in which there is the accumulation of available phosphates and potash from geological periods of weathering. Forest, scrub, or grass cover prevented these materials being lost by erosion. Careless agriculture may lose in a decade what nature has accumulated in centuries. Although Nature may add small amounts of available phosphates and potash to soils each year, we are exceeding this amount and working on capital; efforts should be made to postpone the time when we will have to fertilise as liberally and at a similar cost to older agricultural communities. This, of course, affects population since the country which loses its land capital may eventually not only be unable to attract migrants but have difficulty in caring for its natural increase.

Droughts.

A factor which will permit of the settlement of a number of farmers permanently and safeguard the interests of the present population and of migrants is the development of a scheme in which fodder reserves are accumulated for the drought years which assuredly will occur in Queensland's future as they have in its past. Since 1888 there have been at least eighteen years which might be regarded as drought years. Droughts have seen losses indicated by such things as minimum average yields per acre of $4\frac{3}{4}$ bushels of wheat, $14\frac{3}{4}$ tons of cane, and 19 bushels of maize.

The fall in cattle numbers from 7,470,000 in 1921 to 5,209,000 in 1929 was accounted for to a considerable extent by drought losses. The fall in sheep numbers from 20,663,000 in 1925 to 16,861,000 in 1926 was largely a drought phenomenon; the low lambing percentage of thirty-four in 1926 may be similarly ascribed. In "A History of Queensland Dairying" published in December, 1923, by the Queensland Council of Agriculture, the total loss to the Dairying Industry as a consequence of the 1915 drought was stated to be £2,300,000. Besides the direct loss to the agricultural and pastoral industries there is a consequential lack of business and using up of some reserves in the secondary and tertiary industries. The State experiences a period of depression which adversely affects the security of almost every member in the community. A severe Queensland drought may not cost the State less than five million pounds. Suitable lands with irrigation facilities could be used to accumulate stock foodstuffs for drought purposes conserving the State's assets and producing power. The methods of conservation and the economics of such a scheme are not part of the present problem, but it should be remembered that mere consideration of costs of conserved fodder ignores the heavy indirect losses which are part of drought's disorganisation, the widely-spread hardships which a drought entails, and the difficulties besetting orderly planning of the future. Migrants arriving during a drought as at present tackled would have a parlous time.

IRRIGATION.

Irrigation settlements being areas of close settlement, it is natural to enquire what possibilities there are here.

The development of the Dawson scheme with the Nathan dam and the extension of the project was not favoured by the Development and Irrigation Commission as an area in which to spend largely from the funds available under the £34,000,000 agreement. The area is suitable for rice varieties of a longer growing period than the M.I.A. area which now supplies the Australian market. It might be developed for the production of a drought foodstuffs reserve, including cotton-seed meal as a by-product of irrigated cotton.

It would appear that there are helpful things that can be done for established farming areas. The provision of frequent weirs along creeks and rivers to hold water for irrigation of nearby farming lands may be economic, particularly if unemployed relief fund moneys could provide some of the expenditure without proportionate capital charges. All materials required are Queensland produced.

While our State has not snow-capped mountains to feed its rivers and streams, the bulk of its rainfall does come during a period of high evaporation from land surfaces and offsets these losses. Irrigation makes for surety of farming income and for intensive farming. These are favourable to migration. Development in irrigation areas in Queensland of fruits of the types which the Sugar Industry (itself protected) now subsidises to the extent of £216,000[9] per annum will not help us.

Crops and Stock.

I am taking agriculture in the wide sense embracing all crop and stock industries. As far as the practice of crop raising and dairying are concerned, there are large areas of the State which, after certain preliminary work, can be made available for increased production. No great agricultural problem would be presented in increasing the production of sugar one and a-half times as much again. The difficulties are associated with the economics of the industry. The estimated value of the production of crops in the year 1934, perhaps a fair average year, was as follows:—

Crop.	£
Maize	562,095
Wheat	776,689
Other Cereals	40,402
Green Forage	676,624
Hay and Straw	615,985
Sugar-cane	6,934,764
Apples	89,940
Bananas	335,685
Grapes	68,715
Oranges and Mandarins	97,900
Pineapples	207,870
Other Fruits	147,985
Cotton	397,263
Peanuts	79,500
Potatoes (English and Sweet)	208,955
Pumpkins	119,224
Tobacco	69,400
Tomatoes	194,140
All Other Crops	282,670

Taking these crops in turn—

Maize.

The climate of Queensland favours summer crops—maize, sorghums, and millets—and, were a greatly increased demand to develop for maize, at a price, the State would find little difficulty in meeting it. An important food for horses, the demand for it is not keeping up with the

[9] Official Year Book of the Commonwealth of Australia, 1936, page 686.

growth of Australian industry because of the substitution of cars, trucks, and tractors for horse-drawn vehicles. Maize is a summer crop flourishing under conditions of summer incidence of rainfall. Maize products, particularly glucose, are making an increasing demand and much of the production of the Atherton Tableland has been used up this way. As a reserve grain for drought conditions maize offers distinct possibilities. It is easily fed, and the technique and economics of its storage are well known. The United States produced more than 2,500 million bushels in 1934, Queensland averaged 4 million bushels over ten seasons, 1925-1935; U.S.A. yield per acre, 1925-1929 was 27 bushels, and Queensland 24½ (1925-1935)[10].

The possibilities are in pig food, industrial alcohol, and drought reserve.

Wheat.

There have been many demands and rosy forecasts with regard to the growing of increased quantities of wheat in Queensland. The acreage under wheat has not increased very greatly over a considerable period of years. The industry is mostly located on the black earths of the Darling Downs, and the Queensland average per acre is the highest State average of continental Australia. Some of the lowest costs of production figures presented by the Wheat Industry Commission have been from Queensland. Within the area of the Darling Downs wheat production has been a stable industry although subject to fluctuations in yield from 4·75 to 18·8 bushels per acre.

The wheat country is located in the most southern portion of the State, where favourable winter rains are more likely than in the more northern areas. This, coupled with the use of varieties of short growing period, early ploughing, and bare fallows to conserve the monsoonal rains for the wheatgrowing period, have made the industry on this area a reasonably safe one over an average of seasons. Considerable extension, however, is hard to see unless there be a plant-breeding development which will permit of wheat being grown over a different portion of the year than that normal in Queensland. This industry does not offer a great deal in the way of increased settlement. Actually with the continued progress on the mechanical side, it is possible that fewer people will be required for the handling of the acreage at present in use. Queensland has imported some wheat from the Southern States to meet her domestic requirements on many occasions. The Southern States have climatic advantages with wheat, a winter cereal, as we have them with maize, sorghums, and other summer grains.

Grain, Hay, &c.

Queensland presents excellent possibilities for the increased growth of summer crop grains, green and dried forage, particularly also with the making of grass and other silage—as simple labour saving methods such as those associated with trench silos become a normal portion of farm management. The coastal strip presents a farming problem which time will undoubtedly solve and we shall witness the increased production of pastures and forage for cattle, and probably cross-bred or British sheep.

Sugar-cane.

As Australian requirements increase, so can additional cane sugar be produced in Queensland; there is no shortage of agriculturally suitable

[10] Official Year Book of the Commonwealth of Australia, 1936, pages 670-1.

land. The difficulties associated with beet sugar production in Australia are best emphasised by the fact that, though the Maffra supply is sold at the Australian price, there has not been the remarkable increase in beet sugar production which would follow such a price applied to the whole of the cane sugar output. With the economics of the sugar industry as they are at present, an increase in sugar production can only result in increasing hardships on large numbers of the industry's pioneers. A cane harvester of merit would greatly alter the economics of the industry.

Certain sugar-canes and allied plants will furnish some of the green feed in the extension of coastal dairying.

Fuel Alcohol.

The petroleum and shell spirit imported into Queensland in the year 1934-35 was about 34 million gallons.[11]

It is probably conservative to assess Commonwealth requirements at 6½ times the Queensland figure; some 200 million gallons of such products may be required annually.

With both main methods of hydrogenation of coal disappointingly commented on, little immediate likelihood of obtaining fuel supplies from well sources, the comparative lack of adoption of suction gas for propulsion of vehicles here (or in France), and the limitations in supplies from shales, Sarina may be the precursor of alcohol production in a big way. This State is agriculturally suited for the grain and root crops suitable for the production of fuel alcohol. The possibilities from molasses are not great; 4½ million gallons out of a total of 18½ million gallons[11] of molasses were used by distilleries in 1934; 7½ million gallons were used as fuel or manure, and 1 million run to waste. The fuel value of molasses is about 10s. per ton. Australian consumption of petroleum being over 200 million gallons per annum, there is not much real relief in sight from alcohol from molasses; but defence requirements might make the production of alcohol from sub-tropical and tropical crops advisable. An Australian policy of fuel alcohol production would mean an opportunity for settling many thousands of migrants in Queensland. Peace time strategy would require the mistakes in production and manufacture to be made now, and expansion in war be based on a cadre of skilled farming and manufacturing personnel.

Cotton.

This is a crop for which Queensland is well suited. Experimental work is being continuously carried out and, despite many serious seasonal difficulties, the trend of the industry has been upward; difficulties should not be experienced in continuously meeting the raw cotton requirements of the Commonwealth. The export outlook for cotton is not good. The quality of the cotton is satisfactory. Picking is at present done by hand. A good mechanical cotton picker would reduce harvesting costs and alter the economic aspects of the Queensland industry.

Tobacco.

The prospects for tobacco are good. It requires too great a stretch of imagination to believe that this continent and, in particular, Queensland, cannot combine human ingenuity and soils so as to make Australia

[11] A.B.C. of Queensland Statistics, 1936, page 213.

eventually independent of other countries for the supply of the bulk of its tobacco requirements; tobacco-growers would increase in numbers in Queensland.

There are, too, certain of the vegetable crops, such as tomatoes and pumpkins, and many tropical fruits, besides bananas, which have an expanding future in this State.

Merino Sheep.

Allowing for the swing from sheep to beef cattle and *vice versâ* it remains true that the potential carrying capacity for sheep in the areas devoted to the Merino in Queensland has not yet been reached. Better methods for the management of pastures will enable the reseeding of native grasses, the preservation of edible shrubs, and the reservation of pasture areas; the formation of grain and fodder reserves will help in the process. Sheep numbers, of course, are not an exact measure of the productivity of the industry. Wool is better, and the weight of wool per fleece has notably increased in Australia as a consequence of the activities of sheep breeders. The importance of breeding sheep for Queensland conditions has not yet received the attention it should. Nutritional studies, already commenced, will lower feed costs. Better water facilities and conservation in this State, which is so extraordinarily fortunate as to possess the major portion of the world's greatest artesian basin, will help in increased carrying capacity also. The tendency to decrease size of holdings results in carrying a greater human population and, with suitable financial backing for smaller graziers to tide over adverse times, closer settlement of the pastoral areas should become stable. Linked up with the stability of the stock industries must be some measure of mitigation of the effects of droughts, and its importance becomes greater as smaller men enter more and more into the sheep industry, and have not the alternative grazing properties or financial resources of the pastoral companies.

British and Cross Bred Sheep.

The North Island of New Zealand carries large numbers of Romney Marsh sheep which are crossed with the Southdown for the lamb trade. These New Zealand lambs sell well, the best weights bringing 8¼d. per pound last year. The perennial Rye Grass—Certified White Clover—pastures are extraordinarily good but, of course, pass through periods of shortage in the winter months when hay, grass silage, and roots are used to tide over. It is impossible for me to believe that much of the elevated country facing the coast in Queensland cannot become good British sheep country. The pastures for such country are a problem but, with the work being done by the Council for Scientific and Industrial Research, the Department of Agriculture and Stock, private breeders like J. M. Newman, Esq., and the extension of this work on a scale proportionate to the importance of these lands and the grasslands industries, the solution will come within a comparatively short time judged from a national viewpoint. Parasites are troublesome in New Zealand and are satisfactorily handled. There should be less difficulty from this source here.

The extraordinary rise in the comparative values of crossbred wool, which characterised recent sales in New Zealand, is abnormal, and may be a result of the war preparation measures of the buyers' countries; but, with the pre-war low rates in comparison with the merino, the New Zealand crossbred and British sheep industry was then on as sound a basis as most agricultural industries. Large areas east of the Divide are envisaged as potential crossbred and British sheep areas for mutton and fat-lamb production.

Beef Cattle.

Much of what has been written with regard to sheep applies also to beef cattle. There are the great possibilities presented by the chilled baby beef industry on the eastern side of the Divide. Research will reveal grassland establishment and management measures of which we are now ignorant. "North of twenty-eight" presents a whole series of animal and grassland problems to which most temperate regions' grassland research stations, including those of New Zealand, Southern Australia, Great Britain, and North Germany have no answer. The production of pastures in sub-tropical and tropical areas for sheep, beef cattle, and dairy cattle have not yet been attempted in a measure suited to its importance to Queensland and to the Commonwealth's interest in the development of Northern Australia. The research work of Dr. Vickery, as discussed by him at a meeting of this Society, indicated that hotter climates (Wyndham, Townsville) are in some ways more favoured for the production of chilled beef of a satisfactory keeping quality because of the low atmospheric and soil content of micro-organisms which can grow (comparatively) rapidly at chilling-room temperatures. This indicates in some degree the special nature of Northern Australian investigations. Some investigations to determine the beef animal of most value under the conditions are now in being.

Dairying.

The Queensland dairying industry has shown much growth in recent years and the State has become one of the important butter exporting States, and it has for many years been the most important exporter of cheese. The industry extends from the Warwick factories on the Downs, latitude about 28° S to the Daintree, latitude about 16° S.

The range of country and climate which this represents presents problems, a solution of which will, I believe, make Queensland the greatest dairying State in the Commonwealth and one of the great dairy States of the world. The contribution of engineers in refrigeration and the marked use which can be made of rural electrification schemes, together with modern transportation, have removed some of the difficulties associated with the technology of tropical dairy manufacturing, but the grassland problems remain unsolved. The present Molasses and Para grasses of the Daintree, and the Paspalum, Rhodes, and Kikuyu and native grasses of the South are but a pioneering stage in the grassland work of Queensland's eastern areas. We can expect varietal work in these grasses which will greatly improve their contribution to pastures. It is likely, too, that varieties of new species will be introduced with success and that the legume problem of the Queensland's coastal areas will be solved. The building up of poor lands to ones of high fertility is a distinct accomplishment of the New Zealander in Waikato and much of the Pumice lands. The Queensland problem is no greater, but unfortunately we have not New Zealand's access to climatically parallel grassland work such as that of North-Western Europe, which formed the basis of the New Zealand endeavour and which New Zealand has surpassed in some phases by its own contributions.

Provided that the markets are available dairying, with coastal sheep raising and baby beef production offers the greatest promise for expansion, not only for Queensland as a State but in Queensland's development as a factor in Australian defence.

Horses.

The horse-breeding industry has been affected in a similar way to the maize industry. The demand for draughts for farm and city haulage work has been greatly lessened as a consequence of truck and tractor haulage, while lighter horses are a rarity in city streets and have been replaced to a somewhat unexpected extent in country towns by motor cars and motor cycles. The mechanisation of armies has lessened the requirements for remounts, and consequently this demand is a fading one. The figures for horses in Queensland are as follows:—[12]

Year ended 31st December.	Horses.
1860	23,504
1890	365,812
1900	456,788
1910	593,813
1914	743,059
1920	742,217
1921	747,543
1922	714,055
1923	661,593
1924	660,093
1925	638,372
1926	571,622
1927	548,833
1928	522,490
1929	500,104
1930	481,615
1931	469,474
1932	452,486
1933	450,024
1934	448,604

and the picture needs little comment.

Low prices for farm products have discouraged the use of comparatively high-priced fuels but, given good prices, tractors and trucks have an abiding place in many Queensland farming districts where high humidities and temperatures are hard on horse efficiency but do not adversely affect suitably designed tractors and trucks.

Pigs.

In both New Zealand and Australia the consumption per head of pig products is low compared with England, the United States of America, and Canada. The pork average for Australia was 9 lb. compared with 66 for Canada and 72 for the United States of America.[13] It would appear then that there are possibilities of increased consumption

[12] A.B.C. of Queensland Statistics, 1936, page 172.

[13] Official Year Book—Commonwealth of Australia, page 714.

in Australia for pork products; probably this can only be at the expense of some other form of meat such as beef and mutton. The consumption of meats per head in Australia and some other countries is as follows:—[14]

PER CAPITA CONSUMPTION, AUSTRALIA, AND OTHER COUNTRIES.

Description.	Australia, 1934–35.	New Zealand, (*a*).	Great Britain, 1933.	Canada, 1934.	United States of America, 1933.
	Lb.	Lb.	Lb.	Lb.	Lb.
Beef and Veal	120·93	117·00	62·80	68·66	54·20
Mutton and Lamb	77·44	110·00	(*d*) 31·10	6·28	7·00
Pork	9·31	6·00	(*b*) 47·80	66·36	72·20
Totals	207·68	233·00	141·70	141·30	133·40
Bacon and Ham	10·36	11·00	(*c*)	(*c*)	(*c*)
Total, all Meats	218·04	244·00	141·70	141·30	133·40

Average, three years ending 1933–34. (*b*) Including lard.
(*c*) Probably included with pork. (*d*) 1934–35.

Australian consumption of meats may reach the higher New Zealand figure if economics, taste, and nutritional desirability favour it. There are possibilities for increased consumption of meats in Great Britain, Europe, Canada, the United States of America, and particularly the countries to the north of us (the Far East) and, had these peoples the required purchasing power, countries like Australia, and in particular Queensland, would be hard put to it to supply a fraction of the world's additional meat requirements. It will be remembered that the Nutrition Committee of the League of Nations included meat as one of the important requirements for good nutrition. It is, of course, possible that the Australian uses more meat and less of other substances, particularly fresh fruits and vegetables, than is wise. The above figures do not encourage a view that the consumption of meats in Australia is likely to greatly increase though pork products may displace portion of the beef, veal, mutton, and lamb. Queensland produced more bacon and ham than any other Australian State in 1934-35, the total being 22,000,000 lb. as against 20,000,000 lb. for New South Wales,[8] the next most important producer.

The pig industry has generally been regarded as a subsidiary of the dairying industry, and first-rate carcases are produced where mixed farming, including dairying, is practised. The United States of America has shown that pigs can be produced in very large numbers from areas devoted mainly to the production of maize, provided that supplementary feeds are used—abattoirs by-products play a large part. Queensland is better fitted for the production of maize than any other Australian State, and it has many meatworks at intervals along its coastline. The number of cattle (including calves) slaughtered in Queensland in 1934 was 851,000,[15] so it would appear that shortage of meatworks by-products is not likely to restrict the pig industry in this State when the demand for meat meal as a supplement to maize for pig feeding is made in a big way. The United States of America, however, does not favour for

[14] O.Y.B., C. of A., 1936, page 625.
[15] O.Y.B. of C. of A., page 630.

this type of pig-raising any of the breeds commonly in use in Queensland or Australia. At the Chicago saleyards, or any of the centres handling large numbers of pigs, it would be found that the lard type of pig, the Duroc-Jerseys and Poland-Chinas together outnumber other breeds by something of the order of 10 to 1. American packing houses have solved the production and marketing problems associated with pork products from this type of pig, and Queensland's interests in the development of the pig industry cannot afford summarily to dismiss these breeds because pigs of other types are somewhat easier for the manufacturers to handle and market. The pig feed possibilities of Queensland and Victoria are not similar, and eventually we may not closely follow Victoria, New Zealand, and Great Britain in the type of pig selected to make the most of our pig-feeding possibilities. A Queensland packing house handling pig products in the mode of any of the big five of Chicago might quite conceivably revolutionize the demand and requirements of the Australian trade. We are experimenting with Zebu blood in our beef cattle industry and the Duroc-Jersey and Poland-China may help us too. Just as our grassland problems differ from those of temperate climes so also our materials for pig feeding need not slavishly adhere to those found successful in temperate regions. Most of our bacon and ham is consigned chiefly to the Pacific Islands and to the East, a trade not unfavourable or unfamiliar with pig products of the United States of America.

The pig figures for Queensland are as follows:—[16]

Year ended 31st December.	Pigs.
1860	7,147
1890	96,836
1900	122,187
1910	152,212
1914	166,638
1920	104,370
1921	145,083
1922	160,617
1923	132,243
1924	156,163
1925	199,598
1926	183,662
1927	191,947
1928	215,764
1929	236,037
1930	217,528
1931	222,686
1932	213,249
1933	217,448
1934	269,873

These figures show that the trend is up although irregular. Irregularities, as usual, are a reflex of market and seasonal conditions. When Queensland had 270,000 pigs—1934 figures—New South Wales had 398,000. With the expansion possible in Queensland dairying and the possibilities of pig production on American lines, there is a reasonable prospect of Queensland being the important pig-producing State of Australia.

[16] ABC of Queensland Statistics, page 172.

C. MARKETS.

The opening up of something approaching the 1913 situation, when international markets were relatively free, might produce a degree of prosperity in the Commonwealth which would enable migration to be resumed in a thoroughly satisfactory way to all concerned. Continental markets which were competitors for Australian exports are virtually closed. Self-sufficiency has obtained such a hold in so many continental political systems that a rapid expansion of Australia's exports to the old markets hardly looks likely. An old idea of each country producing that for which it was best fitted had some basis in reality in 1913, but now seems unlikely as an objective of international policy within the near future. Such an organisation of production necessarily must take cognisance of living standards to which nations have attained; a tolerant, scientific attitude in discussions of a matter of such importance and complexity is basic, but impossible now to obtain.

The British market has been and is the most important factor in Australian exports; for instance, the United Kingdom took 90·5 per cent.[17] of the total shipments of Australian beef in 1934-35; it took 98 per cent.[18] of the frozen mutton and lamb, and 35 per cent. of wool in 1935-36[19] (computed from figures); 54 per cent. of wheat in 1934[20] (computed from figures); 94 per cent. of sugar in 1935[21] (computed from figures); 94 per cent. of wine;[22] 64 per cent. of the raisins and currants for 1934-35;[23] 65 per cent. of the exported cotton;[21] 93 per cent. of the Queensland butter, cheese, and milk;[21] 99 per cent. of the eggs exported from Queensland[21] (computed from figures).

Nutrition Councils and Committees have been established in Australia with a view to improving the human dietary. A Committee of the League of Nations has drawn attention to the importance of certain articles and their products in the diet. A greater amount of attention is being given to nutrition in journals and newspapers than at any previous time. The publicity with regard to sounder methods of selecting foodstuffs is increasing, and it would appear that a continuous and progressive effort will be made to cause the foodstuffs and their amounts eaten to coincide approximately with recommendations based on our nutritional knowledge. This factor will certainly increase the demand for milk, fresh fruits, and green vegetables within the Commonwealth, but increased demand is much less certain in the case of butter since Australia is already consuming 31 lb. per head as against 25 lb. in the case of the United Kingdon, a colder country. In the case of cheese, however, the United Kingdom consumes 9·5 lb. per annum whereas the Australian consumption is 3·5 lb. per annum. The New Zealand figure for cheese is ½ a lb. greater than ours, but their butter consumption is 40 lb. per head. It would appear that the Australian consumption of cheese could be quite easily increased, both on the basis of present consumption and nutritional desirability. Cheese is generally the dairy pioneer's marketable product. Ten or twelve suppliers reasonably close together can keep a cheese factory going, but many times this number

[17] O.Y.B. of C. of A., 1936, page 630.
[18] O.Y.B. of C. of A., 1936, page 635.
[19] O.Y.B. of C. of A., 1936, page 641.
[20] O.Y.B. of C. of A., 1936, page 660.
[21] ABC of Queensland Statistics, 1936, page 207.
[22] O.Y.B. of C. of A., 1936, page 689.
[23] O.Y.B. of C. of A., 1936, page 691.

are required for a modern butter factory. The production of cheese in Queensland in 1934-35 was 12,200,000 lb.[22] and the net Australian exports for the same year were 16,750,000 lb.[23] With 6,500,000 people in the Commonwealth and an increase in cheese consumption from 3½ lb. per head to 7 lb. per head (still well under the United Kingdom figure) the amount of cheese exported in 1934-35 would be required for Australian consumption. The figure of 16,750,000 lb. of exported cheese is the highest figure in the last five financial years, ending 1935-36.

The quantity of milk recommended for consumption in a well-balanced diet is much in excess of that now used per head; the approximation of the quantity used to the figure recommended would greatly increase the consumption of milk in the Commonwealth. These Australian factors are somewhat encouraging from the point of view of the marketing of additional dairy produce, due to an expansion of the Queensland dairying industry which, as previously remarked, seems to be a certain development.

The market for wool has been considered to be threatened by substitution of products such as woolstra and lanital. The threat from woolstra, which is not a protein material like wool, may be less dangerous, from the point of view of quality, than that from lanital, which is produced from casein. It is estimated by Oxholt-Hove[24] that 30,000 tons of artificial casein wool would be required to replace present Italian imports of wool. He estimates that this would require the milking of an additional 450,000 cows and that one of the problems would be the disposal of the butter produced, roughly the same amount, about 30,000 tons, of which only 1,000 tons would be required to meet the present Italian imports.

With nations' thoughts running towards self-sufficiency with regard to the materials for manufacturing industries, it is possibly not desirable that the price of wool should rise to a figure which will encourage greater efforts to produce a satisfactory substitute. Experience with regard to margarine and butter on the English market has been that there are certain critical prices for butter which must not be passed, otherwise butter sales rapidly decrease and the margarine sales increase. If international markets become freer than they are at present, a somewhat similar relationship between wool and wool substitutes might obtain. Wool substitutes which are protein in origin may not only bear a chemical family resemblance to wool but, with increasingly better methods of manufacture, may closely approximate its physical properties.

The Ottawa agreement witnessed an endeavour, amid the self-sufficiency efforts in countries which originally traded freely with Great Britain and other countries of the British Empire, to obtain a measure of self-sufficiency within the Empire itself by reciprocal trade relationships. Obviously many political beliefs and attitudes were cut across and, in the case of Great Britain, radical changes were made in fiscal policy. From some points of view the effort was late timed since preferential trade in Australia was initiated in the early Federal years. Recognizing that Britain has very large capital interests in non-Empire countries like the Argentine, and the closeness of these countries as a factor in the necessary protection of trade routes during war, it still remains somewhat more than desirable that inter-Empire trade should be encouraged until such time as a return to freer trade relationships becomes feasible.

[22] O.Y.B. of C. of A., 1936, page 712.
[23] O.Y.B. of C. of A., 1936, page 713.
[24] Hansen Dairy Bulletin—Oct., 1936.

Markets are largely a matter of business relationships when uninterfered with by political considerations. Political considerations now, perhaps more than ever before, indicate the necessity for placing Australian trade where possible within the Empire, but Australia cannot afford to weaken herself as an Empire unit by neglecting the development of markets which strengthen her economic position nor can she afford rashly to offend nations whose decisions in the Pacific may be critical for the Commonwealth. Markets and migration obviously are interdependent. The prosperity which increasing demand for Australian goods would occasion would bring migration in its train.

D. AGRICULTURE, MIGRATION, AND MARKETS.

Consideration of the three factors and their inter-relationships leads me to believe that, markets being available which will give a margin of profit to efficient farmers, deliberate, fully-planned migration to Queensland can be encouraged with benefit to the State. It is fundamental to realise that this required margin of profit can come in two ways of which there is apt to be emphasis only on the first, that is, higher prices for products. The other is nationally even more important—lower production costs. It does not follow that a lower production cost will reduce the standard of living on a farm.

The profit margin is the essential feature. Reducing the cost of production by better farming also makes for more interesting farming, which keeps young men of initiative and business ability on the land.

It is apparently not possible under present conditions to farm or graze hundreds of thousands of acres of country along the Queensland coast, but I feel sure that, given the necessary research and experimental work, solutions can be found to the problems which prevent settlement of much of this land now. Of these problems the greatest is the grasslands problem. Pasture surveys, the investigation of species and varieties of grasses and of legumes, their combination to produce sub-tropical and tropical pastures, and the determination of methods of management of such pastures which will give maximum paying production and enable settlement on areas now unused—these phases must be investigated. The continuation of suitable grassland management will convert many second class grazing areas into first class ones.

Fodder conservation in Queensland has only begun. Conservation of grassland products (by the simplest possible methods available for areas with moist conditions during the harvest period) should be adopted; ensiling in "trenches" costs little in capital and harvest time labour. Successful migration necessitates that grassland research bears in its personnel and the money devoted to its activities a close relationship to the value of Queensland's grasslands products, and their obviously even greater future. In 1934 the production of the dairying industry was £5,950,000 and the pastoral industry £14,600,000, a total of over £20,000,000, of which the bulk was from grassland products. The production of the agricultural industry in the narrow sense, grain, crops, green forage, hay and straw, sugar-cane, fruit, and all other agricultural products was £11,906,000.[25] Had there been as much attention and money devoted in research and experimentation to the problem of grasslands as there were to all crops in the ordinary sense, the provision for grasslands would still be below that which could be

[25] ABC of Queensland Statistics, 1936, page 188.

justified by consideration of the State's interests. This is more than ever the case if the State's financial basis is considered to rest on its exports, since 1934-35 export values were as follows:—

	£
Butter	3,676,486
Hides and Skins, including furred ..	211,908
Meat—	
Bacon, ham, and pork	288,244
Frozen beef	2,040,770
Other	506,601
Tallow	231,898
Wool—	
Greasy	6,047,655
Scoured	1,322,278
Mainly Grassland Products ..	£14,326,278
Crop products—	
Sugar	2,178,536
Wheat	102
Crop products	£2,178,638

These are the only items given as principal ones relating to crops.[26]

In connection wth the planning of migration, may I quote these words of the Rt. Hon. Sir Leslie Wilson:—

> "I am one of those who feel that there is much that can and will be done in this State of Queensland, if all give to the work of development, the determination to undertake a task which means so much for the future, not only of this State and Continent, but of the British Empire.
>
> "One word more. Let us not forget how young we are, and the old Latin motto: Let us 'hasten slowly,' and lay our foundations well."[27]

I have mentioned many possibilities and lines of action to ensure the success of migration, but the first basic step in a sound scheme appears to me to be thoroughly well endowed and staffed grassland research for our sub-tropical and tropical areas.

The activities in connection with the grasslands would be almost in the words of Professor Wadham—[28]

"(*a*) Learning how to develop the poor soil types cheaply and effectively; and

"(*b*) Increasing the intensity of production of the better soils."[30]

A method of approach, although a subsidiary one, is the procedure adopted in connection with New Zealand prison farms at Hautu and Rangipo. These farms had numbers of prisoners placed on them who

[26] ABC of Queensland Statistics, 1936, page 213.

[27] The Right Honourable Sir Leslie Wilson "Queensland Assets"; an address to this Society 12-10-1936.

[28] S. M. Wadham—Australian Absorptive Capacity—The Primary Industries, Australian Institute of Political Science, Canberra, 1937.

erected their own buildings, cleared the manuka, and established (Hautu) or were establishing (Rangipo) pastures on pumice lands previously regarded as entirely valueless. The older farm (about 700 acres) will probably be divided up into a number of farms and leased to settlers. A method of exploratory prison farms using the labour to clear areas of country at present not producing and, in collaboration with the grasslands research people, finding the methods of producing a maximum return from pastures, is one that has possibilities. The fitness and expediency of such farms being settled by persons whose sentences have expired might not be lost sight of.

The type of migrant who will meet with the most success as an agricultural settler is the young man ambitious to make a home for himself out of the bush and who has had sufficient training to carry out the work of clearing, fencing, and routine dairy farming operations. The comparative failure of some closer settlement schemes, group settlements, and soldiers' settlements has been due to poor, unsatisfactory preliminary surveys of the problems to be met, exaggerated land values, and areas unsuited to the type of production to be undertaken.

A perusal of the rainfall map of Queensland shows a very large area of country with more than 30 inches of rainfall. The incidence of this rainfall is mainly a summer one, and the settlement of this country in a much closer and somewhat new way seems to be a certainty. The industries which will make this possible are dairying, pig raising, a British and cross-bred sheep industry, and baby beef raising. For the success of all of these, it is repeated that it is necessary to determine grasslands mixtures and managements which will justify the expenditure involved in clearing and fencing the areas, providing and sowing the grasslands mixtures, and the provision of fertilizers as the research work will indicate to be necessary. As to the number of migrants that this area of Queensland can absorb there is no telling, but provided that the basic grasslands work is undertaken at once and in sufficient volume, subsequent settlement will take place on a surer and less costly basis than has characterised other development schemes in the Commonwealth.

Euryphyllum: A New Genus of Permian Zaphrentoid Rugose Corals.

By Dorothy Hill, Ph.D., Associate of Newnham College, Cambridge.

(Plate I.)

(*Tabled before the Royal Society of Queensland*, 31*st May*, 1937.)

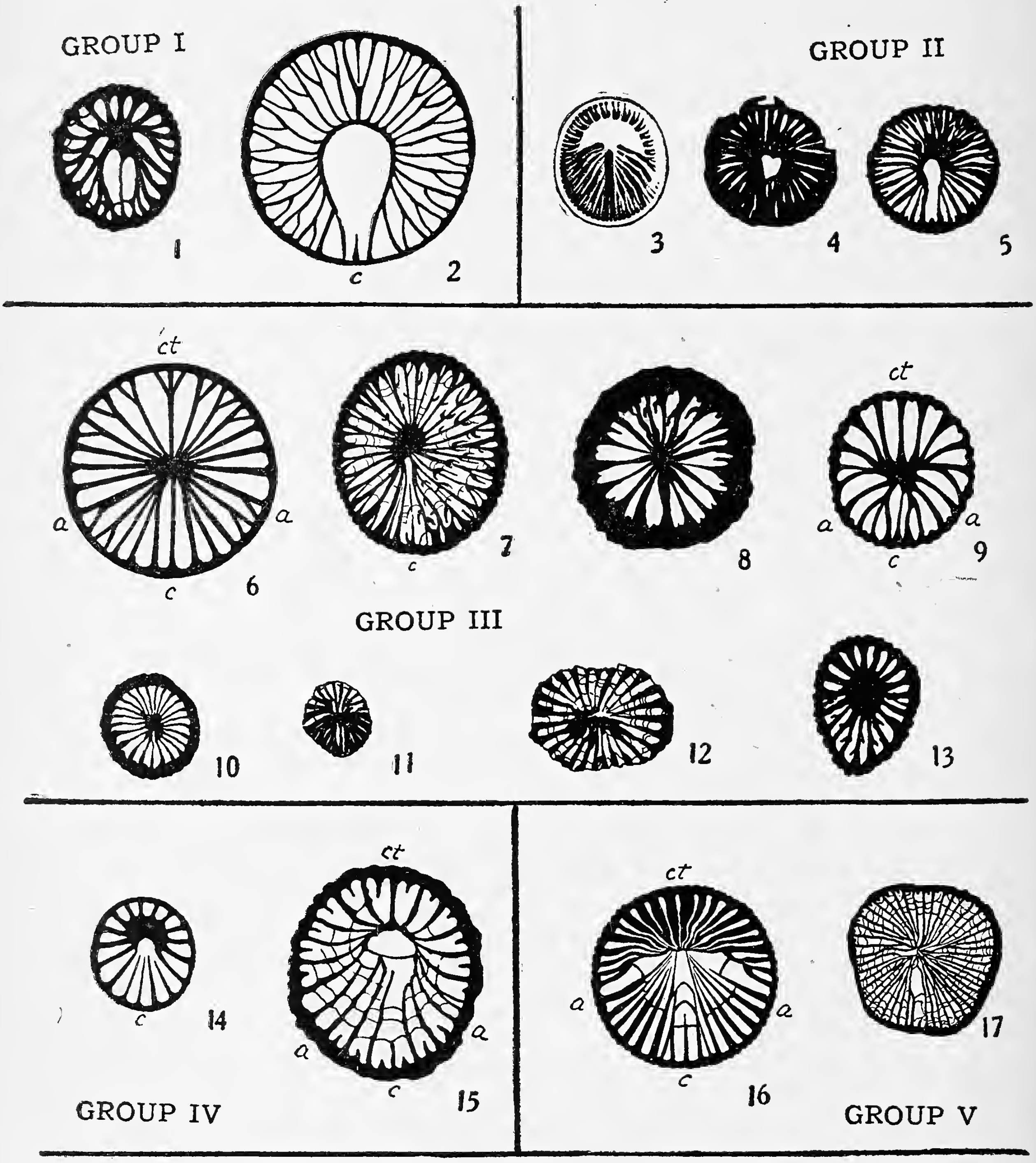
This paper describes the type species and gives the distribution of a new genus of Permian zaphrentoid Rugose corals. It briefly defines five morphological groups of zaphrentoid genera from Devonian, Carboniferous and Permian strata.

Rugose corals may in general be divided into two types, those with dissepiments, and those without. Those with dissepiments seem to have arisen from those without, either directly, or through other dissepimented forms. Usually they quickly become compound and inhabit the reefs. No case is known where a form without dissepiments has evolved from one with. Those without dissepiments are nearly always solitary, and they can exist in more diverse conditions than their descendants with dissepiments. They may give rise to series of non-dissepimented forms also. Thus we must look amongst them for the root-stock or stocks of the Rugosa, and the study of phylogeny in Rugosa resolves itself into an endeavour to recognise any such root-stocks, and the series of forms, with or without dissepiments, evolved from them. Their characters have usually been summarised by the adjectives streptelasmoid and zaphrentoid, which imply a corallum in which all development is at a primitive stage. Thus it is solitary; the arrangement of the septa is still pinnate, dependent on the septal insertion, the cardinal and alar fossulae being very obvious; major septa extend to the axis; minor septa are very short, and dissepiments are not developed; tabulæ are complete, and dilatation of the skeletal tissue may be great.

A survey of the Rugosa shows a large number of such genera, and parts of the evolutional history of some of them are known. As examples of the evolution of forms with dissepiments from forms without, we may cite the Silurian *Phaulactis,* shown by Ryder (1926) to be evolved from *Pycnactis,* the Devonian *Heliophyllum,* which can be shown to be evolved from *Zaphrentis phrygia,* and the Carboniferous *Caninia* with dissepiments, shown by Salée (1910), following the work of Carruthers (1908), to be evolved from the non-dissepimented *Caninia cornucopiæ.* The classic example of an evolutional series of forms without dissepiments is that proved in the Lower Carboniferous by Carruthers (1910), *Zaphrentis delaneoui* leading to tachylasmoid and amplexoid forms.

In the Devonian, Carboniferous, and Permian, we may distinguish at least five morphological groups of zaphrentoid corals. The morphology of each of the genera in a group is remarkably similar. Some or all may form a related series, or be homeomorphs, or some of the names may be synonymous, but speculations on their relations seem profitless in the present state of our ignorance, and in this paper I wish only to draw attention to the groups. Grabau (1922 and 1928) has studied many of the zaphrentoid corals, and has arranged them in different groups from those which I suggest. He has given his groups the status of families, and his works should be consulted for this alternative treatment.

(1) All the septa unite to form a wall around the fossula, which is on the concave side of the corallum; e.g., the Lower Carboniferous *Zaphrentis delaneoui* of Europe (Carruthers, 1908, p. 63), *Hapsiphyllum* Simpson (1900, p. 203) of America, and *Cypellophyllum* Tolmatchaff (1933, p. 287) of Russia.



EXPLANATION TO TEXT FIGURES.

Text-figures 1-17.

1. *Zaphrentis delaneoui* (after Carruthers). 2. *Hapsiphyllum* (after Simpson). 3. *Menophyllum* (from Edwards and Haime). 4. *Zaphrentis konincki* (after Carruthers). 5. *Homalophyllum calceolum* (after Grove). 6. *Stereolasma* (after Brown). 7. *Lopholasma* (after Simpson). 8. *Metriophyllum* (Sedgwick Museum A8477f). 9. *Zaphrentis omaliusi* (after Carruthers). 10. *Densyphyllum* Thomson *non* Dybowski (after Vaughan). 11. *Disophyllum* (after Tolmatchoff). 12. *Zaphrentis costata* (McCoy) (from the lectotype, S.M.A. 2392b). 13. *Lophocarinophyllum*, young stage (after Grabau). 14. *Meniscophyllum* (after Simpson). 15. *Allotropiophyllum* (after Grabau). 16. *Triplophyllum* (after Simpson). 17. *Zaphrentis enniskilleni* group (after Thomson). *a*, alar septum; *c*, cardinal septum; *ct*, counter septum. In all figures the cardinal fossula is at the bottom.

(2) All the septa unite to form a wall round the fossula, which is on the convex side of the corallum. This is seen in the Devonian *Menophyllum* Edwards and Haime (1851, p. 348) and the Lower Carboniferous *Z. konincki* of Europe (Carruthers, 1908, p. 67), and in *Homalophyllum calceolum* of America (Grove 1935, p. 354).

(3) All the septa unite at the axis, the cardinal fossula is on the convex side of the corallum, and a false counter fossula appears. Examples are the Devonian *Stereolasma* Simpson (1900, p. 205) and *Lopholasma* Simpson (1900, p. 206) of America, and *Metriophyllum* Edwards and Haime (1851, p. 306) of Europe, the Lower Carboniferous *Zaphrentis omaliusi* (see Carruthers, 1908, p. 25), *Fasciculophyllum* Thomson (1883, p. 448) [= *Densyphyllum* Thomson (1883, p. 445) *non* Dybowski, and *Centrocellulosum* Thomson (1883, p. 452)] and *Disophyllum* Tolmachoff (1931, p. 341) of Europe, and *Lopholasma* of Asia (Grabau 1922, p. 43), and the Permian *Lophocarinophyllum* Grabau (1922, p. 46) of Asia.

(4) Only the septa of the counter quadrants and the alar septa unite, forming a crescentic group; the fossula is on the concave side and the remaining septa are amplexoid;[1] e.g., the Lower Carboniferous *Meniscophyllum* Simpson (1900, p. 199) of America and *Allotropiophyllum* Grabau (1928, p. 130), which occurs in the Lower Carboniferous of Europe and the Upper Carboniferous and Permian of Asia.

(5) The septa are arranged as in Group 1, but do not form a complete wall round the fossula because they are slightly amplexoid; e.g., the Devonian and Carboniferous *Triplophyllum* of America (Grove, 1935, p. 339) and the *Zaphrentis enniskilleni* group of Europe and America (Lewis, 1935, p. 125).

The new Permian genus described below has the morphology of Group 1; it differs from *Cypellophyllum* and *Zaphrentis delaneoui* (which are possible synonymous), in having more septa, a characteristic dilatation of the tissue, and a narrower fossula expanded at the axis, and from *Hapsiphyllum* in the shortness of the minor septa.

Genus *Euryphyllum* nov.[2]

Genotype: *Euryphyllum reidi* sp. nov., here described, from the Permian of Queensland.

Diagnosis.—Simple, turbinate to ceratoid Rugose Corals, erect except at the tip, which is turned aside; with well-marked interseptal ridges, and typically an oblique calical floor. The major septa, which are never carinate or serrate, extend to the axis and are pinnately grouped about a long closed cardinal fossula, bisected by a long cardinal septum on the concave side of the corallum; alar fossulæ are present. The septa are dilated, and first are laterally contiguous throughout, but during ontogeny dilatation decreases in a widening zone midway between the periphery and the axis, leaving a wide peripheral stereozone, and an

[1] It is possible that *Heptaphyllum* Clark (Geol. Mag., 1924, p. 416) and *Caenophyllum* Clark (Geol. Mag., 1926, p. 86) have been misinterpreted, and that they are members of this group.

[2] Owing to delay in the publication of this paper, the genus *Euryphyllum* dates from the diagnosis given on p. 150 in Hill, D., 1937 (April), "Type Specimens of Palaeozoic Corals from New South Wales in W. B. Clarke's First Collection, and in the Strzelecki Collection," *Geol. Mag. Lond.*, LXXIV., 145-153, 9 text-figs., while other species of the genus are described in Hill, D., 1937 (June), "The Permian Corals of Western Australia," *J. Roy. Soc. West. Aust.*, XXIII., 43-63, 11 text-figs, 1 pl.

axial structure formed by the conjoined dilated axial ends of the septa. Very short minor septa appear late, and remain buried in the stereozone. Tabulæ are distant, usually dilated, complete or incomplete, and there are no dissepiments.

Distribution.—Species other than the genotype are distributed as follows:—

"*Strombodes?*" *australis* McCoy (1847, p. 227, pl. xi., fig. 9, Sedgwick Museum No. A8002, from the calcareous [Permian] Upper Marine shale of Wagamee, Illawarra District, New South Wales); doubtfully included in the genus.

"*Zaphrentis* sp. c.f. *Gregoryana*" (Trechmann, 1917, p. 61, pl. iv., fig. 7, from the Permo-Carboniferous Maitai Limestone of New Zealand).

"*Stereolasma*" *minus* Sochkine (1925, pl. i., figs. 6, 6a) in the Artinskian (Lower Permian) of the Western Urals.

Some of the *Zaphrentis* spp. described by Koker, 1924, pp. 6-11, from the Permian of Timor, probably belong here.

Euryphyllum sp. nov. from the Permian of Fossil Cliff, Irwin River, Victoria District, Western Australia.

Euryphyllum sp. nov. from the Permian Callytharra Limestone of Creek half a mile west of Callytharra Springs, Wooramel River, W.A.

My statement that *Euryphyllum* is a Permian genus rests on its occurrence in the Artinskian of the Western Urals, and with a coral fauna in Western Australia whose age I am showing elsewhere[1] to be Permian.

Euryphyllum reidi sp. nov.

Holotype.—Specimen F3243 in the University of Queensland Collection from the [Permian] Upper Dilly Stage of Cabbage Creek, Springsure District.

Horizons and Localities of Other Specimens, from various Permian Localities in Queensland are: L238, U. of Q. collection, Dilly A Horizon, Consuelo Creek, 2½ miles above the junction with Cattle Creek, Springsure District. F3245, U. of Q. coll., *Productus* bed 1½ miles N.W. of Consuelo Homestead, Springsure District. L236, Somerton (Springsure District). 14, J. H. Reid collection, Peawaddy Creek, Springsure District. 22-26, J.H.R. coll., Little Gorge Creek, Springsure District. 31-32, J.H.R. coll., Fifteen-mile Swamp. 33-35, J.H.R. coll., Jabores Dam. 11-13 J.H.R. coll., Mt. Bora, 30 miles S.S.W. of St. Lawrence. L229, U. of Q. coll., Castle Creek, Theodore.

Diagnosis.—*Euryphyllum* with oblique calice; the peripheral stereozone is irregular and very wide, and septal dilatation does not decrease till very late.

Description.—The corallum is simple, trochoid, almost erect save for a short apical part which is turned aside, and regularly expanding. The smallest corallum attained a diameter of 10mm. in a height of 20 mm. The largest corallum, incomplete, had a calical diameter of 30 mm. In none of the specimens is the steeply sloping calical platform preserved unbroken, but the calice was probably nearly half as deep as the corallum was tall. The floor of the calice is very oblique; it shows a deep cardinal fossula on the shorter side of the corallum, and a shallow trough between the platform and the wide axial boss formed by the

[1] Journ. Roy. Soc. W.A., 1937.

conjoined axial ends of the septa. The epitheca shows well-marked longitudinal ridges and grooves, the number of grooves indicating that minor septa were potential from the beginning. Growth annulation and growth swellings are pronounced.

Usually only major septa can be seen in transverse section, and they vary in number between 34 and 48, the average being 40. The septa are dilated throughout, with plane sides, and, as far as can be ascertained, a smooth upper edge. They may be laterally contiguous throughout, but typically dilatation decreases slightly towards the top of the corallum, in a gradually widening zone midway between the axis and the periphery, leaving a very wide if somewhat irregular peripheral stereozone, and an axial structure which consists of the conjoined and dilated axial ends of the septa. The axial ends of the septa are arranged about the cardinal and alar fossulæ, and the axis of the corallum is excentric on the counter side. All three fossulæ are typically widest at their axial ends. The cardinal septum usually extends to the axis, bisecting the cardinal fossula. Usually the tissue of the dilated septa shows growth lamination very plainly. The lamination is to be seen at right angles to the direction of the fibres, when, rarely, the latter can be distinguished. In some specimens the tissue has split along the divisional planes between the growth laminae. The median dark line of the septum is usually very distinct. In transverse section the growth laminae of two neighbouring septa are continuous in the stereozone, where they form an arch, and are parallel to the median dark line in the middle parts of the septum.

The tabulae are rarely seen, owing to the excessive dilatation of the septa. They are complete or incomplete, and dilated, and are steeply inclined downwards from the excentric axis to the periphery.

Remarks.—The specimens from Castle Creek, Theodore, and from Jabores Dam are larger than the others, having an average height of 40 mm., with a shorter calical diameter of 20 mm., and a longer calical diameter of 25 mm. One specimen, J.H.R. 23, from Little Gorge Creek, Springsure District, shows a much greater decrease in dilatation than the others, and in transverse section it has a regular peripheral stereozone, septa very thin in their middle course, and an axial structure, as in *Euryphyllum* sp. nov. from the Irwin River of Western Australia.

Acknowledgments.

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EXPLANATION TO PLATE 1.

Euryphyllum reidi gen. et sp. nov. from the Permian of Queensland.
All figures except figs. 1 and 12, x 2 diameters.

Fig. 1. Paratype, Upper Dilly Stage, Cabbage Ck., Springsure District. Natural size. F3244. University of Queensland collection.

Fig. 2. Holotype F3243. U. of Q. collection. Transverse section.

Fig. 3. The same. Vertical section along the line AB in fig. 2.

Fig. 4. J.H.R. collection No. 22. Transverse section. Shows growth lamination (g.l.) in the septa, and the median dark line. Little Gorge Creek, Springsure District.

Fig. 5. The same. Vertical section.

Fig. 6. J.H.R. 23. Transverse section. Shows, with fig. 7, an unusual degree of decrease in the dilatation (see p. 27). Little Gorge Creek, Springsure District.

Fig. 7. The same. Vertical section along line AB in fig. 6.

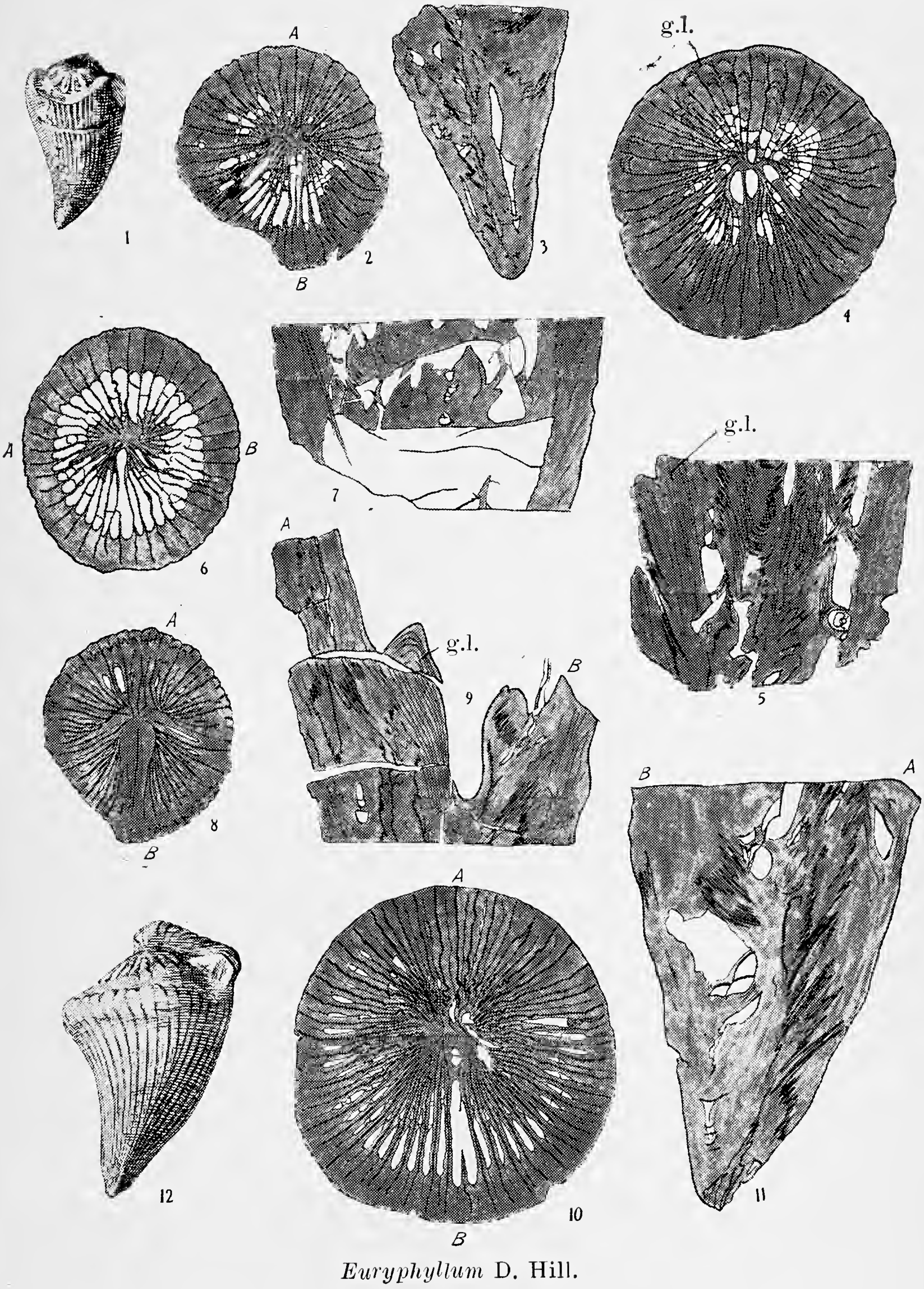
Fig. 8. F3245, U. of Q. collection. Transverse section. The fossula is completely filled by the dilatation of the septa. Productus Bed (Lower Bowen), 1½ miles N.W. of Consuelo Homestead, Springsure District.

Fig. 9. The same. Vertical section along line AB in fig. 8.

Fig. 10. F3246, U. of Q. Transverse section. Castle Ck., Theodore.

Fig. 11. The same. Vertical section along the line AB in fig. 10.

Fig. 12. F3247, U. of Q. Natural size. Castle Ck., Theodore



Euryphyllum D. Hill.

An Investigation of a Taint in Rib Bones of Bacon. The Determination of Halophilic Vibrios (N.Spp.).

By Frank Berry Smith, D.Sc., F.I.C.

(Plate II.)

CONTENTS.

ABSTRACT.

The bacterial cause of a taint in ribs of bacon is identified as an obligate halophile to which the designation *Vibrio costicolus* (n.sp.) is accorded. A description of the saline relations of this organism as well as of a second obligate halophile, *Vibrio halonitrificans* (n.sp.), isolated from curing brines, is given; and methods of control of taint based both on the saline relation of the causal organism and on regulation of an oxygenated metabolism in the rib by means of nitrate. It is believed that the implied dependence of production of malodour by a bacterium on the oxidation-reduction potential of the medium has not hitherto been drawn attention to. Study of these halophiles focuses attention on the function of salinity of curing media in regulating adaptation of potential halophiles from non-saline environments and infection by them.

1. THE STATUS OF THE HALOPHILE.

Involvement of an halophilic vibrio as causal agent in taint of ribs of certain Australian bacon adds an instance of technical damage by a salt preferent organism to those already exemplified in the reddening of salted fish (Harrison and Kennedy, 1922; Petter, 1931; Cloake, 1923),[1] the "red-heat" of salt-cured hides (Lochhead, 1934; Lloyd, Marriott, and Robertson, 1929),[2] and a fermentation of pickled olives (Estey, 1930).[3] The taint, distinguished from deep-seated taint of cured meats by occurrence in a surface albeit special structure, affords an apparently rare example of spoilage initiated through pickle;[4] and thereby an extreme illustration of the observation of Horowitz-Wlassowa (1931) that the flora of the curing medium may be in part detrimental. The art of curing in its micro-organic relation is, indeed, the maintenance of an environment to discourage the harmful and favour the beneficial factors.

The derivation of the micro-flora of the concentrated saline solutions employed in curing practice, whether autochthonous or adaptations of bacterial forms common in non-saline habitats, is comprehended in the broader issue of the nature and origin of halophiles. According to Hottinger (1911) some bacteria become accustomed to salt and may grow well in heavy brine. Le Fevre and Round (1919) questioned whether obligate halophiles may not be "common saprophytes which by growth in salt solution have developed mutants which demand salt for their growth." van Niel (1931), dealing with the definiteness of species adapted to high salt concentration, quoted the work of Baars in genus *Vibrio*, and the latter's opinion that differing environments are without significance in diagnosis of species. He cited also the investigations of Haag, of Oesterle, and of Stahl on the variability of *Bacillus mycoides* which showed that under highly saline conditions a common soil bacterium can develop forms resembling in several respects bacteria isolated from natural brines. van Niel then concluded that "it would not be surprising if further studies on 'halophilic' organisms show that they are nothing but growth forms of ordinary soil bacteria." Kluyver and Baars (1931), on demonstrating the interconvertibility of non-halophilic *Vibrio* (*Microspirum*) *desulphuricans* (Beijerinck) and halophilic *Vibrio* (*Microspirum*) *aestuarii* (van Delden) by gradual alteration of the salinity of the medium, suggested derivation from a common parent pluripotent organism and specific identity of the non-halophilic and halophilic forms.

Kluyver and Baars (1931) have propounded the doctrine of "physiological artefacts" by which it is held that halophilism is developed by the conditions of artificial culture in saline media from a prepotency latent

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[1] *Serratia* (*Pseudomonas*) *salinaria* (Harrison and Kennedy).
Bacterium halobium (Petter), probably *Serratia* in the American classification.
Sarcina morrhuæ, Klebahn (Petter).
Rhodococcus (Cloake).

[2] *Serratia cutirubra* (Lochhead).
Sarcina sp. (Lloyd, Marriott and Robertson).

[3] *Saccharomyces* sp. (Estey).

[4] Dr. W. S. Sturges (private communication) writes:
"We have rarely encountered (in curing brines) anything we could consider a spoilage organism."

in the habitant of the saltless environment. The anticipations of van Niel and others that the halophile is evolved by adaptation from the common non-saline form thus find embodiment. Kluyver and Baars, indeed, have adduced evidence that the halophilic habit tends to be fixed by continued saline culture. Hof (1935) has latterly shown that adaptation may be immediate, obligate, and irreversible for certain strains transferred from natural non-saline environments to highly saline culture media. She has demonstrated, further, that power of adaptation to saline growth is confined to bacteria in natural habitats and is lost by these on artificial non-saline culture; that capacity for adaptation is apparently graduated for strains of the one organism to various concentrations of salt; and is lacking in certain type bacteria.

In regard to the specific distinction of halophilic from non-halophilic forms Hof expresses the view that "bacterial variations (in salt preference) should be considered as functional phenomena comparable with those occurring in the individual existence of the higher organisms." She cites in support of this opinion the dictum of van Loghem that the clone rather than the bacterial individuum should be considered the entity.

Prior, however, to the modern denial to the halophile of a specific entity entailed by the halophilic property Sturges and Heideman (1923-4), from the number, diversity, and special characters of isolations of halophilic bacteria from curing brines, had advocated formulation in systems of classification of new genera and species and of tribe *Halophileæ* to include them. Nor is it apparent, halophilic character apart, that separate specific identity should be withheld from the obligate halophiles here described. They possess no counterpart in the sum of biological characters presented in established classification by described soil and water forms of genus *Vibrio* with which they may be judged kin (Table 1).

There is proposed, therefore, for the etiological factor in taint of rib bones of bacon, from which isolation was primarily effected, the designation *Vibrio costicolus*. The second vibrio, isolated in course, is apparently closely kin to species isolated by Sturges and Heideman (1923-4) from curing brines, differing in property of slowly liquefying gelatin. Its prominent property of active nitrite formation from nitrate and its obligatory halophile character suggest for it the specific naming *halonitrificans*.

2. DESCRIPTIVE.

Detailed examination of isolations from the following sources served to determine the specific characters of *Vibrio costicolus*, namely:—

From ribs of bacon cured at factory O.	Isolations O 11, O 13, O 34, O 35.
From tank brines, factory O.	Isolations OB 1, OB 3, OB 5.
From ribs of bacon cured at factory P.	Isolations P 1, P 3, P 4, P 6.
From ribs of bacon cured at factory W.	Isolation W.

Strain Variation.—Evidence of strain variation was observed in isolations of *Vibrio costicolus* in the following particulars, namely: pellicle in broth absent to pronounced; an appreciably higher saline optimum for growth of isolations P. Of twelve isolations five—namely O 11, O 34, OB 3, P 6, and W. possessed the property of liquefying gelatin. These afford basis for differentiating *Vibrio costicolus* var. *liquefaciens*.

TABLE I.

Comparison of Characters of *V. costicolus* and *V. halonitrificans* with those of Established Species (Bergey *et al.* 1934).

	Gel liq.	Milk coag.	Indol.	Nitrate red.	Dextrose.	
					Acid.	Gas.
V. aquatilis	+	—	—	—	?	?
percolens	—	—	—	—	—	—
neocistes	+	?	?	—	+	—
cyclocistes	—	?	?	—	+	—
cuneata	+	?	?	—	—	—
berolinensis	+	—	+	+	?	?
schuylkilliensis	+	+	+	+	?	?
danubicus	+	+	+	+	?	?
COSTICOLUS	∓[5]	—	—	+	+	—
HALONITRIFICANS[6] ..	+	—	—	+	—	—

? = not recorded by Bergey *et al.*

A. Morphological and Physiological Characters of *Vibrio costicolus* and *Vibrio costicolus* Var. *liquefaciens*. Halophilic.

(All media saline.)

Curved rods, usually 2·0 to 4·0 by ·5 micron. Occurs singly. Actively motile with single polar flagellum. Spores not formed. Young cultures show pronounced beaded staining; older coccoid and lenticular forms. Variation in form in media of various salinity not marked. Gram negative. On agar slant growth abundant, filiform, transparent or translucent. Colonies glistening, convex, circular with entire edge, non-viscid, maximum diameter 2 mm. In broth pellicle formation varied from virtually absent to pronounced, whitish, non-coherent. Growth on potato moist, sparse, brownish layer.

Gelatin not liquefied by some strains; some liquefied within two days at 32° C. (var. *liquefaciens*). Milk not coagulated, growth minute or absent.

Indol not produced. Nitrate reduced to nitrite. Hydrogen sulphide formed. Acetyl-methyl-carbinol not produced. Catalase formed.

[5] Variable with strain.

[6] Description of Vibrio spp. (Sturges and Heideman, loc. cit.). "Obligate or preferential halophiles, gram negative, comma or spiral forms, motile, non-spore forming. Gelatin not liquefied. Nitrate is reduced. Dextrose, lactose, and sucrose fermented only slightly or not at all. Milk not coagulated."

Dextrose, laevulose, sucrose, mannose, mannite, and glycerin fermented with production of acid; but not gas. No action on galactose, lactose, maltose, rhamnose, raffinose, arabinose, xylose, sorbite, dextrin, starch, and salicin.

Non-lipolytic.

Aerobe, facultative anaerobe. Optimum temperature for growth 30 to 35° C.; limiting temperatures 2 and 42° C. Thermal death of 24-hour culture in 10 per cent. saline broth in 10 minutes at 55° C. Limiting reactions for growth pH 5·2 and pH 9·8. Saline limits for growth 2 and 23 per cent. NaCl; [7]optimum 6 to 12 per cent.

The vibrio makes good growth on peptone media. No growth was observed in dilute gelatin and casein broths, in diluted sterile blood serum, or with ammonium salts, asparagin, or urea as sources of nitrogen with or without added dextrose. Growth in pork infusion without peptone was sparse.

The characters of *Vibrio halonitrificans* were studied in five isolations, two from tank brines of factory O., and three from tank brines of factory Z. These showed little evidence of strain variation.

B. Morphological and Physiological Characters of *Vibrio halonitrificans* (N.Sp.) Halophilic.

(All media saline.)

Curved rods, usually 1·2 to 2·5 by ·3 micron. Occur singly. Motile with single polar flagellum. Spores not formed. Stains somewhat faintly with usual stains. No marked variation of form in media of various salinity. Gram negative.

Colonies on peptone-agar light amber, glistening, convex, transparent, non-viscid, slightly spreading. Growth on potato moist, fairly abundant, whitish.

Gelatin liquefied within seven days at 35° C.; at 20° C. shallow superficial liquefaction was evident in twenty days. Milk not coagulated, growth absent or slight.

Indol not produced. Nitrate reduced to nitrite. Hydrogen sulphide not formed. Acetyl-methyl-carbinol not formed. Catalase negative.

Dextrose, laevulose, galactose, lactose, maltose, sucrose, mannose, rhamnose, raffinose, sorbite, and glycerin not fermented.

Non-lipolytic.

Aerobe, obligate. There was no growth of the organism either in plain or nitrate broth under the micro-aerobic condition imposed by a paraffin oil seal.[8] Optimum temperature for growth 30 to 35° C. There was slow growth at 4° C., inoculated agar slants showing visible colonies within fourteen days. Thermal death of 24-hour culture (6 per cent. saline broth) in ten minutes at 55° C. Saline limits for growth 1 and 23 per cent.; optimum growth at 4 to 6 per cent. NaCl. Limiting reactions for growth pH 5·4 and pH 9·2.

No physiological reaction was observed in guinea pigs or in mice into which these organisms were injected in normal saline.

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[7] Saline concentrations are expressed in grammes per 100 ml.
[8] Hall (1921).

3. EXPERIMENTAL.

A. Methods.

The following methods and tests were employed in cultural work with *Vibrio costicolus* and *Vibrio halonitrificans*.

Flagella were well demonstrated by the staining methods of Safford and Fleischer[9] and of Bailey[10]. Culture media were generally 2·5 per cent. peptone (Witte) broth or peptone-agar, made appropriately saline. Anærobic cultures were over alkaline pyrogallol in exhausted jars, or beneath vaseline-paraffin seals.

Indol was tested for by the Ehrlich reagent. Nitrite by sulphanilic acid-a-naphthylamine. Hydrogen sulphide by lead acetate paper held by the cottonwool plug. Acetyl-methyl-carbinol by the usual Vosge-Proskeaur reaction. Catalase by evolution of oxygen on flooding agar slants with dilute hydrogen peroxide.

The fermentation reactions were determined at 2, 4, and 7 days in peptone broth (pH 7·4) at optimum salinity to which 1 per cent. of the substrate was added; acid by marked acid change of brom-thymol blue; gas by means of Durham tubes. Lipolysis, employing lard and cottonseed oil, by the Nile blue sulphate test according to Collins and Hammer[11].

Reactions of media were determined colorimetrically, introducing Parsons and Douglas' corrections for salinity[12]. Saline and temperature optima were determined by close turbity comparisons of cultures in peptone broth. In examination of the nutritional requirements of *Vibrio costicolus* methods and media prescribed by Frazier and Rupp were employed[13].

B. The Saline Relations of *Vibrio costicolus* and of *Vibrio halonitrificans*.

The vibrios are obligate halophiles making no growth in media of usual salinity (·5 per cent. NaCl). Minimum growth of *Vibrio costicolus* was shown at 2 per cent. NaCl; the range of of vigorous growth being from approximately 4 to 15 per cent. above which growth markedly declined. Minimum growth was maintained at 23 per cent. NaCl, established by initial and subsequent plate counts. At 24 to 25 per cent. salt there was a definite death rate. Held in sterile tap water the organism was found non-viable within one hour. It retained viability, however, for some days in water of as low salinity as 1 per cent. NaCl. Air-dried on salt from an active culture *Vibrio costicolus* was found non-viable within four days on retransfer to saline peptone broth. The detail of certain of these experiments is given in Table 2.

As shown in Table 3 vigour of growth of *Vibrio costicolus* is unaffected by concentrations of potassium nitrate as high as 1 per cent.; and is not markedly affected by nitrite below ·08 per cent. Nitrate is reduced to nitrite; but 100 per cent. recovery of nitrite was made from a seven-days culture of the organism in ·02 per cent. nitrite broth. The concentration of nitrite produced by growth of the vibrio in nitrate broth is shown in Table 4.

The saline optimum for *Vibrio halonitrificans* was determined as 4 to 6 per cent.; the upper limit for vigorous growth 10 per cent.; and the saline death point as at 24 to 25 per cent. NaCl. There was survival of the organism for many days in dilute saline, and for some days in water. Nitrite formation from nitrate was abundant, but nitrite was not further reduced.

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[9] Stain Tech 6, 41 (1931).
[10] Science 72, 1856, 195 (1930).
[11] Journ. Bact. 27, 487 (1934).
[12] Journ. Bact. 12, 263 (1926).
[13] Journ. Bact. 16, 57 *et seq.* (1928).

TABLE 2.

The Saline Survival of *Vibrio costicolus*.

40-hour culture transferred to dilution approx. 10- to 20,000 per ml.

	Viability.*			At Hours.			At Days.		
	¼	½	1	24	120	240	30	40	60
In water	— + +	— + —	— — —						
1 p.c. NaCl ..				+	+	+			
5 p.c. NaCl ..				+	+	+			
25 p.c. NaCl 75°C.				+	—	—			
25 p.c. NaCl—peptone 5°C.							+	+	—
27·5 p.c. NaCl—peptone 5°C.							+	—	—

* + indicates viable, — non-viable.

TABLE 3.

Tolerance of *Vibrio costicolus* for KNO_3 and $NaNO_2$ in Saline Peptone Broth.[14]

KNO_3, per cent. ..	0	·2	·4	1·0			
Growth	100	110	90	100	..	..	..
$NANO_2$, per cent.	0	·01	·02	·04	·08	·12	·20
Growth	100	100	110	100	80	70	40

TABLE 4.

Concentration of Nitrite produced by growth of *Vibrio costicolus* in 10 per cent. NaCl-Nitrate Broth (32-35 deg. C.).

Present KNO_3 per cent.	·08	·20	·40	1·0
Formed KNO_3 per cent.—				
48 hours	·04	·08	·15	·20
96 hours	·06	·10	·16	·22

C. Conditions affecting Production of Malodour by *Vibrio costicolus* in Growth in Culture Media.

A slight sourness only was developed by the vibrio in saline egg-pork medium (Rettger), and no odour in other saline cooked meat media, saline blood serum, saline pork broth containing no peptone, saline pork gelatin broth, or in a saline cooked bone medium consisting of one part ground cancellar tissue of rib and two parts water, either autoclaved or fractionally sterilised in flowing steam. Growth in all these media was, however, sparse or absent.

When placed under anaerobic conditions in saline peptone-agar or in saline peptone or nutrient broth, cultures of all strains of the organism developed a distinctly foetid odour, evident in culture jars and absorbed on cottonwool plugs. In aerobic culture production of malodour was

[14] Growth in twenty-four hours at 32-35 deg. C. expressed comparatively with growth in 10 per cent. NaCl peptone broth (100).

variable. With pellicle forming strains P1 and O34 in growth at 32-35 deg. C. in 8 to 12 per cent. saline peptone broth held in 100 ml. bulk in globular boiling flasks so as to expose a free surface of 50 sq. cm., the incubator was strongly permeated within forty hours, and the odour of the medium remained distinctly foetid till the fourth or fifth day; thereafter it became mawkish rather than foetid. The quality of odour produced under the same conditions by the non-pellicle forming strain O35 was at any time no more than mawkish. Relatively well aerated in shallow layers, e.g., in 100 ml. bulk with free surface of 150 sq cm, the culture of any strain became no more than mawkish in odour.[15] It was considered significant that the gradations of odour noted in these and subsequent experiments with culture media paralleled the odours observed about the ribs of affected bacon.

The inter-related effects of temperature, salinity, and aeration on production of malodour by *Vibrio costicolus* in a peptone medium are included later in the data of Table 5.

The Effect of Nitrate.—It was early observed that presence of nitrate in culture media markedly restrained production of malodour by the vibrio. Parallel effect of nitrate in the rib was demonstrated by the following technique. Rib bones excised from chilled pork sides and freed under as aseptic conditions as possible of adherent meat were either (*a*) subjected to antiseptic treatment for some days by steeping in 60 per cent. alcohol and then pickled in changes of 10 per cent. saline; or (*b*) pickled in saturated brine and the salinity finally adjusted by immersion in 10 per cent. brine. Transferred from pickle to sterile wide-mouthed bottles the bones were then incubated some days at 32-35 deg. C., and any evidencing even slight malodour rejected. Covered with sterile 10 per cent. NaCl or sterile 10 per cent NaCl containing ·5 to 1·0 per cent potassium nitrate, and infected therein by means of an active culture of the vibrio (strain O34), the bones were ultimately retransferred to sterile bottles and held singly in two series at 30-35 deg. C. for development of odour. At end of four to six days the bones of the nitrate series compared with uninfected controls were virtually odourless; the series pickled and infected in brine without nitrate were mawkish or foetid. Examination of all infected bones by smear or culture showed abundant presence of the vibrio as sole or predominant organism.

To elucidate further the relation of foetidness to the factors of temperature, aeration, and salinity, and particularly to indicate the concentration of nitrate in the medium sufficient to avoid production of malodour, the following series of experiments was carried out. Freshly autoclaved peptone medium was held, generally at 30 to 35 deg. C., in approximately 50 ml. bulk in containers chosen to afford varying free surface, and at varying salinity and nitrate content. Inoculated with active culture the media were frequently examined over a period of ten days following initially vigorous growth for quality of odour and condition of oxygenation as indicated by permanence or decolorisation of added methylene blue. Typical results are summarised in Table 5.

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[15] In these and in all other experiments involving noting of odour the author's observations were checked by two or more independent observers.

TABLE 5.

Correlation of Factors affecting Production by *Vibrio costicolus* of Malodour in Culture Media.*

Strain.	Temp. °C.	Ratio Surf/Vol.	NaCl p.c.	KNO_3 p.c.	Odour.	Meth. Blue.
Pellicle 0 34	17–25	· : 1	10	0	f	—
				·08	s.m.	—
				·16	s	±
				·20	0	+
Pellicle 0 34	30–35	·33 : 1	10	·08	f	—
				·16	f	—
				·20	m/f.	—
				·24	s.m.	—
				·30	0	+
			15	·16	m.	—
				·20	0	+
				·24	0	+
			20	·16	0	+
				·20	0	+
Pellicle 0 34	30–35	·66 : 1	10	·08	f.	—
				·16	f.	—
				·20	s.m.	—
				·24	0	+
Pellicle 0 34	30–35	·33 : 1 Par. †	10	0	f.	—
				·08	f.	—
				·16	m.	—
				·24	0	+
			20	·08	s.	±
				·16	0	+
Non-pellicle 0 35	30–35	·33 : 1	10	0	f.	—
				·08	f/m.	—
				·16	s.m.	—
				·20	0	+
Non-pellicle 0 35	30–35	·66 : 1	10	·08	m.	—
				·16	s.	+
				·20	0	+

NOTES—
* Ratio surface/volume sq. cms./c. cms.
† Par = covered with layer of paraffin oil (2 cms.) to further reduce seration.
Odour. 0 = no odour. *s.* = sweetish. s.m. = slightly mawkish.
m. = mawkish. f. = foetid.
Methylene Blue. — = decolorised. + = not decolorised.

D. The Identification of *Vibrio costicolus* as Causal Organism of Taint of Rib Bones.

Pronounced taint was observed in the product of a southern factory P.—where it was reported to have been of summer seasonal recurrence—shipped green to a northern Australian port and there finished for market. Much of the bacon was merchantable only after removal of the rib plates. The concavity left by lifting the ribs was malodorous and the meat superficially tainted; but the taint speedily disappeared on exposure and was not afterwards manifested. Rib bones broken across emitted a mawkish or distinctly foetid odour.

A milder manifestation of taint was subsequently revealed in bacon cured in a northern establishment O., where it had been recurrent at summer seasons. The causal organism in both occurrences was found to be specifically identical.

Rib bones from a number of affected flitches, some strongly tainted and some less so, were freed of adherent meat, flamed, and broken across. Smear preparations from the substance of several showed abundant presence of a bacillus curved in form. Fragments or scrapings from the interior of the bones were inoculated on to nutrient pork-agar (·5 per cent. NaCl) and held both aerobically and anaerobically. Generally there developed a micro-coccus with fewer straight bacillary forms. Employing, however, a medium of peptone-agar with from 3 to 10 per cent. NaCl and inoculating from freshly exposed cancellar tissue there was obtained in the majority of cultures, both aerobic and anaerobic, from tardy to vigorous growth of the "curved bacillus." The organism was not recovered in culture from the meat surface of the concavities left by lifting the rib plates.

Typical and well isolated colonies cultured from ribs were repeatedly subcultured on peptone-agar (10 to 15 per cent. NaCl), and the purity of the isolated organism assured.

The bacillus was regularly isolated at all seasons from the ribs of many flitches, both tainted and apparently normal, product of affected factories. In 126 cultures of rib bones taken indiscriminately from bacon cured at factory O. the presence of the vibrio was ascertained in 102 instances. In course of the enquiry some twenty examinations at all seasons, involving approximately 120 cultures, were made by the procedure described for presence of the vibrio in ribs of bacon cured in seven establishments at which occurrence of "rib taint" had not been reported. It was not discovered. It was, however, identified in a single examination of ribs forwarded from a western factory W. but occurrence of taint there was not admitted.

Typical taint was reproduced in ribs of flitches by agency of the vibrio in the following manner, utilising the principle of low nitrate content of curing medium which appeared to be established by experiments on production of malodour by the organism in artificial culture. At factory Z., at which it had been established by numerous examinations of the product that infection by the organism did not normally occur, three lots of three each flitches were cured in brines containing respectively ·4, ·8, and 1·6 per cent. of potassium nitrate after infection of the brines with ·1 per cent. of an active culture of the organism (Isol. P1). At end of the usual curing procedure and period the flitches were soaked, dried, and smoked in the customary manner, and stored at summer temperature for fourteen days. The flitches cured in ·4 per cent. nitrate brine were then found to show strongly all the characters of the original affected meats. Many of the ribs were foetid or mawkish, and the concavities beneath the ribs were more or less tainted. The flitches from cure in ·8 per cent. nitrate brine were but slightly affected, but mawkishness was noticed in some ribs. The flitches cured in 1·6 per cent. nitrate brine were not tainted, but, in contrast to the normal product of the establishment they reproduced a typical sweetish odour about the rib region that had been a feature of slightly affected meat of the shipment from factory P. Three lots of flitches cured as controls in the same range of brines uninfected with the bacillus were normal in odour. Twenty other flitches cured at factory Z. in infected brines containing from 1·0 to 1·5 per cent. nitrate showed no pronounced taint, but there was apparent a slight mawkishness in a few ribs of the lower nitrate cures. In examination of sixty ribs, tainted and untainted, of this experimentally infected bacon the vibrio was identified in 80 per cent. of the cultures. Coccus and straight rod forms only were observed in smears prepared from cancellar tissue of ribs of the control flitches, or were recovered in culture on saline peptone-agar.

E. Isolation of *Vibrio costicolus* and of *Vibrio nitrificans* from Curing Brines.

Direct plating of tank brines on peptone-agar of a range of salinity failed to reveal presence of either vibrio. By enrichment culture of loop inoculations in 10 per cent. saline peptone broth, however, and plating therefrom on 10 per cent. saline peptone-agar good growth of *Vibrio halonitrificans* was obtained. By enrichment in and subculture on media containing 20 per cent. NaCl the predominant organism secured from four out of six tank brines of factory O. cultured was *Vibrio costicolus.* When media containing 15 per cent. NaCl were employed a mixed culture of the vibrios was sometimes obtained. Presence of *Vibrio costicolus* was detected in the mixed growth secured by direct plating of stack brines of factory O. on 20 per cent. saline peptone-agar.

The identity of the vibrio isolated from brines was fully established after repeated subculture of typical well isolated colonies of the original plate growth.

F. The Rib as Medium for Growth.

Apparent dependence of manifestation of taint on saline and nitrate concentration, deduced from work in culture media, warranted analytical survey in respect thereto of ribs of bacon in course of cure.

Analytical Methods.—The moisture content of cancellar tissue was determined usually by drying at water oven temperature; sodium chloride by titration of the aqueous extract or of brine with N/20 silver nitrate with potassium chromate as indicator.

Nitrate in brines by measure of nitric oxide from ferrous chloride reduction (Schloesing-Wagner), following detail prescribed by the Institute of American Meat Packers (1930)[16]. Nitrate and nitrite conjointly, and reported as nitrate, by prior drying in vacuo over sulphuric acid, repeated extraction at below 80 deg. C.[17], and determination in the extract by reduction with Devarda alloy in presence of magnesia, with colorimetric reading by a Klett comparator of the Nessler registration of the ammonia obtained in standardised distillation, correcting for the NH_3 blank obtained with fresh cancellar tissue. The amount of rib substance taken for each determination was usually ·5 to 1·0 gramme.

The substantial accuracy of the method for nitrate in rib substance was assured by the following test determinations of definite amounts of KNO_3 and $NaNO_2$.

TABLE 6.

Taken in Aqueous Extract of Rib.	Recovered.	Per Cent. Recovery.
KNO_3 ·004 grm.	·0038 grm	95
·008	·0082	102
·016	·0164	103
$NaNO_2$ ·001[18]	·0009	90

[16] Method of Determining Nitrate in Lean Meat.

[17] Instit. Amer. Meat Pckrs. publ. (1930). Recommended Procedure for Determining Nitrite in Meat.

[18] From 1 ml. 1 per cent. solution absorbed in 1 gramme cancellar tissue, dried and extracted as detailed.

The salient features of saline distribution in the "regular" cure[19], summarised in the following protocols, are the considerable variation in sections of a single rib and from rib to rib in bacon issuing from tank brines; greater uniformity on issue from stacks apparently from equilibrium reached with the salinity of stack brines; and further marked irregularity of distribution in the ribs of finished bacon. The small variation shown throughout in range of moisture in the bone shows that as a factor in concentration changes dehydration need be taken little into account. The figures for NaCl and KNO_3 in ribs in Tables 7, 7A, 8, 9 and 10 express percentage concentrations in the moisture of the tissue.

TABLE 7.

Concentration of NaCl and KNO_3 in Brines, and Distribution in Ribs, Regular Cure Factories O. and Z.

	Moisture.			NaCl.		KNO_3.	
	Max.	Min.	Av.	Max.	Min.	Max.	Min.
Ribs of bacon from Tanks	51·2	22·0 *(68)	39·7	26·0 (68)	7·3	1·00 (14)	·41
Stack Brines		..		21·0 (8)	17·3	·68 (12)	·43
Ribs of Bacon from Stacks	46·8	28·5 (55)	37·0	23·3 (21)	17·0	·72 (14)	·38
Finished Bacon	52·6	22·6 (94)	35·8	26·8 (103)	9·0	·50 (28)	·12

* Figures in brackets indicate number of determinations.

The frequency distribution of the determined salt and nitrate concentrations in ribs of the finished bacon are shown on a percentage basis in Table 7A.

TABLE 7A.

Frequency Dstribution of Determinations of NaCl and KNO_3 in Ribs of Finished Bacon.

NaCl, per cent. range	9–12	12–14	14–16	16–18	18–20	20–22	22–25	25–
Number, per cent...	5	10	17	17	22	11	9	9

KNO_3, per cent. range	–·20	·20–·30	·30–·40	·40–·50
Number, per cent.	7	28	50	15

The uneveness of salt distribution is exemplified by the following typical determinations of salt in ribs of bacon from tanks and of finished bacon, the determinations being made on five sections in each taken progressively from the dorsal to the sternal end.

[19] Vide Appendix.

TABLE 8.

The Distribution of Salt in Ribs.

	Bacon from Tanks.			Finished Bacon.		
	1.	2.	3.	1.	2.	3.
NaCl, per cent.	7·8	9·5	19·0	16·7	11·6	9·5
	7·3	8·2	15·5	19·2	18·2	12·5
	12·8	8·8	15·4	23·4	16·0	12·3
	22·2	12·5	18·4	26·0	18·4	16·0
	26·0	14·3	15·9	20·5	12·7	14·3

The Salt and Nitrate Content of Tainted and Untainted Rib.—The hypothesis that taint follows free growth of the causal organism at favourable salinity and at relatively low concentration of nitrate in the rib is apparently confirmed by comparative salt and nitrate determinations in tainted and untainted rib. The cases examined were of regional taint in ribs of bacon rejected as tainted in commercial handling, and the determinations apply to neighbouring tainted and untainted sections.

TABLE 9.

Comparative Salt and Nitrate Concentrations in Tainted and Untainted Rib.

Tainted—						
NaCl per cent. . .	13·6	11·5	11·5	10·6	9·1	12·8
KNO_3 per cent. . .	·12	·13	·13	·15	·18	·16
Untainted—						
NaCl per cent. . .	16·8	14·8	17·4	15·8	15·8	15·0
KNO_3 per cent. . .	·20	·22	·24	·28	·25	·25
Tainted—						
NaCl per cent. . .	12·7	9·6	10·3	13·2	. .	. .
KNO_3 per cent. . .	. .	. .	. .	. .	. .	. .
Untainted—						
NaCl per cent. . .	15·7	17·3	16·6	. .	. .	. .
KNO_3 per cent. . .	·25	. .	·28	. .	. .	. .

The Effect of Soaking on Saline Concentration in Ribs.—The effect of prolonged soaking in reducing the concentration of salt in the rib is reflected in the following determinations (Table 10) of salt in excised single pork ribs brought uniformly throughout to a salinity of 20·5 per cent. by some days immersion in 20·5 per cent. NaCl solution, and then partially depleted of salt by soaking in water in two series for two and four hours respectively. Preliminary experiments had shown that the former period yielded a general level of salt content in the rib comparable to that of ribs *in situ* after regular six to eight hours' soaking of flitches. It was deemed legitimate to assume that four hours would parallel in effect the practice of twelve to sixteen hours' soaking of flitches, the occasional adoption of which to meet the trade demand for extra-mild bacon was suspected to have conduced to manifestation of taint.

TABLE 10.

The Salinity of Ribs from Regular and Long Soaking.*
Initial salinity 20·5 per cent. NaCl.

	Per Cent. Concentration NaCl.					
	1.	2.	3.	4.	5.	6.
Time, 2 hours (6 to 8 hours)	16·6	10·0	13·7	19·8	19·0	13·1
	18·2	14·7	18·0	19·6	19·8	14·5
	18·6	14·7	15·7	19·7	19·8	13·3
	14·7	15·5	16·5	19·0	19·6	..
	..	13·7	..	17·7	11·7	13·8
Time, 4 hours (12 to 16 hours)	7·9	7·3	14·0	15·0	14·0	9·3
	8·8	8·8	13·8	16·5	14·1	16·8
	8·0	9·7	13·8	..	11·0	12·1
	6·2	8·4	14·4	13·8	11·0	12·1
	..	7·5	14·2	6·5	13·3	13·2

* Determination on five sections of rib, progressively from dorsal to sternal end.

There is shown for the longer soaking period more marked approach of salinity to the optimum of the causal organism of taint. Increased depletion of nitrate concentration would be concomitant.

4. FURTHER DATA AND DISCUSSION.[20]

A. The Microflora of Curing Brines.

The survey of Sturges and Heideman (1923-24) shows the essentially halophilic character of the microflora of curing brines, the most prominent bacterial forms among their isolations being salt facultative micrococci, salt preferential and salt obligate vibrios, and salt preferential rods which suggest Achromobacteria. Haines (1933) and Empey and Vickery (1933) have shown the preponderance of low temperature type Achromobacteria on carcases receiving usual slaughter floor treatment and proceeding through the chilling process. The prominence in Sturges and Heideman's isolations of forms common in manure, soil, and water, or air-borne is notable; and it is to be inferred that the origin of the brine flora is in adaptation from the non-saline environment, probably largely by introduction on meat surfaces.

Establishment as constituent of the microflora of brine will depend on capacity for adaptation to the saline concentration of the latter. It is to be remarked that the salinity of brines in the American curing system is substantially below[21] that operated in the Australian "regular" cure, and the halophilic flora of the latter is likely to be more highly selected and less diverse than that illustrated by Sturges and Heideman. In the bacterial population enumerated by them genus *Vibrio* occupies a conspicuous place as comprising the bulk of the obligate halophiles isolated. In the present instance *Vibrio costicolus* and *Vibrio halonitrificans* are seemingly sparsely occurrent, and are apparently to be accounted members of a "temporary" flora.

It is deemed warrantable, indeed, both for purposes of classification and from practical considerations to distinguish "permanent" and

[20] For explanation of technical terms here included see Appendix.

[21] Receding from about 22 per cent. salt (75 deg. salinometer) (Inst. Amer. Meat Pckrs., 1924).

"temporary" brine floras, the distinction being, however, dependent on the maintained saline concentration of the brine. It is conceived that on introduction to brine of environmental organisms there will be death more or less speedy, depending on the saline strength of the brine and the intensity of the inoculation, survival short of saline adaptation, or adaptation with proliferation in the brine at suitable temperature. There may, however, apart from adaptation, be considerable capacity for survival, for Horowitz-Wlassowa instances retention of viability by certain micrococci for as long as thirty to fifty days in brine saline above the saline death point of the organisms.

In case of preferential and obligate halophiles in relation to saline strength there is displayed a gradation in adaptability. One organism studied by Le Fevre and Round (1919) failed to grow in media containing 15 per cent. salt; other three showed an upper saline limit to growth of 25 per cent. Growth of *Micrococcus lipolyticus* is terminated by 18 per cent. NaCl; and 22 per cent. is fatal to some other micrococci occurrent in curing brine (Horowitz-Wlassowa, 1931). The saline death point of the present isolations, *Vibrio costicolus* and *Vibrio halonitrificans,* is at 24 to 25 per cent. salt. *Bacillus halobicus,* a brine bacterium of Horowitz-Wlassowa, survives 25 per cent. salt; and *Serratia salinaria* and other chromogenic halophiles grow in saturated salt solution (Harrison and Kennedy, 1922; Petter, 1931; Lochhead, 1934).

Among early investigators Forster (1889), de Freytag (1890), Petri (1890), and van Ermengen (1897) noted that some pathogens possessed considerable power of survival in highly saline solutions. On the other hand, Stadler (1899) determined the limiting concentration of salt at which a number of non-halophilic bacteria grew was not above 7 to 10 per cent. and Petterson (1900) demonstrated a marked toxic action for salt, putrefying bacteria and obligate anærobes being sensitive to as low as 5 per cent.[22] The studies of Matsuschita (1900) and of Sperlich (1912) relate to salt optima, growth, and morphology, generally at low salinity, of a number of common bacteria previously isolated on artificial media; and it appears, therefore, that apart from the experiments of Hof (1935) on the capacity for adaptation of some type bacteria to various high saline concentrations there is little in literature that is applicable to the question of ultimate tolerance, survival times, or adaptability to growth in highly saline media of the common saprophytes, air, soil, or water-borne, as introduced from natural habitats. In view of the now recognised contribution of bacteria to cured flavour, and of the definition by Horowitz-Wlassowa of favouring and detrimental micro-organic factors in curing media, there appears need for more intimate study both of the derivation from the non-saline environment of the bacterial flora of curing brines and of its determination by environmental factors and by saline concentrations[23] maintained in the curing media, and of the contribution of individual species and strains to the course and quality of cure.

This much, however, may be predicated: infection of brined and salted meats by micro-organisms derived in the curing medium will depend on survival of these through the saline concentrations encountered in the operations of brining and salting and on their subsequent development.

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[22] Early investigators cited by Le Fevre and Round (1919) and by Hof (1935).

[23] A selective action of salt on the surface bacterial flora of chilled pork, and predominant survival of *Micrococcus* spp. at higher salt concentrations is already referred to by Ingram (Dept. Ind. Sci. Res.; Rept. Fd. Invest. Bd., 1934).

B. Infection of the Rib by *Vibrio costicolus* and the Development and Control of Taint.

Failure of *Vibrio costicolus* and of *Vibrio halonitrificans* to propagate on direct plating on a favourable medium in competition with other brine bacteria is indication of relatively sparse occurrence in tank brines. In view of the saline death point of the organisms (24-25 per cent. NaCl) they cannot be regarded as part of the "permanent" flora of tank brines maintained at saline concentration above 25 per cent. NaCl. Portions of tank brines at this salinity in which presence of the vibrios had been demonstrated during tanking, withdrawn at time of removal of flitches from tanks to stacks and held at cellar temperature in sterile bottles, failed to reveal the organisms on re-examination after ten to fourteen days.

It is conceived in terms of the tenet of "physiological artefacts" that the vibrios are saline adaptable forms from the non-saline environment carried into tank brines possibly on introduced meats. Infection of brines heavy enough to ensure survival through the tanking period at the salinity at which these are usually maintained, and transference on the meat surfaces still viable to stacks, would permit subsequent development at the more favourable salinity shown for stack brines in the "regular" cure, and invasion of the rib by *Vibrio costicolus.*

On the other hand it was apparent that single acquirement from the non-saline environment by tank brines might not ensure survival through the tanking period in a medium at concentration above the saline death point of the organism. The validity of this assumption was subsequently apparently established. Salinity of the brines, however, occasionally falling to and remaining for a period following introduction of meats at a saline level permitting adaptation and proliferation would create a "reserve of infection." It is to be remarked that *Vibrio costicolus* grows at usual curing cellar temperature. There was, indeed, evidence that the infecting organism in brines at factory O. had been assisted in establishment by occasional failure to maintain fully the saline strength of tank brines. It was anticipated that raising the level of salinity throughout the cure would delimit infection of the rib.

The above outlined mode and course of infection of the rib by *Vibrio costicolus* and the anticipated reduction of infection by increase of salinity are substantiated by the following experimentally established facts:—

(*a*) In four attempts, involving cultural examination of thirty-two ribs, to establish presence of the vibrio in the rib in the pre-curing period, wherein at factory O. ribs were excised from chilled pork sides, freed as aseptically as possible of adherent meat and pickled in sterile 20 per cent. saline prior to examination, only negative results were obtained.

(*b*) Although cultural experiments with material from the interior of ribs excised cleanly from flitches on removal from tanks failed to reveal presence of the vibrio, due it is thought to removal in cleaning of the light surface infection, derivation of infection from tank brines at factory O. was subsequently well demonstrated by prompt transference therefrom of flitches to factory Z. where they were dry salted as in the "regular" cure, soaked, and smoked. *Vibrio costicolus* was recovered by culture in twenty-five of thirty-six examinations of ribs of these.

(*c*) The vibrio was repeatedly recovered from ribs immediately on removal from stacks.

(*d*) By maintaining salinity of stack brines at a higher level than in the "regular" cure by the device of somewhat heavier salting, particularly at the rib concavities, incidence of infection of the rib was reduced to 36 per cent. (67 examinations) compared with 80 per cent. infection following "regular" salting (vide p. 38). The saline concentration of the stack brines in the amended salting was found in eighteen out of twenty-three samples examined to be raised to between 25 and 28 per cent.; and the saline concentration in the ribs of finished bacon proceeding therefrom did not fall below 14 per cent. (45 determinations).

(*e*) By preserving further high saline level of the curing medium by means of careful avoidance of depletion of tank brines below 25 per cent. NaCl and by prompt restoration of maximum salinity immediately on removal of flitches by stirring up "salt bottoms" there was, after a period during the winter season, failure to recover *Vibrio costicolus* from tank brines previously infected, examined by enrichment culture of ·1 ml. at time of removal of flitches to stack. Concordantly, there was ascertained the complete absence of the vibrio in culture of numerous ribs of bacon issued from cure. In replicate experiments in early summer, when infection from the non-saline environment was anticipated to likely approach maximum, there was recovery of *Vibrio costicolus* in one only of six tank brines examined. The occurrence was apparently extremely sparse, as not more than 5 per cent. of the colonies of the mixed growth obtained on plating from the initial enrichment culture were positively identified. Concomitant examination of ribs of upward of twenty flitches from as many salt fortified tanks, lightly salted in stack to afford the most favourable condition for development, failed, however, to reveal presence of the organism. It is to be inferred that by maintaining sufficient saline concentration in tank brines it may be possible, depending on the intensity of inoculation from the non-saline environment, to check transfer of the organism viable to stacks, and thereby prevent entirely infection of the rib by it. The persistence of *Vibrio halonitrificans*, recovered generally from these tank brines by appropriate culture, indicated either more intense initial infection by it or slower saline death rate.

It has been demonstrated by work with *Vibrio costicolus* in peptone culture that manifestation of malodour follows prolific growth in absence or deficiency of molecular oxygen or of nitrate. The factors determining prolificacy of growth are favourable temperature and suitable saline concentration. There is, indeed, dependence on saline concentration in the medium of the amount of nitrate required to obviate malodour, and a lesser influence of such gradation in aeration as is comprehended in the cultural experiments (Table 5). The efficacy of salinity and nitrate content of the rib in regulating taint has been amply shown by controlled experimental cures.

It is significant in relation to effect of temperature on evidence of taint that in course of the experiments rib-plates of infected bacon passed as free of taint in commercial handling not infrequently developed marked and typical malodour in certain ribs when held for some days at temperature near optimum for the causal organism.

The effect in the rib of degree of aeration on evolution of taint is less certain. It would appear, particularly from the fact that in many examinations of rib tissue the obligate aerobe *Vibrio halonitrificans* was in no case isolated, that the internal condition of the rib is one of considerably restricted oxygenation. It is believed possible, however, that a limited aëration may be a determining factor in some cases of critical nitrate content. Nor can there be ignored the possible specific stimulating effect on the facultative anaerobe of traces of atmospheric oxygen, to be inferred from the finding of Knaysi and Dutky (1934) with *Bacillus megatherium*. There is, indeed, some evidence of this stimulating action on *Vibrio costicolus* in the data of Table 5.

It is apparent that a salinity favourable to prolific growth and a concentration of nitrate insufficient to inhibit taint in the active growth of the causal organism is found in a proportion of ribs of bacon issued from the "regular" cure. A concentration of ·25 per cent. nitrate may be taken as requisite to avoid malodour in peptone culture under conditions most favourable to growth (Table 5). The apparent limiting saline conditions for taint in ribs of infected bacon in commercial summer storage are approximately 15 per cent. salt and nitrate substantially above ·20 per cent. concentration.

In measures designed to avoid taint of the rib in infected bacon it was found possible, as would be anticipated from the thermal death point of the causal organism and the surface situation of the rib, to apply successfully elevated drying temperature. In one experiment in which six flitches from an infected line were held at 125-135° Fahr. air temperature in accordance with American drying schedules[24] for three hours there was complete failure to recover the organism in twenty cultures of rib substance. Since, however, application of this method at affected factories would have entailed expensive structural alteration of drying plants, for technical control of taint of ribs reliance was placed on manipulation of saline and nitrate concentrations in cure. As additional measure it was laid down that undue depletion of the rib of salt and nitrate should be avoided by appropriate restriction of soaking periods.

Major occurrence of taint in the product of factory P., following partial study of its manifestation, was relegated to relatively insignificant proportions by appropriate increase of nitrate in the low nitrate cure derived from tank brines containing as little nitrate as ·5 per cent. *Vibrio costicolus* was subsequently still found abundantly in ribs. Consequent on heightened nitrate and saline levels in the cure at factory O., employing 5 per cent. admixture of nitrate in salt employed in salting in stacks and additionally lightly salting rib concavities, there was no reported taint during the 1935-36 summer, wherein approximately 40,000 flitches were handled to the trade. Occasional examination of the ribs of this output showed a restricted occurrence of the causal organism of taint (vide p. 45). The general level of nitrate concentration found in the rib was from ·43 to 1·00 per cent. (twenty-four determinations). It is apparent that by meticulous management of tank brines and consistent maintenance of their saline strength at maximum it may be possible to still further reduce infection or avoid altogether establishment of the causal organism of taint of ribs (vide p. 45). The complete efficacy of this measure may, however, be held to be dependent on the intensity of inoculation of the brine from the non-saline environment.

The Mode of Action of Nitrate.

Application of the potential conception of oxidation-reduction to bacterial systems, originally made by Gillespie (1920), has been much

[24] Inst. Amer. Meat Pckrs. publ. "*Readings in Packing House Practice, Pork Operating*" (1924).

extended in a voluminous literature bearing on the relation of potential to initiation and maintenance of growth (Fildes, 1929; Allyn and Baldwin, 1930; Knight, 1930; Knaysi and Dutky, 1934, 1936), and on changes in potential occurring in bacterial culture (Thornton and Hastings, 1929; Hewitt, 1930; Frazier and Whittier, 1931). Oxidation-reduction systems involved have been extensively studied by Quastel *et al* (1924-1928).

From the literature cited, particularly from the work of Hewitt, it may be deduced that (*a*) the facultative anaerobe is adapted to active growth at a wide range of potential; (*b*) the potential of a medium falls to a maximum negative value during the logarithmic phase of growth; (*c*) the reducing activity of an organism is directly proportional to its growth concentration; (*d*) oxygen supply to the medium has a very marked effect on the potential developed in cultures; (*e*) the most intense reducing conditions may in certain instances follow limited oxygen access; (*f*) in absence of hydrogen peroxide (that is, in case of catalase formers) a high reduction potential is well maintained subsequent to the logarithmic phase of growth.

Cannan, Cohen, and Clark (1926) stated that a fundamental importance of potential lay in its fixing of the direction of the oxidative or reductive reactions induced by bacterial growth. In bacterial cultures, according to Mansfield Clark,[25] there is a correlation of the appearance of certain products of growth and the attainment of certain levels of reduction intensity. It is a feature of anaerobic growth that a high reduction potential is set up in the medium and that the products of the substrate assume more highly reduced forms characteristic of that potential. Hewitt (1930) states that varying degree of access of atmospheric oxygen must affect the metabolism of bacteria and their general biological behaviour, and that fermentation reactions, products of metalbolism, morphology, and toxin production are correlated with oxidation-reduction potential. The analysis of Wurmser (1930) showed that the bacterial synthesis of alanine (1923) by reduction of pyruvic acid by glucose in presence of ammonia is on thermodynamical grounds possible only at below an upper limiting potential. It may, indeed, be affirmed that attainment of a certain potential is a pre-condition for realisation of given reactions, although it is conceded that potential alone may not be a sufficient condition. The organism must bring into play mechanisms requisite for accomplishment of the reactions.

Knaysi and Dutky (1936) point out that the rôle of free oxygen in bacterial growth and metabolism is two-fold. It maintains a favourable or less favourable potential, and it furnishes energy to the cell through oxidative processes. In the first rôle it may be adequately replaced by certain other substances; in the second its replacement may or may not be possible. It is apparent that the second eventuality will depend on presence in the bacterial system of activating mechanisms appropriate to the substitute. Replaceability of molecular oxygen by other hydrogen acceptor is, indeed, notably shown by Wieland's (1912) successful reliance on methylene blue in the acetic fermentation under anaerobic conditions.

It was early recognised that anaerobic growth of facultative anaerobes was frequently promoted by presence of nitrate in the medium, and there is now general acceptance that the biological significance of

[25] Cited by Stephenson, "Bacterial Metabolism" (1930).

nitrate is that by its agency oxygen may be supplied the purposes of the organism when free oxygen is no longer available. Quastel, Stephenson, and Whetham (1925) showed that nitrate could produce anaerobic growth of some facultative anaerobes on inclusion in media otherwise unsuitable to anaerobiosis although capable of supporting aerobic growth. They demonstrated, in other words, that nitrate could take the place of molecular oxygen. Quastel and Whetham (1924) showed that this utilisation of nitrate as hydrogen acceptor depended on power of the organism to activate the nitrate molecule, and Stickland (1931) has apparently demonstrated that there is an activating enzymic mechanism specific for nitrate. Stickland has shown also that oxygen of nitrate is utilised by *Bacterium coli* as molecular oxygen both in manner and degree, each serving equally for oxidation of formate, lactate, and succinate to carbonate, pyruvate, and fumarate respectively.

It may be opportune here to refer to the observed failure of *Vibrio halonitrificans* to initiate growth in nitrate broth under micro-aerobic conditions. The organism actively reduces nitrate in usual aerobic culture, and it is to be inferred that the enzymic factor adapted to nitrate activation is not produced by the cell, or is inoperative, under the condition of greatly reduced oxygen supply. In light of modern conceptions of activation of substrates by the bacterial cell, it will appear that the term ''obligate anaerobe'' is in fact a relative one.

Quastel, Stephenson, and Whetham (1925), dealing further with the mode of participation of nitrate in bacterial metabolism, suggest activation of nitrate at the cell so that it becomes capable of oxidising substances at the cell surface. Each cell may then be regarded as in a state comparable with that which exists under aerobic conditions. A quantitative conception also is introduced in the view that the cell surface may become ''saturated'' with regard to activated nitrate, and that the oxidative condition about the cell is then at a maximum and will be maintained if the nitrate in the medium remains at above a certain concentration. Nitrite, product of the oxidative function of nitrate, is not activated by *Bacterium coli* (nor by *Vibrio costicolus*) and will not, therefore, participate in oxidation of hydrogen donators by the cell. It appeared possible, however, in the present experiments that nitrite formed might disturb the equilibrium of potential through inhibition of further bacterial proliferation; a contingency, indeed, referred to by Stephenson (1930) in connection with growth of *Bacterium coli* in nitrate broth. This effect was produced in 10 per cent. saline peptone cultures of a non-pellicle forming strain of *Vibrio costicolus* with surface volume ratio ·66 : 1 (vide Table 5) by addition after forty hours' growth of ·1 to ·2 per cent. sodium nitrite. There was recovery of potential more positive that the transition point of methylene blue within a few hours, and inhibition of malodour in the incubated cultures for the further six days of the experiment.

Correlation of production by *Vibrio costicolus* of some degree of malodour in a peptone medium with ability of the medium to decolorise methylene blue is clearly defined (Table 5). It is evident that production of malodour in the medium, and inferentially in the rib, is consequent on metabolic activity of the organism at reduced potential more negative than the full transition point of methylene blue to the leuco form,[26]

[26] The function of methylene blue as an indicator of the anaerobic condition in culture media has been discussed from the aspects of oxygen tension and composition of media by Hall (1921). Whitehead (1930) revives the statement of Clark, Cohen and Gibbs (1928) that the dye when present in small amount in culture media is merely an indicator of reducing potential analogous to an indicator of hydrogen ion concentration.

and on evolution of malodorous bodies in the metabolism at the maintained negative potential. The conditions for attainment of sufficiently low potential level are vigorous growth of the organism and restricted oxygen supply, either molecular or afforded by nitrate. At the same time, in accordance with the recorded influence of traces of free oxygen on fall of potential (Hewitt, 1930), it is conceived that a very limited aeration such as may obtain in the rib may be a conducing influence. The efficacy of sufficient nitrate in inhibiting malodour is consequent on its capacity to maintain, equally with free oxygen, an oxygenated metabolism unsuited to production by the organism or accumulation of malodorous bodies.

An efficacy, parallel to that displayed by nitrate, in maintaining high potential level with avoidance of malodour in growth of *Vibrio costicolus* was demonstrated likewise for ferric ammonium citrate, previously employed by Knaysi and Dutky (1934) to raise the oxygen potential in culture of *Bacillus megatherium*. Decolorisation of methylene blue and production of malodour in abundant and apparently unimpeded growth of the organism were avoided by inclusion in the medium of ·4 and ·5 per cent. of the ferric salt; but both were evidenced at lower concentrations.

The conception in terms of potential of differentiation of "aerobic" and "anaerobic" metabolisms of the facultative anaerobe and of the quantitative effect of a poising agent such as nitrate on these metabolisms is still furthered by the views of Hewitt and of Clifton, Cleary, and Beard. Hewitt (1935), dealing with oxidation-reduction equilibria in cultures states: "Other systems will have a poising effect and tend to obstruct oxidation or reduction processes since they themselves have to be oxidised or reduced before the level of the electrode potential can be altered appreciably. It will be seen, therefore, that the quantity present of such systems as well as their oxidation-reduction level of intensity will affect the drift in potential." Clifton, Cleary, and Beard (1934), following Boyd and Reed (1931), discussing the growth of a facultative anaerobe (*Eschirichia coli*) with restricted oxygen write: "As growth begins an aerobic type of metabolism occurs for a varying time during which the bacteria utilise oxygen and other oxidising agents in the medium. As concentration of these reagents is decreased and the total metabolic activities of the cells increase the potential falls and an anaerobic type of metalbolism predominates in the culture. The potential reaches a maximum reducing value when the total metabolic requirements of the cells are at a peak value and all available reduction (sic) systems are employed to meet these demands."

Capacity (in relation to oxygen supply) for production of malodour and property of pellicle formation are evidently connected in strains of *Vibrio costicolus* (vide p. 36 and Table 5). It is noteworthy, therefore, that in case of *Corynebacterium diphtheriae* and haemolytic streptococci Hewitt (1930) correlates pellicle formation with attainment of more intense reducing conditions, and prevented the former by maintenance of more positive potentials by means of aeration of the cultures. Strains of *Vibrio costicolus* usually pellicle forming cultured in nitrate broth formed no pellicle.

It is notable that bulk cultures of *Vibrio costicolus* in 10 per cent. saline peptone broth containing ·5 and 1·0 per cent. potassium nitrate, which in course of the experiments failed to decolorise methylene blue on incubation for ten to fourteen days, invariably became malodorous and acquired the power to decolorise on subsequent long standing. It is suggested that the effect was consequent on liberation of reducing endoenzymes on death of the bacterial cells. A parallel effect on long storage has yet not been observed in infected ribs of bacon in which manifestation of taint for usual storage periods was obviated by high nitrate cure.

The results of McNeal and Kerr (1929) showed but feeble bactericidal action for nitrate; nevertheless, later investigations indicate that in conjunction with salt it may exercise a distinct protective action. Not only is nitrate source of fixative for cured colour, but either *per se* or through its reduction product, nitrite, exercises a specific effect against bacterial action greater than that of an equal amount of salt (Inst. Amer. Meat Pckrs., 1930). A distinct inhibition of proteolysis by *Clostridia,* inferentially through unfavourable influence on oxidation-reduction potential, was demonstrated.

Recent work in the technical field confirms the conception of the "preservative" action, in certain circumstances, of nitrate. Jensen, Wood, and Jansen (1935) describe an alteration of type of spoilage in low temperature processed canned chopped ham according to whether nitrate or nitrite was included in the cure. Nitrate by inducing potential unfavourable to *Clostridia* and other anaerobes discouraged putrefaction, but not "aerobic" spoilage with gas formation. Nitrite in the amounts employed in the cure failed to inhibit putrefactive change, but did not afford in the can conditions of potential favourable to fermentation.

The prevention by nitrate of taint in ribs of bacon through growth of *Vibrio costicolus* is probably unique in illustrating function of nitrate in obviating spoilage by alteration of the course of metabolism, as opposed to inhibition of growth and activity, of an infecting organism.

5. SUMMARY.

The causal agent in a taint of rib bones of certain Australian bacon is an obligate halophile, *Vibrio costicolus* (n.sp.). The organism was isolated from curing brine and from the product of three widely separated curing factories. Characteristic taint of ribs of bacon was reproduced by means of the isolated organism under controlled conditions of cure.

A second obligate halophile, *Vibrio halonitrificans* (n.sp.), isolated from curing brine, the specific designation of which is suggested by its most prominent character of nitrite formation from nitrate, differs from the vibrio group isolated from American curing brines by Sturges and Heideman, and briefly described by them, in property of gelatin liquefaction. A strict aerobe, *Vibrio halonitrificans* is probably to be regarded as possessing little importance in the curing process under conditions prevailing generally in the Australian "regular" cure.

Both halophiles are on the hypothesis of "physiological artefacts" acquirements from the non-saline environment. Their saline death points would constitute them mere survivals at the salinity of tank brines generally prevailing in the Australian "regular" cure; to be adapted, however, at the lower salinity of stack brines.

The narrow margin obtaining between the upper saline limit of growth of *Vibrio costicolus* (23 per cent.) and the saline death point established for it (24 to 25 per cent. NaCl) indicates the importance of close regulation of the salinity of the curing medium in control of the taint of ribs of which the vibrio is causal agent.

The conditions in the infected rib inducing manifestation of taint are favourable temperature and salinity favourable to an active de-oxygenated metabolism in presence of low nitrate concentration. Higher nitrate content of the rib inhibits taint through maintenance of metabolism of the organism on the ''aerobic'' plane.

Measures for eradication or for control of taint of rib bones due to *Vibrio costicolus* are to be found in obviation of infection by maintenance of higher saline level in the curing process at or above the saline death point of the organism; in maintenance of its metabolism in the rib on the ''aerobic'' plane by high nitrate cure; or in destruction of the organism in the infected rib by adoption in post-cellar treatment of the flitch of a drying temperature at or near its thermal death point.

There is demonstrated in this study a ''preservative'' action of nitrate exercised through effect on oxidation-reduction potential and, thence, on the course of metabolism of a potential spoilage organism.

There is emphasised the need of more intimate knowledge of the derivation of the halophilic flora of the curing medium from non-saline environments, of its determination by salinity, and of its participation in the curing process.

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1st December, 1936.

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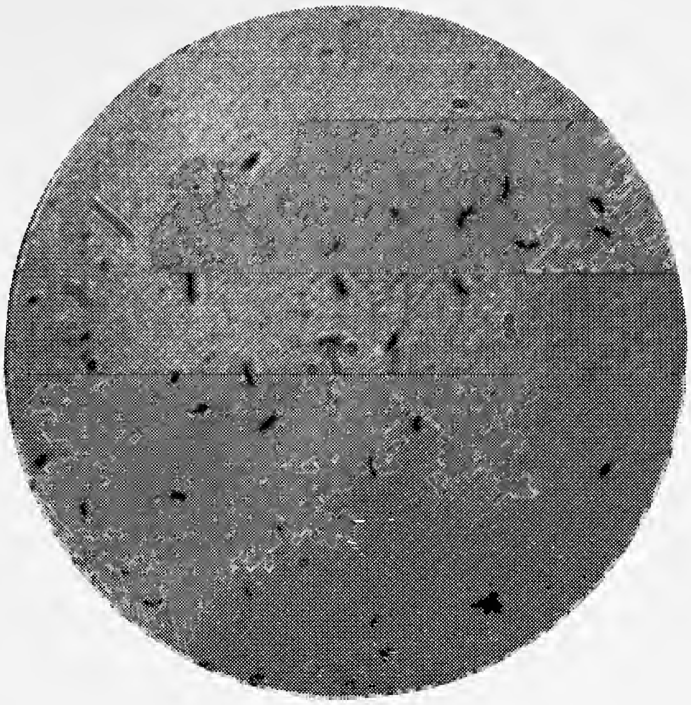
7. APPENDIX.

THE AUSTRALIAN "REGULAR" CURE.

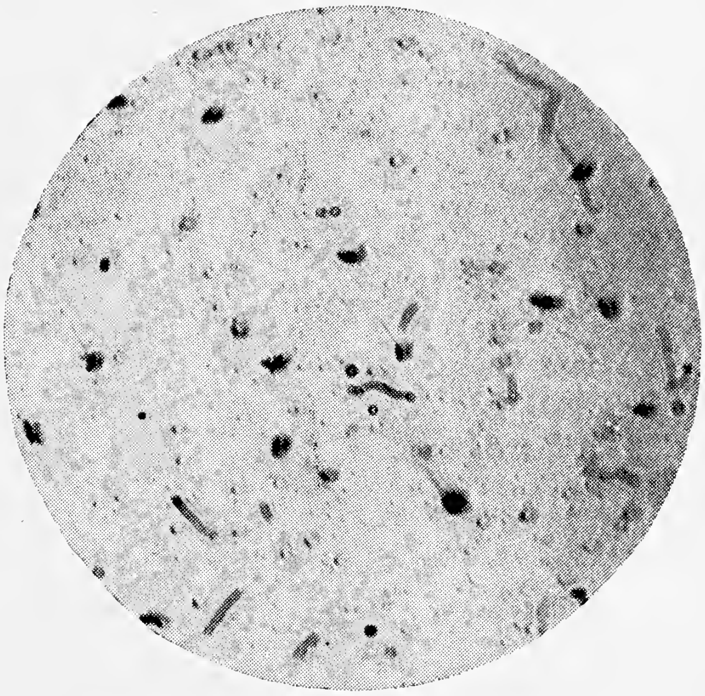
The method of curing bacon widely used in Australian curing factories, and referred to in this paper as the "Regular" cure, is a combination of tanking and dry-salting. Curing is by middle, flitch, or side with ribs *in situ*. Tanking is in brines maintained nominally at not below 90 deg. salinometer (25 per cent. w/v NaCl), and containing usually about 1·5 per cent. KNO_3. The brines are not periodically pasteurised as in American practice. In tanking it is customary to stir up the tanks and raise to about 98 deg. salinometer just prior to immersion of the meats, which are "salted in" by addition with them of an allowance of dry salt. During the tanking period, about six days, there is normally a recession of the brines to about 90 deg. salinometer, at which strength they may lie idle for a period until tanking of further meats.

Tanking is succeeded by dry-salting in stacks for a period of three to five weeks, salt being applied to the thicker portions of the cuts. During dry-salting brine accumulates in the rib concavities ("stack brine"). No addition of further nitrate is usually made in dry-salting. Cellar temperatures are usually 38-40 deg. Fahr.

Soaking, for the purpose of removing excess, principally surface salt, is customarily for six to eight hours. Temperatures in drying and smoking vary with season, but do not in current practice at any time exceed 105 deg. Fahr. for relatively short periods.



1. *Vibrio costicolus* (n. sp.).
Mag. x 900. Bailey Flagella Stain.



2. *Vibrio halo nitrificans* (n. sp.).
Mag. x 900. Bailey Flagella Stain.

The author is indebted to Mr. C. W. Leece, Bureau of Sugar Experiment Stations, for photo-micrographs.

Notes on Australian Muscoidea III.

Dexiinae, Phasiinae, some Tachininae and Appendix.

By G. H. HARDY.

(*Read before the Royal Society of Queensland, 26th July,* 1937.)

In the first part of this series of papers, the Tachinidae were divided into four subfamilies on the system then standing, but an advance was made in so far as the Dexiinae were defined on a better basis than previously attempted. In the present paper the same principles then used have been applied to the rest of the Tachinidae, resulting in subfamily divisions given in the following key:—

Key to subfamilies of the *Tachinidae*.

1. Primitive terminalia in which the aedeagus consists of membrane and chitin, never very long and the general features parallel with those of the Calliphorinae. The forceps may be (a) paired structures in the normal type, or (b) fused into one median structure lying between the accessory plates; though widely varying, these main features remain consistent .. .. *Tachininae*

   Advanced terminalia in which the aedeagus is invariably long, bristle-like and chitinous throughout, except perhaps hyaline at the extreme apex 2

2. Aedeagus consisting of one elongate bristle-like part, rarely expanding towards apex and then provided with some minute appendages there. Forceps fused or paired .. .. *Phasiinae*

   Aedeagus in two bristle-like parts, the apical one articulating with the basal one, and the forceps are invariably paired structures *Dexiinae*

The old subfamily Ameniinae becomes merged into the Tachininae and appears to be the most primitive of the Australian forms extant and hardly, at sight, distinguishable from the primitive genus of the Dexiinae. The structure referred to as "fused forceps" has yet to be ascertained morphologically for it seems to be highly important phylogenetically.

The new rendering of the Phasiinae is one which cannot be avoided at present, for it has to dispose of those forms before me which are apparently heterogeneous but do not conform to the more typical Tachininae. The group thus incorporates *Palpostoma* and certain other genera, but I do not know its limits. When these genera are better known, doubtless they will be viewed in true perspective and hence re-allotted to their natural affinities.

Subfamily DEXIINAE.

It is doubtful if the Australian Dexiinae contains more than seven to ten valid genera for which there are some thirty-five names proposed. I am acquainted with the terminalia of most of these and have concluded that possibly *Chaetogaster* Macq. 1849, and *Paramphibolia* B. & B. 1891, may be too closely related to *Amphibolia* Macq. 1832, to warrant more than one distinct generic conception.

Many of the names proposed may be allotted to subgeneric rank when the species are adequately revised, but at present it would seem those known to me fall into the following synonymy:—
1849

Rutilia Desvoidy 1830.—*Formosia* Guer. 1843, *Diaphania* Macq. 1843 (probably a good subgenus), *Grapholostylum* Macq. 1849, *Pseudoformosia* B. & B. 1889, *Chrysorutilia* Towns. 1915, *Prodiaphania* Towns. (new name for *Diaphania*) and *Euamphibolia* Towns. 1916.

Prosena St. F. & Serv. 1826.—*Prosenina Mall.* 1930.

Rhynchiodexia Bigot 1885.—*Austrodexia* Mall. 1930, *Lasiocalypter* Mall. 1930, and *Lasiocalyptrina* Mall 1930.

Chaetogaster Macq. 1849.

Paramphibolia B. & B. 1893.

Amphibolia Macquart 1846.

Thelaira Desvoidy 1830.

Heterometopia Macq. 1846.

Apatemyia Macq. 1846.—*Toxocnemis* Macq. 1854, *Anatropomyia* Mall. 1930.

Other genera may come here but I have not examined the typical species and in addition I am at a loss to account for *Senostoma* Macquart 1847, in literature. A species before me is evidently congeneric and also from Tasmania. If it be a *Rutilia* then it is comparable to *Diaphania,* but apparently it belongs to *Rhynchiodexia* which name it may supersede. Brauer and Bergenstamm treat the genus in quite a different way, using a different genotype, and Malloch may have been unnecessarily giving the genus a new name in his *Chaetogastrina.* The type is *variegata,* said to have a variegated abdomen and Malloch refers to "checkered" in his genus. The whole matter is very confusing and having only the female I am unable to place Macquart's genus. I suspect the produced oral margin in Macquart's figure is an exaggeration, for on my specimen the extension of the oral margin is present but of moderate dimensions. At most it seems to be a valid generic conception lying between subgenus *Diaphania* and *Rhynchiodexia.* I can see no alliance with the *Amphibolia* group.

Key to the genera of the *Dexiinae.*

1. With a broad carina, flat on its outer surface	2
With a carina reduced and rounded on its outer surface, or knife-edged, but exposed between antennae	4
With carina absent, or at most represented by a keel below the contiguous antennae and thus more or less hidden ..	6
2. With a large broad abdomen, or if conical then metallic, and the legs normal	*Rutilia*
With conical, non-metallic abdomen and the legs frequently elongate	3
3. Proboscis very elongate, several times longer than the oral cone and longer than the head depth; it cannot be withdrawn entirely into the oral cavity (unique to genus)	*Prosena*
Proboscis normal, not much longer than the oral cone or head length, and readily withdrawn into oral cavity	*Rhynchiodexia*
4. Highly metallic species with yellowish wings	*Chaetogaster*
Non-metallic species	5
5. Brown species, marked only with black	*Paramphibolia*
Black species with large well defined ashy-grey markings ..	*Amphibolia*

6. First and fifth radial veins with setae (unique to genus). Eyes occupying in profile almost the whole depth of the head (unique to genus) .. .. *Thelaira*
   First radial vein without setae. Eyes occupying in profile only about two-thirds of head depth 7
7. Frons on both sexes broad, and together with face bare, highly silvery throughout (unique to genus) and bristles much reduced on male .. .. *Heterometopia*
   Frons normal, that of the male reduced in width, hair and bristles normal though variable .. .. *Apatemyia*

The term "proboscis" in the above key follows the restricted use, referring to the part lying beyond the oral cone which bears the palpi. The key does not attempt to isolate the genera on valid structures for which further study is needed, but it covers enough to permit recognition of each segregation. *Prosena* and *Thelaira* are widely distributed, the rest being restricted to the Australian region or practically so.

Subfamily Phasiinae.

Tribe Phasiini.

Morphology.—The mouth parts are subject to wide variation and in one genus the oral cone and proboscis form a single organ, short, apparently functional and with palpi almost equal in length and cylindrical. In another genus the proboscis articulates with the short movable oral cone that bears large broad palpi and the total length does not or hardly exceeds the oral cavity. More frequently the oral cone is found to be long and the palpi either short or very long and even the oral cavity is adjusted to meet these varying lengths which again reflect on the shape of the face.

The nature of the female terminalia is well known and varies from an apparent simple type to that which has one or more horny appendages that constitutes a specialised ovipositor; the advancement may even include a ventral sheath for the structure. The terminalia of the male, however, seems more important at the moment as half the species are described from unique males. Typically the aedeagus is bristle-like in structure and of considerable length, sinuous, curving forward at the basal half and rearwards at the apical half, the amount of curvature varying. On each side of the aedeagus a pair of claspers occurs, small, probably not particularly functional and perhaps even missing at times, or at least not readily seen. In the more generalised species a pair of forceps is present, flanked by the accessory plates, but a modification takes place in the majority of species examined, and there is only one central process, referred to as the fused forceps and is somewhat claw-like.

Taxonomy.—It is my intention to use these characters (hitherto neglected) for the formation of genera, this proposal being of course, the fundamental principle upon which the generic conceptions rest. The following four definitions cover all the species known to me, and appear quite valid as genera.

Genus 1.—Proboscis extremely short, only one apparent segment standing in an ill-defined oral cavity; palpi well developed, about as long as the proboscis. Accessory plates large and much broader than the fused forceps. Vein R_5 and M_1 do not meet. Apparently no species have been described from Australia and I do not know any exotic genera that conform.

Genus 2.—Proboscis short, not longer than the oral cavity within which it lies, the oral cone being very short and bearing large broadened palpi that reach nearly to the apex of the proboscis. Accessory plates tapering, slender, claw-like and conspicuously shorter than the fused forceps. Vein R_5 and M_1 do not meet. Apparently no species are described.

Genus 3.—Proboscis normal; *i.e.,* when protruding is seen to extend further than the oral cavity, the oral cone being long. Palpi cylindrical but short. Accessory plates and fused forceps apparently always short and equal in length. Wings of normal breadth with R_5 and M_1 uniting before reaching the wing margin. *?Hyalomyia.* Most of the described species seem to fall here.

Genus 4.—Proboscis normal; palpi very long and slender, cylindrical. Forceps normal, the two branches being broad and separated; accessory plates very slender and about as long as forceps. Wings conspicuously broadened, the male at least having an inflated costal margin. Veins R_5 and M_1 uniting before reaching wing margin. *?Alophora.* Evidently *aureiventris* Curran comes here.

I do not know how many species have been described, but there are fifteen names in literature that definitely are placed in the tribe, and six generic names applied to the various species. I have seen two of Curran's species (paratypes) and find one may prove to be another genus lying between the second and third given above—*Catharosia varicolor* Curran 1927.

Macquart recorded *Gymnosoma rotundata* Meigen, from Tasmania, and I note from Townsend's manuscript catalogue of Muscoidea of Australia, he has added the record of *Verreauxia auripilis* also from Tasmania and attributed to Desvoidy in 1863, but I have not seen the record. Apparently the first of these is referable to the list of exotic species erroneously labelled in locality and of which there are quite a number now known.

Tribe Palpostomini.

The outstanding character of this tribe lies in the lateral process each side of the labrum and which is palp-like in shape; the feature is mentioned by Desvoidy.

On fresh material these processes are quite palp-like, cylindrical and isolated; they stand at right angles to the broad surface from which they arise and may be flexed at their base to lie in any direction but invariably return when released, for there seems to be no "joint" involved but they arise as a direct continuation of the cuticle of the labrum. On drying the distortion of the labrum may cause these processes to lie directed in some other manner and even the processes may partially collapse.

Palpostoma Desvoidy.

Palpostoma Desvoidy 1830; type *P. testacea* Desv.

Opsophasiops Townsend 1915; type *flava* Coquillett quoted but this was misidentified by that author.

Pseudopalpostoma Townsend 1926; type *P. desvoidyi* Aldrich.

Eustacomyia Malloch 1927; type *E. breviseta* Mall.

Apalpostoma Malloch 1930; type *A. cinerea* Mall.

Synonymy.—I may be premature in placing *Apalpostoma* as being a synonym, but in the description there is nothing mentioned that makes a valid genus, even the spur on the radial vein is encountered as an abnormality in normal *Palpostoma* species. I would suggest that the mouth parts and terminalia be examined to see if the genus should be validated.

Palpostoma aldrichi new name.

Palpostoma testacea Aldrich. Proc. U.S. Nat. Mus lxii., 1922, 4. nec Desvoidy 1830.

Synonymy.—The host of this species, *Lepidoderma albohirtum* Waterhouse, is a North Queensland beetle and it seems impossible for Desvoidy to have received its parasite over 100 years ago and so the fly can hardly be the same species as Aldrich suggested at a venture. Desvoidy's species is more likely to be *P. apicalis* Malloch.

Note.—There are three species before me reared from *Pseudoholophylla furfuracea* Burm., *Lepidiota trichosterna* Lea and *Anomolopha sp.* by Mr. R. Mungomery whilst several more have been reared in other States and again further ones, captured in Brisbane, New South Wales and Tasmania, are before me. It would seem that every large species of Melolonthinae is affected by a different species of *Palpostoma*. There are ten specific names already published and only three of them are likely to be recognised again without access to types.

Subfamily Tachininae.

Section 1.—Genera in which the terminalia have normal, paired forceps.

Genus *Amenia* Desvoidy.

The species in this genus have apparently become so confused that no two authors apply the specific names in the same way. The synonymy has thereby become very involved. The following key is built up on the common forms that have been closely studied, and it will be found that many of the characters given are incorporated in their original descriptions. Several species have been compared with types at the British Museum.

Key to species of genus *Amenia*.

1. Costa of wing on male with the apical half bowed forwards	6
Costa of wing normal	2
2. Second tergite of male abdomen without long median bristles; fourth tergite dark coloured and less metallic than the others	3
Second tergite of male abdomen with long median bristles; fourth tergite coloured as the others	4
3. Frons of the male extremely narrow, at the narrowest point being only the width of one ocellus	*parva* Schiner.
Frons of the male about the width of the ocellar tubercle ..	5
4. Frons of the male narrow, the eyes being separated by little more than the width of the ocellar tubercle. Small species under 10 mm. long and with silvery postocular orbits	*chrysame* Walker
Frons of the male wide, being four times the width of the ocellar tubercle	*dubitalis* Malloch.
5. Species with a pair of coppery longitudinal stripes on the thorax, embedded in the blue or green ground colour ..	*leonina* Fab.
Species without such stripes and smaller in average size ..	*albomaculata* Macq.
6. Frons of the male narrow as on *chrysame* to which it conforms in most characters including silvery postocular orbits ..	*sp.* near *chrysame*
Frons of the male as wide as or wider than that of *dubitalis*	7

7. Medium sized species with frons about five times the width of the ocellar tubercle: proportion 11:2 .. .. *sp.* near *dubitalis*
Large species 8
8. Frons nearly four times the width of the ocellar tubercle: proportion 11:3 .. .. *sp.* near *imperialis*
Frons about seven times the width of the ocellar tubercle; proportion 14:2 .. .. *imperialis* Desvoidy

I do not claim that every species so isolated in the above key is a distinct form, for it has to be determined exactly which characters are specific; nevertheless structural characters like the width of the frons have proved elsewhere very useful for specific recognition and may be relied upon here. The bowed part of the costa is a feature that may prove deceptive and must be used with caution. Malloch added *sexpunctata* to the eastern species, relying on colour characters; I believe I have his form before me, but hestitate to place it at present and anyhow it does not become involved with the purpose of these notes.

Amenia leolina Fabricius.

This was redescribed by Wiedemann and recorded by Macquart. Specimens identified at the British Museum coincide with Wiedemann's description and they correspond with what is presumably *albomaculata* but differ in accordance with the characters given in the key. I do not know if the two forms are conspecific as generally supposed. Engel and Malloch apparently give the name to other species which correspond neither with the coppery stripes, nor with size except the latter in the case of Engel's determination. When the coppery colour occurs on the other species, it is diffused and not stripe-form.

Amenia albomaculata Macquart.

This, I think, is the *leolina* Schiner, and may prove to be a variety of the previous species.

Amenia imperialis Desvoidy.

The confusion between this form and *leolina* seems to have started with Walker and followed by Engel, for I have seen specimens bearing Engel's labels. From Malloch's description it is not possible to tell if he had the present species or the one marked in the key as allied.

Amenia chrysame Walker.

There can be no doubt concerning this determination as specimens have been compared with the type. It is the *parva* of Engel and Malloch and the latter made an error in putting it as a synonym of *parva*. Schiner.

Amenia parva Schiner.

This seems to be the *leolina* of Townsend, Aldrich and Malloch, and I have seen specimens so labelled by Aldrich. Evidently Coquillett was responsible for the initial error. Engel described it as *stricta* Schiner MS., following Brauer and Bergenstamm who evidently regarded another specimen as the type described later by Engel as *parva* but in reality was *chrysame*.

To validate this, reference must be made to the original description of *parva* which is definitely described as having a linear frons and there is no other species known with such a character. It will also be noted that the words "parva" and "stricta" both apply to the frons and Schiner may have made an error in his labels.

Zebromyia ornata Macq.

Phorocera ornata Macquart. Dipt. Exot. suppl 4, 1849, 199.

Zebromyia obesa Malloch. Proc. Lin. Soc. N.S. Wales, liv., 1929, 321.

This synonymy is new and can hardly be disputed. Both sexes are before me. Notwithstanding the marked differences, the species seems to be related to the *Microtropeza*-group, joining it to *Tritaxys*.

Male.—The characters are identical with those of the female except the slightly narrower frons and the fronto-orbital bristles are missing; the summit is about five times the width of the ocellar triangle. The markings of the body are bolder than those on the female but otherwise the same.

Hab.—Tasmania Zeehan, 1924, one male allotype and a female with the head missing. Another female from Hobart, 14th March, 1917.

Tritaxys Macquart.

Tritaxys Macquart. Dipt. Exot. suppl. 2, 1847, 65.

Goniophana Brauer and Bergenstamm. Denk. Akad. Wiss. Wien., lvi., 1889, 97.

Anamastax Brauer and Bergenstamm. Ibidem., lviii., 1891, 349.

Acnephana Townsend. Canad. Ent. xlviii., 1916, 153.

Opsophana Townsend. Ibidem., 153.

Quadra Malloch. Proc. Lin. Soc. N.S. Wales, liv., 1929, 320.

Gonanamastax Townsend. Journ. N. York Ent. Soc., xl., 1932, 472.

A group of genera containing species commonly bred from Lepidoptera and very confused in the literature includes *Sturmia* Desv. and three other genera apparently all valid. The line between some of these genera is not well defined, for *Sturmia* approaches *Winthemia* but has the fringe on the posterior femora interrupted at least by one outstanding long bristle about the centre. *Winthemia*, from two other genera, is separated by the less broad frons containing less bristles and the three are to be recognised in the following key:—

1. Frons very broad in both sexes, the bristles being arranged in two rows each side of the interfrontalia. The fringe of the posterior tibiae is variable but usually present and interrupted by one outstanding long bristle 2
   Frons narrower, normally with only one row of bristles each side of the interfrontalia, although occasionally fortuitous bristles may simulate a second row and then the uninterrupted uniform fringe of the posterior tibiae may be relied upon in cases of doubt .. .. .. *Winthemia* Desv.
2. With a grey-white pulverulent overlay on all tergites. Usually dull coloured species .. .. *Tritaxys* Macq.
   Without such covering, or at most limited to the fourth tergite. Much brighter species with claws irregular in length .. .. *Calopygidia* Mall.

In *Tritaxys* there are variations in the fringe on the anterior dorsal side of the posterior tibiae and some very small specimens seem to have the row reduced to scattered bristles; these small specimens conform to the named forms in other respects and do not seem specifically distinct. Like all the other larger Tachinidae there is a wide range in size of specimens and characters regarded as important for specific recognition are not invariably consistent, making it necessary to check determinations with reliably named material.

Key to species.

1. Discal bristles on third abdominal tergite and often on the second 2
   Discal bristles absent on second and third abdominal tergites. Normally without bristles on the ocellar tubercle .. 4
2. Without bristles on the ocellar tubercle. Eyes bare. Arista with second segment about four times longer than wide, reaching one quarter the length of the thickened part, but the first segment is longer than usual. The radial and median veins meet at or before costa. Abdomen distinctly banded black and white with a slight median interruption of the white (*Quadra*) .. .. .. *ornata* Mall.
   Male with a pair of bristles on the ocellar tubercle. Second segment of arista very short, only as long as wide .. 3
3. Radial and median veins meet at or before reaching costa. Abdomen with marginal bristles on second, and normally on first tergite and discal bristles on third with which it agrees with *ornata*, but in addition, there are normally discal bristles on the second tergite. Eyes normally bare. Female with bristles on ocellar tubercle *dissimilis* Mall.
   Radial and median veins widely separated at wing margins. Eyes normally hairy. Female without bristles on the ocellar tubercle. (*Tritaxys, Opsophana,* and *Gonanamastax*) .. .. *goniaeformis* Macq.
4. Marginal bristles on second abdominal tergite and may be indicated on first 5
   Marginal bristles absent on second abdominal tergite. Second segment of arista about as long as broad or less. Normally with antennae very short, the third segment being about twice the length of the others combined. Eyes bare. (*Anamastax*) .. .. *braueri* n. name.
5. Second segment of arista abnormally long, occupying up to one half of the thickened portion. Normally eyes hairy on male, bare on female .. .. *milas* Walker.
   Second segment of arista occupying up to one third of the thickened part. Normally eyes hairy. (*Acnephana*) *rubrifrons* Macq.
   Second segment of arista occupying one quarter the length of the thickened part. Eyes hairy. (*Goniophana*) .. *heterocera* Macq.

From Tasmania comes a specimen (female) differing from *rubrifrons* Macq. by having yellow-brown legs and a very short second segment on the arista, whilst from the National Park, Queensland, there is a male with brownish legs largely suffused with black on the femora, bare eyes, and bristles on the ocellar tubercle. Both these run to section 5 of the key.

Tritaxys ornata Malloch.

Quadra ornata Malloch. Proc. Lin. Soc. N.S. Wales, liv., 1929, 320.

Hab.—Western Australia: Perth. One male allotype, 16th November, 1912. This specimen has the head less brightly coloured than Malloch's description would indicate, but otherwise it agrees with the female. The frons is about the narrowest I have seen in this genus.

Tritaxys dissimilis Malloch.

Quadra dissimilis Malloch. Proc. Lin. Soc. N.S. Wales, lv., 1930, 343.

Hab.—New South Wales, Queensland. Two males and three females, the latter forming the allotype and paratype series. This is quite a common species of typical *Tritaxys* differing only in two veins meeting. On both sexes the frons is narrower than on *T. goniaeformis* Macq.

Tritaxys goniaeformis Macquart.

Blepharipeza goniaeformis Macquart. Dipt. Exot. suppl. 1, 1846, 157.—Townsend, Ann. Mag. Nat. Hist. (10), ix., 1932, 50; Townsend, Journ. N. York Ent. Soc., xl., 1932, 472 (*Gonanamastax*).

Tritaxys australis Macquart. Dipt. Exot. suppl. 2, 1847, 66.

Masicera rufifacies Macquart. Ibidem., 71.—Brauer, Sitz. Akad. Wien. cvi., 1897, 340; Townsend. Canad. Entom., xlviii., 1916, 153 (*Opsophana*).

Synonymy.—The above are all described from Tasmania, the first as having bare eyes, the second put into a new genus, and the third in yet a third genus all by the one author. Brauer only examined the type of the third, and characters given by him strongly suggest the present position. The synonymy, as here accepted is new, although it has previously been suggested that the first two are conspecific.

The antennae are of average length and the frons is as wide on both sexes as on the majority of the mainland species.

Hab.—Tasmania: Hobart, Garden Island, Eagle-hawk Neck and Strahan, October to March, 1916 and 1924. Two males, four females. Apparently the species is limited to the island.

Tritaxys rubrifrons Macquart.

Gonia heterocera Macquart. Dipt. Exot. suppl. 1, 1846, 153. Males from Tasmania only.

Masicera rubrifrons Macquart. Ibid., suppl. 2, 1847, 69.—Brauer, Sitz. Akad. Wied. cvi., 1897, 339; Townsend, Canad. Ent., xlviii., 1916, 153 (*Acnephana*).

Tritaxys heterocera Townsend. Ann. Mag. Nat. Hist. (10), ix., 1932, 50.

The antennae are very long, the yellowish head is more or less suffused with red, the abdomen is brown, the black being limited to a broad median line and the apex. The ocellar tubercle occupies one fifth the width of the summit which is exceptionally wide, instead of the normal one third.

Hab.—Tasmania: Hobart, November, 1916, and Wynyard, February, 1924.

Tritaxys milas Walker.

Gonia milas Walker. List Dipt. B. Mus., iv., 1849, 799.

?*Tritaxys heterocera* Malloch. Proc. Lin. Soc. N.S. Wales, liv., 1929, 113 (at least in part).

I use the name given by Walker, pending comparisons on the type as it would seem this form and *heterocera* are the only two species likely to be involved. The head characters on the male show slight variations but the ocellar tubercle occupies approximately one-fifth the width of the summit. Malloch's description and figure seem very poor and possibly confused more than one species.

Hab.—Queensland, New South Wales, Victoria. A long series including five males that form the allotype and paratype series. Western Australia: A single female from Perth apparently belong to this species.

Host.—*Clania ignobilis* Walker (Psychidae). Two females were reared from the pupa by Dr. A. J. Turner, collected at Dalby (24-1-26), Queensland.

Tritaxys heterocera Macquart.

Gonia heterocera Macquart. Dipt. Exot. suppl. 1, 1846, 153; suppl. 3, 1849, 44—females only.

Macquart's species is clearly indicated by his comparison with the Tasmanian form, and Malloch may have the species under this name too, although his remarks fit better the species here referred to as *milas* On the average the summit is a little smaller in the present form.

Hab.—Queensland, New South Wales, Victoria. A long series including five males that form the allotype and paratype series.

Host.—Noctuidae: *Heliothis armigera* Hubn., *Remigera frugalis* Fab., and also some abnormal specimens reared from *Exoa radians* Gn. All reared specimens in the Queensland Department of Agriculture.

Tritaxys braueri new name.

Anamastax goniaeformis Brauer and Bergenstamm. Dank. Akad. Wiss. Wien., lviii., 1891, 349; lx, 1893, 123.—Townsend, Ann. Mag. Nat. Hist. (10), ix., 1932, 50—nec. Macquart; ?nec Malloch, 1929.

Anamastax australis Townsend. Journ. N. York Ent. Soc., xl., 1932, 473.

This is the genotype of Brauer and Bergenstamm's *Anamastax,* although Macquart's species is quoted by them. I think Malloch's determination cannot be the same as he gives his figure a wrong length for the antennae. The ocellar tubercle is so small that it occupies one fifth of the summit which is only normally wide, comparable to that on *ornata.*

Hab.—Queensland. The species is represented in every collection I have examined.

Host.—*Cirphis unipunctata* Haw. (Noctuidae), in the Queensland Department of Agriculture.

Genus *Calopygidia* Malloch.

Calopygidia Malloch. Proc. Lin. Soc. N.S. Wales, lv., 1930, 349.

Malloch's definition does not hold good for his typical species, based on a variation using three specimens, one said to be damaged. I am unable to define the genus on structure as it bears wide variations that bring it into genus *Tritaxys,* differing, perhaps in having the claws of the anterior legs elongate and short on the others, whereas in *Tritaxys* the species have them either all long or all short. The ridge of the face mentioned by Malloch again is met with in *Tritaxys,* some species having it there, thus invalidating its importance, and I can see no marked difference in the terminalia. The name is worthy of retaining at least as being of subgeneric value.

Calopygidia analis Malloch.

Calopygidia analis Malloch. Proc. Lin. Soc. N.S. Wales, lv., 1930, 350.

This abundant species has possibly been named by an earlier author, but I have not detected it in Macquart's works and I have not yet made the necessary search amid Walker's descriptions. Malloch compares it with *Winthemia* which is somewhat misleading, the two not being comparable. The colour of the abdomen is normally black with tracings of brown lateral areas more or less defined and is made conspicuous by the dense pulverulent covering of the apical tergite, this being ashy-white.

Hab.—Queensland to Tasmania. A long series of both sexes. On the wing, the male of this fly is likely to be mistaken for *Calliphora dispar* Macq. as it has the same deportment and general features.

Host.—*Phytometra argentifera* Guen. (Noctuidae), in the Queensland Department of Agriculture.

Calopygidia castanea n.sp.

A large chestnut-brown species with a large part of the thorax dorsally, the antennae and tarsi black, together with the median abdominal line and a variable amount of the abdomen at apex which may also be infuscated.

Male.—Frons very wide, approaching one third the head-width and slightly less golden than the rest of the head, with a red-brown interfrontalia and bristles somewhat weak, but two are clearly directed rearwards followed by a series that reaches level to the apex of the second antennal segment and ends not far from the eye margin. There are no ocellar bristles and the hairs that descend down to the face are mainly restricted to about twenty below the frontal bristles and follow the area near the eyes. The facial ridge has about twelve small bristles above the vibrissa reaching from half way to two thirds towards the base of the antennae.

The chaetotaxy of the thorax shows slight variations from the normal, the sternopleurals being arranged 2:1 (normally 1:1 in *analis*). In colour the black of the dorsal area is bordered by brown at sides and apex and has the normal four thin deeper black lines. The abdomen has the marginal bristles of the first two segments clearly defined and the discals may develop on the second and third tergites.

The fringe of bristles on the anterior dorsal side of the hind tibiae is conspicuously present on the basal half, then becomes broken by three or four outstanding bristles in the central area followed by another bristle extra long after which comes the normal fringe but represented by smaller bristles. The claws of the anterior legs are conspicuously longer than those of the others. In many of these and apparently all other characters, it agrees with *analis*.

Hab.—Tasmania. Holotype, one male, Mount Wellington, January, 1924, and two male paratypes, Mount Wellington, February 1917, and Cradle Mountain, January, 1917.

This fly is very similar in appearance to the blowfly *Calliphora nigrithorax* for which it can be readily mistaken as it has the same size, colour and general deportment. It is very quick on the wing and elusive.

Genus *Winthemia* Desvoidy.

Winthemia Desvoidy. Essai Myodaires, 1830, 173.

The vicissitudes through which this genus is passing have complicated the literature beyond my ability to unravel. The Australian material before me forms quite a valid unit to which several names have already been applied. Austen separated one section as *Blepharipoda* and Malloch another as *Winthemia*, whereas a third may be involved in *Carcelia*, but no modern author seems to have dealt with them. I use the name having priority and am able to apply quite a number of specific names to the group. Other names are excluded from here, as on recognising their identity I have concluded they belong elsewhere. *Exorista diversicolor* and *dispar* Macquart, together with *E. trichopareia* Schiner, said to be a synonym of the latter, will be dealt with in the *Sturmia* complex as they do not belong to the present group unless the generic conception be widened.

All the following forms are consistent in having the fringe of bristles on the anterior dorsal area of the posterior tibiae entirely without interruption, all bristles being of uniform or uniformly grading length, none outstanding nor yet any marked break in the series. No species has more than one normal row each side of the interfrontalia, but one species is liable to have up to three fortuitous ones simulating a second row.

Key to species of *Winthemia*.

1.	Male without, female with one, rearwardly directed bristle on frons, or if more they are weak	2
	Both sexes with rearwardly directed bristles on frons; the female always with two (*?Carcelia*)	5
2.	Abdomen without marginal bristles on the second tergite. Eyes bare. (*Blepharipoda*)	3
	Abdomen on male usually without, on female with marginal bristles on second tergite. (*Winthemia*)	4
3.	Face entirely bare	*australis* Walker.
	Face hairy only on the upper half (female unknown)	*sp.*
4.	Face especially unusually narrow; hair weak on male, minute on female. Legs entirely black	*translucens* Macq.
	Face and frons broader, tibiae distinctly brownish	*sp.* (Tasmania)
	Face and frons still broader, male with marginal bristles on second tergite	*lata* Macq.
5.	Without marginal bristles on second tergite. Male with one rearwardly directed bristle on frons. Eyes and face hairy	*lateralis* Macq.
	With marginal bristles on second tergite. Face bare ..	6
6.	Male with one rearwardly directed bristle on frons, the summit rather broad	*varipes* Macq.
	Male with two rearwardly directed bristles on frons, the summit much narrower (try *Podomyia* B.B.)	*marginata* Macq.

Winthemia australis Walker.

Tachina australis Walker. Ins. Saund. Dipt., 1856, 279.

Tachina zebina Walker. Austen, Ann. Mag. Nat. Hist. (7), xix., 1907, 332, 346 (*Blepharipoda*).

Synonymy.—Austen has dealt with synonymy, claiming that the Indian species *zebina* reaches through the orient to Queensland and New South Wales, whereas before me two species are apparent and yet come here. I do not wish to dispute the synonymy at the present time but think it advisable to retain the name of Walker's species until the complex, if it be one, is revised once more. A third apparently distinct species in Australia is isolated in the key but is only known to me by a male. This form has distinctly indicated, the frontal hairs descending far below the bristles reaching half way down the face, thus approaching the more typical *Winthemia spp.*, but in every other respect it comes into the *australis*-group which is liable to develop fortuitous bristles on the frons.

Host.—*Ochrogaster contraria* Walker (Notodontidae); the Procession moth. The parasite reared is the dark form and was identified by Austen as *zebina* in the Queensland Museum which indicates this should be the typical *T. australis.*

Papilio aegeus Don. The same dark form was reared from this butterfly by myself in 1922.

Sphingidae. The light form has been reared by others as well as myself from the pupa of hawk-moths, the genera not being determined.

Winthemia translucens Macquart.

Exorista translucens Macquart. Dipt. Exot., suppl 4, 1849, 189.

Malloch has put in *Winthemia* two species which apparently fall into the main section and he had but one male in each case and used minor differences in distinguishing them. A very long series before me, largely bred, shows variations especially in size, so I have to leave the determination of Malloch's form but believe *diversa* Mall. will prove a synonym of the present species.

Hab.—New South Wales and Queensland.

Host.—*Euploea corinna* Macleay (Nymphalidae); *Anaphaeus teutonia* Fab. (Pieridae); *Ochrogaster contraria* Walk. (Notodontidae); all in the Queensland Museum.

Winthemia sp.

Hab.—Tasmania: Hobart. Two males only.

I have found no name that can be applied to this species which seems quite distinctive in head characters.

Winthemia lata Macquart.

Exorista lata Macquart. Dipt. Exot., suppl. 3, 1848, 47.

The broad white parafacial area with white hairs is unmistakable for the identification of this species and Malloch may have it under his *albicens.*

Hab.—New South Wales and Queensland. Only a few specimens are available to me and one I have marked as the allotype female.

Host.—*Ochrogaster contraria* Walker (Notodontidae); in the Queensland Museum.

Winthemia lateralis Macquart.

Masicera lateralis Macquart. Dipt. Exot., suppl. 1, 1846, 163.

Hab.—Queensland and New South Wales. Allotype female and a long series of paratypes as well as males.

Host.—*Papilio aegeus* Don. A very long series was reared from this source. Also *Papilio sthenelus* Macleay. Both cases in the Queensland Museum.

Winthemia varipes Macquart.

Masicera varipes Macquart. Dipt. Exot., suppl. 1, 1846, 163.

Hab.—Tasmania: Hobart, October and January, 1913, 1914, and 1924. Four males and one allotype female.

Winthemia marginata Macquart.

Exorista marginata Macquart. Dipt. Exot., suppl. 4, 1849, 188.

Masicera similis Macquart. Dipt. Exot., suppl. 4, 1849, 194.

This is the common Brisbane species met with throughout the year. The female was described as *similis* probably from Sydney, a damaged specimen being used judging from the remark "en grande partie dénudée." The coloration and markings of the abdomen correspond to Macquart's figure of *E. marginata* and according to Macquart's methods should have been placed in *Masicera*, but presumably he overlooked the two backwardly directed, sometimes small frontal bristles, on the narrow frons of the male.

Hab.—Queensland and New South Wales.

Section 2.—Tachininae that have the terminalia with the forceps fused into one central organ lying between the paired accessory plates.

Genus *Peleteria* Desvoidy.

Peleteria Desvoidy. Essai Myodaires, 1830, 39.

This palaearctic genus has not hitherto been recorded from Australia but belongs to the *Echinomyia*-group, or in accordance with Lundbeck, belongs to the *Tachina*-group, if the rules of priority are to stand. The Australian species is very typical of its genus, is black with a densely haired fourth tergite entirely red, resembling somewhat a bee of the genus *Megachile*. There is no name given for the Australian species as far as I have ascertained unless it be *P. javanica* Desv., from Java.

Host.—*Heliothis obsoleta* Fabr. (Noctuidae).

Genus *Tricholyga* Rondani.

Tricholyga Rondani, 1859.

Several palaearctic species are in this genus and one at least reaches Australia. I think I am correct in this as Lundbeck states the forceps of *sorbillans* Wied. contains a covering of dense, yellow-red hairs and the colour on the specimens before me is "old-gold" and the species is from Tasmania.

From Queensland come two further species, one having a curved tuft of yellow-red hairs standing erect at the base of the forceps, the hairs changing from red to yellow with the incidence of the light, and the other species has only a light covering of black hairs, the dense tuft being entirely absent. The first and third species have a golden head, the other has this more silvery and the only female I have belongs to it. The genus is represented in several collections.

Tricholyga sorbillans Wiedemann.

Tachina sorbillans Wiedemann. Auss. zweifl. Ins., ii., 1830, 311. Canary Islands.

Exorista flaviceps Macquart. Dipt. Exot., suppl. 2, 1847, 67. Tasmania.

Synonymy.—Brauer is responsible for placing the species described by Macquart, in a generic position, but it seems from species already known in Australia it is referable to the one form.

Hab.—Tasmania to New South Wales, and probably Queensland.

Host.—*Cirphis unipuncta* Haw., in the Queensland Department of Agriculture, is the host of apparently this fly but I have not examined the terminalia of the parasite.

The *Micropalpus-Chaetophthalmus complex.*

There are a number of species described from the Commonwealth as having small palpi and as the group has been associated with parasitism on Lepidoptera, I have made the attempt to straighten out the very involved taxonomy. I do not regard the generic status given below as well established but it certainly brings together groups of related species. I refer *Micropalpus vittatus* Macq. and *M. pilifacies* Macq., to genus *Cuphocera,* whilst *Aprotheca rufipes* Macq. (try Dexiinae) is apparently a representative of a genus unknown to me. I have failed to discover the identity of *Myobia rufifacies* and *tenuisetosa* Macq., both placed in *Chaetophthalmus* by Brauer notwithstanding the long palpi in the original figures and so doubt if they belong here.

Linnaemyia nigripalpis Tryon, in accordance with its name, should come into this section, but the specimens described seem to be lost and the illustrations somewhat confusing as if the present series, *Tritaxys* and the head of *Metallea* (Calliphoridae) have been mixed.

The genera as here isolated are tentative, the problem of nomenclature being involved in the world's fauna.

Key to genera.

1. Both sexes with frontal orbital bristles. Face hairy. Third and fourth tergites strongly tending to amalgamate, although the division between them is discernible even in the most advanced cases .. *Amphibolosia* Surcouf.
   Only the female with fronto-orbital bristles. Third and fourth tergite not amalgamating 2
2. Face distinctly hairy .. .. *Chaetophthalmus* B. & B.
   Face bare .. .. *Micropalpus* Macq.

Genus *Amphibolosia* Surcouf.

Amphibolosia Surcouf. Nouv. Arch. Hist. Nat., Paris (5), vi., 1914, 109. Type, *Ochromyia flavipennis* Macq.

Ballardia Curran. Bull. Ent. Res., xviii., 1927, 166. Type, *B. pallipes* Curran.

Surcouf described Macquart's species from the type, a female, in such an excellent manner that its identity is not in doubt. In revising collections I was able to incorporate paratypes of Curran's species and it has proved not practical to separate them into another species thus leaving three units that are definitely recognisable as valid. When the terminalia have been subject to more intensive study, it may be possible to define the three forms into more than one species each but I do not think this likely.

Key to species of *Amphibolosia.*

1. Summit of head very wide, the ocellar tubercle being about one fifth of it. Acrostichal bristles frequently only 2:3 but varies .. .. *pallipes* Curran
   Summit of head narrower, the ocellar tubercle being only about one third the width. Acrostichal bristles invariably 3:3 2
2. Ocellar tubercle about one and a quarter its own width from the eyes. Fifth sternite relatively small .. .. .. *sp.*
   Ocellar tubercle hardly more than its own width from the eyes. Fifth sternite enlarged. Frons usually much darker than on the others and in addition there is a conspicuously well developed tuft of hairs at the base of each accessory plate .. .. *nudistylum* Macq.

Amphibolosia pallipes Curran.

Ochromyia flavipennis Macquart. Dipt. Exot., suppl 4, 1849, 245, preocc. Macq. 1843.

Ballardia pallipes Curran. Bull. Ent. Res., xviii., 1927, 166.

Hab.—Queensland, New South Wales, Victoria. This is a very common species and very variable.

Amphibolosia nudistylum Macq.

Ochromyia nudistylum Macquart. Dipt. Exot., suppl. 5, 1854, 111.

Hab.—South Australia to Tasmania. This species which is abundant in Hobart is also represented from the type locality, Adelaide.

Chaetophthalmus similis Walker.

Tachina similis Walker. Ins. Saund. Dipt., 1856, 266.

?*Chaetophthalmus biseriatus* Malloch. Proc. Lin. Soc. N.S. Wales, lv., 1930, 311.

I do not know all the characters of the male on Walker's species as the only male before me has had the terminalia mounted and in the extracting the sternites have broken away, but if Malloch's species proves the same, as expected, then it should have a second row of outstanding black bristles situated on the sternite anterior to that of *brevigaster*. There are other species before me on which no such bristles occur and I have found no names yet that apply to them.

Hab.—New South Wales. This is the common Sydney species.

Chaetophthalmus brevigaster Macquart.

Micropalpus brevigaster Macquart. Dipt. Exot., suppl. 1, 1846, 149.

Hab.—Tasmania. Very abundant in the island and recognisable by the male having a dense row of apical bristles on the preapical ventral sternite.

Micropalpus bicolor Macq.

Micropalpus bicolor Macquart. Dipt. Exot., suppl. 3, 1848, 44.

Hab.—New South Wales. I have no specimens from the type locality which is probably Sydney, but Tasmanian specimens before me agree except in having a jet black area on the parafrons and Malloch gives his specimen as being greenish-black there, whilst Macquart states "brunatre." I cannot judge how many species may be involved.

Micropalpus concavicornis Macq.

Micropalpus concavicornis Macquart. Dipt. Exot., suppl. 4, 1849, 173.

This species is not a *Micropalpus* in the restricted sense as the shape of the palpi and the very long spur of the radial vein are characters it bears in common with *Cuphocera*.

Hab.—Queensland to Tasmania. A very abundant Brisbane species.

Genus *Actia* Desvoidy.

Actia Desvoidy. Essai Myodares, 1830, 85.

These very small parasites of Lepidoptera are well known owing to their abundance, but the species are so dealt with that without types or specimens from the type localities, it is not often that they can be recognised again. Like all the Tachinidae they are subject to variations and doubtless several species are not valid and two names are reduced to synonymy here.

The Australian species described so far are recognisable by the venation which has setae at least along the fifth radial vein as far as the radio-median cross-vein and a pair of dorsal marginal bristles on the third tergite of the abdomen, no discal bristles on the second and third tergites. These together with other species yet to be described are allied to the European forms. There are three marked groups amongst those described and species within each show considerable intergrading.

A. eucosmae-group incorporated *eucosmae* Bezzi., *darwini* Mall., *baldwini* Mall., *niaritula* Mall., *plebeia* Mall., and probably *argentifrons* Mall. There are five valid species certain.

A. fergusoni-group incorporated *fergusoni* Bezzi, *valida* Curran, *parviseta* Mall., and probably *invalida* Mall., together with a number yet to be described. Three names are definitely valid.

A norma-group is a temporary name for a group containing species not certainly recognised and some undescribed forms. The former I would judge to be *norma* Mall. and *lata* Mall. although the descriptions are inadequate for this recognition. The forms before me are apparently associated but not necessarily conspecific.

The following key shows the leading features for the recognition of these three groups:—

1. Outer cross-vein remote from inner cross-vein (radio-median) being about half way towards the bend of the median vein 2
   Outer cross-vein near to, and not much more than its own length from, the inner cross-vein. Antennae short .. *eucosmae*-group.
2. Arista short, second segment often elongate and at most the third segment of arista as long as the third antennal segment .. .. *fergusoni*-group.
   Arista long, second segment always short and the third segment of arista always longer than the third antennal segment ? *norma*-group.

Host.—There are two species in collections reared from Noctuidae, namely *A. plebeia* Mall. from *Erias huegeli* Rogen, and *A. nigritula* Mall. from one of the plague caterpillars on grass.

Actia darwini Mall.

A. darwini Malloch. Proc. Lin. Soc. N.S. Wales, liv., 1929, 334.

A. brevis Malloch. Ibidem., lv., 1930, 309.

A. quadriseta Malloch. Ibidem., lx., 1936, 20.

Synonymy.—The name *brevis* applies to a reduced number, and *quadriseta* to an increased number of setae on the lower median vein, whilst the latter also has the fourth postsutural dorsocentral bristle present. Before me are specimens that incorporate these and other variations showing the synonymy can hardly be disputed.

Hab.—Widely distributed over the northern half of Eastern Australia and it is the most common *Actia* in the Brisbane district.

APPENDIX TO PART 2.

Pyrellia australiensis Curran.

P. australiensis Curran. Ent. Mitt., xvi., 1927, 345.

P. sp. Hardy. Proc. Roy. Soc., Queensland, xlviii., 1936, 25.

The name given by Curran was overlooked and the description indicates the identity of the species is that form left unnamed by me.

Genus *Balioglutum* Aldrich.

Balioglutum Aldrich. Proc. Nat. Mus., lxvi., 1925 9 (Smithsonian separates No. 2555).

This genus, hitherto unknown to me, belongs to the non-metallic group, with sternopleurals arranged 0:1 according to Aldrich and 1:1 on the specimen before me, and has the squama, pteropleura, prosternum, interfrontalia bare; wings as described by Aldrich except the "few distinct hairs below, none above," seems not to apply invariably within the genus, the third vein being entirely bare on the specimen before me. Prescutellar acrostichals absent and the arista with only a few filaments on the basal half. The typical species is described as having parafrontals and parafacials golden, which does not apply to the form before me where these are black.

Balioglutum illingworthi Aldrich.

B. illingworthi Aldrich. Ibidem., 1925, 10.

North Queensland.

An allied species, from Goondiwindi, represented by a single female has the superficial colour nearest to the slate blue of *Passeromyia,* red antennae, and an entirely dark frons which approaches best the shape of that on *Graphomya.*

The Zeolites of Queensland.

By Marjorie J. Whitehouse, B.Sc., Department of Geology, University of Queensland.

(*Read before the Royal Society of Queensland, 30th August, 1937.*)

The object of this paper is to give as complete a list as possible of the known Zeolites of Queensland together with the mode of occurrence of each, and its associated minerals. In addition a short account of the mode of formation of Zeolites in general is presented.

The peculiar properties of these minerals, particularly their continuous dehydration curves and capacity for base exchange, have attracted almost as much attention as their beauty and delicacy.

Zeolites, although hydrous minerals, are so often found filling cavities in igneous rocks that much interest in their origin has been aroused. The original theory, as stated in many works on mineralogy, is that they are secondary minerals derived by surface weathering and similar processes and owe their origin to the decomposition of minerals in the igneous rocks long after consolidation. A Harker (1904)[1] in "The Tertiary Igneous Rocks of Skye" introduced the radically different idea that Zeolites are products of the final phase of consolidation of the rocks and stated that the minerals produced by rock weathering differ from Zeolites in many important respects.

An intermediate position was taken by C. N. Fenner (1910)[2] for although he concluded that the vesicles of the Watchung Basalt were filled while it cooled, he thought the water concerned in the process was drawn not from the lava but from the underlying sediments.

J. J. Sederholm (1910)[3] introduced the term "deuteric" for "certain products occurring as an intergrowth of two minerals by reason of the action of magmatic end-stage emanations." R. J. Colony (1923) extended this term to cover not only the minute structures to which Sederholm referred but also to "all magmatic end-stage emanation phenomena, which frequently cause large scale changes and very profound effects, especially in the way of mineralisation."

J. L. Gillson, W. H. Callahan and W. B. Millar[4] in 1928 stated that the Adirondack gabbro was intruded by emanations or distillations of volatile constituents which rising from the chamber whence the gabbro came, produced "deuteric" minerals and afterwards pegmatites. F. F. Osborne[5] though he agreed with these facts thought the process was, nevertheless, secondary, not deuteric, and restricted the latter term to changes resulting from emanations derived by the crystallisation of the rock itself, and therefore produced in the rock towards the close of the period of crystallisation.

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[1] A. Harker (1904). "Tertiary Igneous Rocks of Skye," p. 41.

[2] C. N. Fenner (1910). Annals N.Y. Acad. Sci., Vol. 20, Pt. 2, pp. 95-187.

[3] J. J. Sederholm (1916). "On Synantetic Minerals and Related Phenomena." Bull. Geol. de Finlande, No. 48, p. 142.

[4] Gillson, J. L., Callahan, W. H., Millar, W. B. (1929). "Adirondack studies, the age of certain of the Adirondack gabbros and the origin of the reaction rims and peculiar border phases in them." Jour. of Geol., Vol. 36, pp. 149-163.

[5] F. F. Osborne (1929). Econ. Geol., Vol. 24, p. 335.

Sederholm[6] in 1929 redefined the term "deuteric" saying that his original purpose was "to make it possible to discriminate between such metasomatic changes as belong to a later period of metamorphism, *i.e.*, are secondary in the strictest sense of the word, and those that have taken place in direct continuation of the consolidation of the magma of the rock itself." The term was not meant to be descriptive of the process, but to denote changes in the minerals caused by the process. He thought it difficult to decide whether the solutions had emanated from the nearest portions of the rock masses undergoing crystallisation or from the magma still remaining liquid at depth, but he was inclined to lay more stress upon the first of these processes.

Inasmuch as many writers have now accepted this view that Zeolites are formed as final stages of consolidation and not as the first stages of destruction, they are now usually regarded as deuteric minerals.

Judging from the interest taken in these minerals overseas, it is rather remarkable that they have escaped attention for so long in Queensland. One of the first accounts of them is E. B. Lindon's paper, "A Catalogue of such minerals as are at present known in Queensland, with their principal associations and places of occurrence," published in 1887. In this Lindon records eight Queensland Zeolites known at the time.

R. L. Jack, with his usual keen powers of observation, noted several occurrences which are scattered through his reports.

In "The Queensland Mineral Index" Zeolites are recorded and all known localities are noted. This was published in 1913. From then until 1926 it is of interest to note that no Zeolites are mentioned in the reports of the Geological Survey.

QUEENSLAND ZEOLITES.

A brief account of the known Zeolites of Queensland with their localities is set out below. Those marked with an * indicate hitherto unrecorded specimens.

1. ANALCITE. Chem. Comp. Na Al $(SiO_3)_2 + H_2O$.
   Crystalline form: Isometric. Sp. Gr. 2.22-2.29.

   A. In cavities and amygdules in altered igneous rocks associated with Prehnite, Thomsonite and Laumontite.

   Loc. Bowen River about 50 to 60 miles S.S.W. of Bowen; at Pelican Creek a branch of the Bowen River, and at Strathmore Creek.

   Ref. "Report on the Bowen River Coalfield," by R. L. Jack. Geol. Surv. Qld. Pub. 4, 1879, p. 6.

   See 7A and 12A.

   B. In basalt.

   Loc. Peak Downs Goldfield, Clermont.

   Ref. "Handbook of Queensland Geology," by R. L. Jack, 1886.

   C. Associated with Natrolite and Calcite.

   Loc. Morinish Goldfield, 29 miles N.W. of Rockhampton.

   Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld. Pub. 241, 1913.

   See 8K.

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[6] J. J. Sederholm (1929). Econ. Geol., Vol. 24, p. 869.

D. In decomposed basalt.

Loc. Fitzroy River, Rockhampton.

Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld. Pub. 241, 1913.

2. APOPHYLLITE. Chem. Comp. $H_7K\ Ca_4\ (SiO_3)\ O_8 + H_2O$.
Crystalline form: Tetragonal. Sp. Gr. 2.2-2.4.

(Although not a true Zeolite this mineral is so closely related that it is included in this report.)

A. In basalt.

Loc. Evelyn Run, 11 miles S. of Herberton.

Ref. "List of Minerals, Walsh and Tinaroo Mining District, North Queensland," by J. Stewart Berge, J. Harrison Brownlea, R. Colin Ringrose. Proc. Roy. Soc. Qld., vol. 15, 1900, p. 61.

B. In basalt.

Loc. Jump-Up Mine, Herberton road, 9 miles S.S.W. of Alberton Rail Station. Walsh and Tinaroo Mineral Fields.

Ref. "List of Minerals, Walsh and Tinaroo Mining District, North Queensland," by J. Stewart Berge, J. Harrison Brownlea, R. Colin Ringrose. Proc. Roy. Soc. Qld., vol. 15, 1900, p. 61.

C. In vein of Quartz in granite country.

Loc. Hidden Treasure Mine, East side of Mundic Creek, 24 miles S.S.W. of Rockhampton.

Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.

3. CHABAZITE. Chem. Comp. $(Ca.\ Na_2)\ Al_2\ Si_4\ O_{12} + 6H_2O$.
Crystalline form: Rhombohedral. Sp. Gr. 2·08-2·16.

A. In basalt, Peak Downs Goldfield, Clermont.

Ref. "Handbook of Queensland Geology," by R. L. Jack, 1886.

B. In basalt, associated with Stilbite. Found by A. C. Gregory. Loc. Toowoomba.

Ref. "Catalogue of Minerals exhibited in the Qld. Court Colonial and Indian Exhibition of 1886," p. 131.

See 11A.

C. In decomposed basalt, Freestone Creek, north of Warwick.

Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.

Note: Specimen in Queensland Museum labelled "Chabazite Loc. Darling Downs" may also refer to this specimen.

*D. In cavities in basalt associated with Natrolite, Calcite, and Quartz.

Loc. Round Mountain, 12 miles S. of Beaudesert.

See 8N.

3. CHABAZITE (var. PHACOLITE).

E. Associated with Calcite, Ferro-calcite and Natrolite in basic volcanic tuff.

Loc. Railway cutting between Spring Bluff and Harlaxton Railway Station, 5 miles north of Toowoomba.

Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913. See 8E.

F. Associated with Calcite, Magnesite, and Natrolite in decomposed basalt.

Loc. Mt. Davidson, 5 miles S.S.E. of Toowoomba.

Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.

See 8H.

4. GISMONDITE. Chem. Comp. $Ca.Al_2\ (SiO_3)_4 + 4H_2O$ (?). Crystalline form: Monoclinic. Sp. Gr. 2.265.

A. In basalt, Rosewood Goldfield, 32 miles N.W. of Rockhampton. Recorded from specimen in Queensland Museum.

Ref. E. B. Lindon "Catalogue of such minerals as are at present in Queensland, with their principal associations and places of occurrence." Proc. Roy. Soc. Qld., vol. 4, 1887, p. 68.

B. In vughs in "granite" associated with Laumontite, Prehnite, Calcite, Chlorite, and Pyrite.

Loc. Enoggera.

Ref. "The Deuteric Mineral Sequence at Enoggera, Queensland," by M. J. Whitehouse. Min. Mag., vol. XXIV., No. 157, June, 1937.

See 7G.

5. HARMOTOME. Chem. Comp. $H_2(K_2\ Ba)\ Al_2\ Si_5\ O_{15}$. Crystalline form: Monoclinic. Sp. Gr. 2.44-2.50.

A. Muldiva Mines, 7 miles W.S.W. of Almaden Railway Station (Chillagoe Line). Walsh and Tinaroo Mineral Field.

Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld, Pub. 241, 1913.

6. HEULANDITE.. Chem. Comp. $H_4\ Ca\ Al_2\ Si_6\ O_{18} + 3H_2O$. Crystalline form: Monoclinic. Sp. Gr. 2-18-2.22.

A. Associated with Calcite and Quartz.

Loc. Plant's Shaft, Golden Gate Gold Mines, Golden Gate Reef, 4 miles N.W. of Croydon Railway Station, Croydon Gold Field.

Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld. Pub. 241, 1913.

B. As a lining in geodes in granite.

Loc. Enoggera.

Ref. Geol. Surv. Museum.

(This Zeolite is not Heulandite but Laumontite q.v.)[1]

[1] See "Deuteric Mineral Sequence at Enoggera, Queensland," by M. J. Whitehouse. Min. Mag., Vol. XXIV., No. 157, June, 1937.

*C. With Natrolite on melophyre.
Loc. Agricultural Reserve, Rockhampton, Qld.
Ref. Queensland Museum.
See 8o.

D. (or Stilbite) In Quartz veins.
Loc. Plant's Shaft, Golden Gate Reef, 4 miles N.W. of Croydon Railway Station.
Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.
See 11D.

7. LAUMONTITE. Chem. Comp. H_4 Ca Al_2 Si_4 $O_{14} + 2H_2O$.
Crystalline form: Monoclinic. Sp. Gr. 2.25-2.36.

A. In cavities and amygdules in altered igneous rocks associated with Prehnite, Thomsonite, and Analcite.
Loc. Bowen River, about 50-60 miles S.S.W. of Bowen, at Pelican Creek, a branch of the Bowen River, and at Strathmore Creek.
Ref. "Report on Bowen River Goldfield," by R. L. Jack. Geol. Surv. Qld. Pub. 4, 1879, p. 6.
See 1A and 12A.

B. Associated with Calcite, Chalcedony, and Agate in basic rock.
Loc. Nr. McGregor, 2½ miles N.E. of Mt. Toby, 2½ miles N.N.E. of Mirani Railway Station (Mackay Line).
Ref. "Report on Geological Features of Hazledean with notes on the Coal, Limestone, and other Mineral Products of the Mackay District." Geol. Surv. Qld., Pub. 164, 1901.

C. In altered igneous rocks.
Loc. Bowen River, about 50 miles S.W. of Bowen.
Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.

D. Associated with Quartz, Calcite, and Stilbite, in andesite.
Loc. Cracow.
A chemical analysis of this mineral is:—

	Per cent.
Water	14·2
SiO_2	50·5
Al_2O_3	22·4
CaO	12·5
Soda (by Dif.)	0·4

Ref. "The Cracow Goldfield," by A. K. Denmead. Qld. Govt. Mining Jour., September, 1932, p. 374.
See 11E.

E. As veinlets or lining joint planes associated with Calcite, Chlorite, Pyrite, and Stilbite in the andesitic lode material.
Loc. Mt. Coolon.
Ref. "Mount Coolon Goldfield," by C. C. Morton. Qld. Govt. Min. Jour., June, 1930, p. 199.
See 11H.

F. As a lining in geodes in granite.
Loc. Enoggera.
Ref. Geol. Surv. Museum.

G. In veins and vughs associated with Prehnite, Gismondite, Calcite, Chlorite, Epidote, Tourmaline, Fluorite, Sphalerite, Molybdenite, and Kaolin in "granite."
Loc. Enoggera.
An analysis of this is—

	Per cent.
SiO_2	52·13
Al_2O_3	23·04
Fe_2O_3	0·20
CaO	11·85
MgO	trace
Na_2O	0·14
H_2O	12·64

Ref. "Deuteric Mineral Sequence at Enoggera, Queensland," by M. J. Whitehouse. Min. Mag., Vol. XXIV., No. 157, June, 1937.
See 4B.

8. NATROLITE. Chem. Comp. $Na_2\ Al_2\ Si_3\ O_{10} + 2H_2O$.
Crystaline form: Orthorhombic. Sp. Gr. 2.20-2.25.

A. In basalt, Peak Downs Goldfield, Clermont.
Ref. "Handbook of Queensland Geology," by R. L. Jack, 1886.

B. In basalt.
Loc. Toowoomba and near Ipswich.
Ref. "Catalogue of such minerals as are at present known in Queensland with their principal associations and places of occurrence," by E. B. Lindon. Proc. Roy. Soc. Qld., vol. 4, 1887, p. 67.

C. At Muldiva, 7 miles W.S.W. of Almaden Railway Station (Chillagoe line). Walsh and Tinaroo Mining Fields.
Ref. "List of Minerals, Walsh and Tinaroo Mining District, N. Qld.," by J. Stewart Berge, J. Harrison Brownlea, and R. Colin Ringrose. Proc. Roy. Soc. Qld., Vol. 15, 1900, p. 61.

D. In basalt.
Loc. Deep Lead, Herberton, 12 miles S.S.W. of Atherton Railway Station. Walsh and Tinaroo Mining Fields.
Ref. "List of Minerals, Walsh and Tinaroo Mining District, N. Qld," by J. Stewart Berge, J. Harrison Brownlea, and R. Colin Ringrose. Proc. Roy. Soc. Qld., Vol. 15, 1900, p. 61.

E. Associated with Chabazite (var. Phacolite), Calcite, and Ferro-calcite in basic volcanic tuff.
Loc. Railway cutting between Springbluff and Harlaxton Railway Stations, 5 miles N. of Toowoomba.
Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.
See 3E.

F. In decomposed basalt.
Loc. Rosella Creek, Havilah, Bowen River.
Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.

G. Loc. Boonah, 55 miles S.S.W. of Brisbane.
Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.

H. Associated with Calcite, Chabazite, and Magnesite in decomposed basalt.
Loc. Mt. Davidson, 5 miles E.S.E. of Toowoomba.
Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.
See 3F.

J. In vesicular basalt. Collected by L. C. Ball.
Loc. "The Falls," Mapleton, about 7 miles S.W. of Nambour Railway Station.
Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.

K. Associated with Analcite and Calcite.
Loc. Morinish Goldfield, 29 miles N.W. of Rockhampton.
Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.
See 1C.

*L. Loc. Minden, Rosewood District.
Ref. Geol. Surv. Museum.

*M. Associated with Chalcedony in basalt.
Loc. Ravenswood.
Ref. Qld. Museum, Reference Collection.

*N. In cavities in basalt associated with Chabazite, Calcite, and Quartz.
Loc. Round Mountain, Beaudesert District.
See 3D.

*O. With Heulandite on melaphyre.
Loc. Agricultural Reserve, Rockhampton.
Ref. Queensland Museum.
See 6C.

9. Scolecite. Chem. Comp. $Ca(AlOH)_2\ (SiO_3)_3 + 2H_2O$.
Crystalline form: Monoclinic. Sp. Gr. 2.16-2.4.

A. Magnet Copper Mine, Cloncurry Field.
Ref. Geol. Surv. Museum.

B. Associated with Calcite in granite.
Loc. Mary Mine, Charters Towers Goldfield.

Analysis:—	Per cent.
SiO_2	49·04
Al_2O_3	26·64
CaO	12·24
H_2O (by ignition)	13·30
Fe_2O_3	trace

Ref. "On the Mineral Scolecite occurring on Granite, Charters Towers," by A. W. Clarke. Proc. Roy. Soc. Qld., Vol. 4, 1887, p. 110.

C. Associated with Calcite in granite.
Loc. Mexican Mine, Charters Towers Goldfield.

Analysis:—

	Per cent.
SiO_2	47·24
Al_2O_3	26·64
CaO	12·95
H_2O	14·20
Fe_2O_3	trace

Ref. "On the Mineral Scolecite occurring on Granite, Charters Towers," by A. W. Clarke. Proc. Roy. Soc. Qld., Vol. 4, 1887, p. 110.

D. Associated with Calcite in granite.
Loc. Queen Block Extd. Mine, Charters Towers Goldfield.

Analysis:—

	Per cent.
SiO_2	46·25
Al_2O_3	27·35
CaO	13·95
H_2O	13·47
Fe_2O_3	traces

Ref. "On the Mineral Scolecite occurring on Granite, Charters Towers," by A. W. Clarke. Proc. Roy. Soc. Qld., Vol. 4, 1887, p. 110.

(*Note.*—In the same year the above report was published, E. B. Lindon wrote: "A Note on a paper entitled 'On the Mineral Scolecite occurring on Granite, Charters Towers,' in which he questioned whether the mineral was really Scolecite and suggested Laumontite for it.

Clarke replied that on comparing chemical analyses it was nearer to Scolecite.)

10. SLOANITE. Chem. Comp. Hydrated aluminous silicate of lime and magnesium.
Crystalline form: Orthorhombic. Sp. Gr. 2.441.

A. Indentified from basalt of Darling Downs.
Ref. "Catalogue of Minerals exhibited at Queensland Court, Colonial and Indian Exhibition, 1886," p. 131.

(*Note.*—M. H. Hey in "Studies of the Zeolites, Part II."[1] states "Sloanite is another species set up by Meneghini and Bechi (1852); their original analysis is very poor, but the description suggests laumontite, and this the British Museum specimen (b.M.31348, presented by the Chevalier Sloane in 1860) unquestionably is. E. Manasse (1906) analysed a specimen of natrolite under this name, and Dana (Syst. Min. App. II. 1909, p. 74) says this analysis proves sloanite to be a variety of thomsonite, a slip several authors have copied)."

[1] Min. Mag., Vol. XXIII., No. 137, 1932, p. 114.

11. Stilbite. Chem. Comp. $(Na_2Ca) Al_2 Si_6 O_{16} + 6H_2O$.
Crystalline form: Monoclinic. Sp. Gr. 2.094-2.205.

A. In basalt associated with Chabazite.

Loc. Toowoomba.

Ref. "Catalogue of the minerals exhibited in the Queensland Court, Colonial and Indian Exhibitions of 1886," p. 131. See 3B.

B. Loc. On the Fitzroy River, Rockhampton.

Ref. "Catalogue of such minerals as are at present known in Queensland, with their principal associations and places of occurrence," by E. B. Lindon. Proc. Roy. Soc. Qld., Vol. 4, 1887, p. 67.

C. Associated with Haematite, Wolfram, Garnet, and Mica in lode in granite.

Loc. Eungella Station, Broken River.

Ref. "Report on the Geological Features of the Mackay District," by R. L. Jack. Geol. Surv. Qld., Pub. 39, 1887, p. 6.

D. (or Heulandite). In Quartz veins.

Loc. Plant's Shaft, Golden Gate Reef, 4 miles N.W. of Croydon Railway Station.

Ref. "Qld. Mineral Index," by B. Dunstan. Geol. Surv. Qld., Pub. 241, 1913.

See 6D.

E. Associated with Quartz, Laumontite, Calcite in veins and fissures, sometimes with payable gold in andesite.

Loc. Rainbow, Spec. and Golden Gate Leases, Cracow.

Ref. "Recent Developments at Cracow," by A. K. Denmead, Qld. Govt. Min. Jour., 1933, p. 238.

See 7D.

F. With Calcite, Pyrite, and Quartz in regular or irregular veins in andesite tuff and conglomerate.

Loc. Walhalla, 8 miles by road N.N.W. from Cracow.

Ref. "Recent Developments at Cracow," by A. K. Denmead. Qld. Govt. Min. Jour., 1933, p. 239.

G. In veins in granite with Quartz, Calcite, pink Kaolinic material and a waxy mineral resembling Halloysite.

Loc. Golden King Claim, Almaden.

Ref. "Golden King Claim, Almaden," by A. K. Denmead. Qld. Govt. Min. Jour., 1934, p. 75.

H. Occurs with Laumontite, Calcite, Pyrite, and Chlorite in andesitic lode material either as disseminated particles or as veinlets lining joint planes.

Loc. Mt. Coolon Goldfield.

Ref. "Mt. Coolon Goldfield," by C. C. Morton. Qld. Govt. Min. Jour., 1935, p. 199.

See 7E.

*J. In rhyolite.
Loc. Cave on south side of Glen Rock, Esk.
Ref. Univ. of Qld. Dept. of Geology Museum.

*K. Associated with Calcite.
Loc. Aramac.
Ref. Qld. Museum, Reference Collection.

12. THOMSONITE. Chem. Comp. $(Na_2\ Ca)\ Al_2\ (SiO_4)_2 + 2\frac{1}{2}H_2O$. Crystalline form: Orthorhombic. Sp. Gr. 2.3-2.4.

A. In cavities in amygdaloidal volcanic rock associated with Prehnite, Analcite, and Laumontite.
Loc. Bowen River, about 50-60 miles S.S.W. of Bowen, at Pelican Creek, a branch of the Bowen River, and at Strathmore Creek.
Ref. "Report on the Bowen River Coalfield," by R. L. Jack. Geol. Surv. Qld., Pub. 4, 1879, p. 6.
See 1A and 7A.

13. ZEOLITES.

(References are sometimes found to Zeolites in general, the particular variety not being mentioned.)

A. A stellate group of Zeolites growing on Cassiterite.
Loc. Chance Mine, Watsonville.
Ref. "Catalogue of Minerals exhibited in the Queensland Court, Colonial and Indian Exhibition of 1886," p. 25.

B. In basalt.
Loc. Burleigh Heads, Point Danger, and Tambourine Mountain.
Ref. "Handbook of Queensland Geology," by R. L. Jack, 1886.

C. Associated with Prehnite in volcanic rocks, both basic and acid in the Lower Bowen beds.
Loc. Outcropping along the Nogoa River from Nandowrie Peak to Springsure.
Ref. "Geological Reconnaissance between Roma, Springsure, Tambo, and Taroom," by H. I. Jensen. Qld. Geol. Surv., Pub. 277, p. 14.

D. In geodes lined internally with Chalcedony.
Loc. Nanango.
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The Genus *Iseilema* in Queensland.

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(*Read before the Royal Society of Queensland, 30th August,* 1937.)

(Plates III. and IV.)

Species of the genus *Iseilema* are well known to Queensland graziers under the collective name of "Flinders grass." In Hooker's *Icones Plantarum tt.* 3284-6 (1935) appears a monograph of the Australian species of this genus by C. E. Hubbard. Nine species are described, of which eight occur in Queensland. Of these, two are based on solitary specimens (*I. ciliatum* C. E. H., and *I. dolichotrichum* C. E. H.), and one (*I. convexum* C. E. H.) is based chiefly on cultivated specimens. Two supposed hybrids are also described.

As a result of intensive field work carried out over large areas of the State during the years 1934-6, knowledge of the genus has been considerably extended. In 1936 the species were particularly abundant over large areas and copious herbarium material was secured, while an excellent opportunity was afforded for working out the field relations between the species.

In the following brief account of the results of this investigation, the species are discussed collectively and individually. Two new species are described, two more hybrids are indicated, and a key to all known forms is included. In constructing the latter, characters have been employed which require some explanation as they were not mentioned by Hubbard.

The usual raceme of the *Andropogoneae* consists in *Iseilema* of a cluster of seven spikelets, of which the four outer are pedicelled with the pedicels fused together at the base. Within this group of involucral spikelets is a short internode (the rhachis) bearing the sessile fertile spikelet (female in the Australian species) and two pedicellate male or neuter spikelets. The involucral spikelets may be male or neuter, and in the latter case may be considerably reduced or represented merely by rudimentary pedicels. In most species they are contracted rather abruptly just below the junction with the pedicel, and in such cases there is a fairly prominent transverse furrow at the actual junction (as seen from the front). In some cases, however, the spikelet is attenuate at base with usually no transverse furrow, so that, when viewed from the front, the spikelet appears to pass gradually into its pedicel.

Each raceme is subtended by a spathe, and one or more spathes, each with its raceme, is more or less enclosed, at least when young, in a leaf-sheath. At maturity, the racemes of most species become laterally exserted and finally disarticulate, thus forming a special kind of "seed." In three species, however, the mature racemes remain more or less tightly embraced by the floral leaf-sheaths. The inflorescence breaks up at maturity, and the "seed" consists of the floral leaf with the raceme enclosed in its sheath. This is referred to as a "leafy seed."

The species are tufted, branched, shallow-rooted annuals, though under favourable conditions growth may continue for many months. For the most part they occur in soils of a heavy nature, and they are essentially summer-growing grasses. But it is interesting to note that on 11th May, 1936, at Kalkadoon Station, south-west of Winton, plants of *I. membranaceum* and *I. vaginiflorum* were collected which were evidently the result of a germination following a shower which fell nine days previously. Though scarcely an inch high, they were flowering. And in July, the Flinders grasses were in full vigour at Birdsville, where also *I. membranaceum* was found in a most unusual habitat, playing the rôle of coloniser on a low sandhill.

When in full vigour, the leaf is usually rather pale green in colour, rarely purplish, while the culms and sheaths are frequently highly coloured, reddish or purplish; sometimes the culms are slightly pruinose. As the plants dry off the leaf assumes a characteristic reddish-brown hue seen also in other *Andropogoneae* (*Themeda, Eulalia, Schizachyrium,* &c.). The precise shade of brown varies from species to species, while the tint is also influenced by local conditions. A few points of rain in winter bleaches the grass, rendering it very brittle and unpalatable. This "blackening," as it is generally called, is not confined to these grasses.

Several species, as indicated below, possess a very characteristic fragrance which is lost on drying. The scent is precisely that of the inflorescence of *Capillipedium parviflorum* Stapf. *I. dolichotrichum* has the peculiar resinous odour of the *Triodia* among which it grows, and which is also possessed by several other plants of the region, such as *Acacia costinervis* Domin, and *Cyperus Cunninghamii* (C. B. Clarke) C. A. Gardner.

Some of the species have been found attacked by the smut *Cintractia iseilematis* D. A. Herbert.[1]

The Flinders grasses as a whole are considered to be among the most palatable and most nutritious of grasses, and they produce excellent hay. The one great drawback is their annual habit. On the Darling Downs, where they appear to be recent invaders, they are apparently not so valuable.

Most of what is known of the genus in this regard refers to the two most widely distributed species, *I. membranaceum* and *I. vaginiflorum*. Around the Gulf of Carpentaria *I. macratherum* is the common species, and is considered to be less valuable than the species further south. Whether this is due to local climatic conditions or is an inherent quality of the species remains to be proved, but it is worthy of remark that some grasses, including the Mitchell grasses (*Astrebla* spp.), definitely do depreciate in value in this region. Of the other species nothing is known beyond the fact that in August, 1936, I found *I. Windersii* to be closely grazed in good mixed pasture north of Hughenden.

There follow the descriptions of the two new species, the types of which are in the Queensland Herbarium, Brisbane.

Iseilema eremaeum S. T. Blake sp. nov. affinis *I. membranaceo* (Lindl.) Domin sed basibus racemorum pilis albis usque ad 5 mm. longis dense barbatis, pedicellis spicularum involucralium tantum leviter sulcatis, spathis parce glandulosis, gluma inferiore spiculae fertilis parce pubescente vix scabrida.

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[1] D. A. Herbert: "Records of Queensland Fungi II." Queensland Naturalist X. (3), 59-60, 1937.

Gramen annuum usque ad 20 cm. altum, plerumque multo humilius. *Culmi* caespitosi, obliqui vel erecti, graciles, vix compressi, rigidi, ramosi (raro simplices), infra inflorescentiam plerumque 1-nodes, glabri laevesque. *Folia* plerumque pallide viridia (in sicco nec glaucescentia), saepe purpurascentia, vetera brunnescentia; vaginae compressae et acute carinatae, laeves, haud glanduliferae, internodis saepe longiores, tenuiter nervosae, marginibus hyalinae; ligulae truncatae, tenuiter membranaceae, ciliatae, 0·7-0·9 mm. longae; laminae lineares vel superiores angustae lanceolatae, acutae, usque ad 6 cm. longae, sed plerumque breviores, carinatae, conduplicatae vel explanatae usque ad 4 mm. latae, rigidae, marginibus carinisque scabridulis exceptis glaberrimae laevesque. *Inflorescentia* foliacea, densa, 2-10 cm. longa; internodia primaria filiformia, inferiora usque ad 1·3 cm. longa, superiora gradatim breviora; foliorum vaginae 8-10 mm. longae, acute carinatae, herbaceae, pallide virides vel purpurascentes tandem pallide brunneae, tenuiter nervosae, marginibus late hyalinae, carina superne scabridae, ceterum laeves haud glanduliferae; spathae ambitu lanceolatae vel elliptico-lanceolatae acutae, herbaceo-membranaceae vel demum papyraceae, tenuiter nervosae, marginibus late hyalinae, 6-10 mm. longae, acute carinatae, carina glandulas minutas sessiles paucas praedita superne hispida. *Racemi* tandem lateraliter exserti, 7-8 mm. longi, oblongi vel elliptico-oblongi, tandem a pedunculis disarticulantes; pedunculi filiformes 1·5-2·0 mm. longi, apice tuberculos minutos gerentes vel laeves; rhachis 0·5-1·0 mm. longa, pilis albis paucis ad 3·2 mm. longis praedita. Spiculae involucrales masculae (vel neutrae?) fere contiguae, ellipticae vel oblongo-ellipticae, acutae, 3-4 mm. longae, dorso compressae, pallide virides vel purpurascentes; pedicelli graciles compressi, ca. 1·5 mm. longi, glabri, apice levissime transversim sulcati, basi connati et pilis albis sericeis ad 5 mm. longis dense barbati; gluma inferior dorso plana vel leviter convexa, tenuiter coriacea, marginibus angustis inflexis tenuiter membranaceis, 7-11-nervis, dorso sparse asperula vel fere laevis, carinis scabrida et interdum glandulis minutis sessilibus perpaucis praedita; gluma superior oblanceolato-oblonga, acutiuscula, coriacea vel membranacea, 3-nervis, glaberrima, 3-3·6 mm.. longa; lemma inferius anguste oblongum, obtusum, hyalinum, enerve, glabrum, usque ad 3·3 mm. longum; lodiculae cuneatae truncatae; antherae 0·8-1·0 mm. longae. *Spicula fertilis* femina lanceolata, acuminata, 5·0-5·5 mm. longa; gluma inferior coriacea, biloba, inferne marginibus incurva, superne bicarinata carinis scaberula, dorso in parte superiore parce et breve pubescens, ceterum glabra laevisque, 8-nervis; gluma superior lanceolata, acute acuminata, coriacea, marginibus incurvis, hyalina, 3-nervis; nervo medio apicem versus scabridula, ceterum glabra laevisque; lemma inferius ovatum, obtusum, emarginatum, hyalinum, enerve, 2·9-3·3 mm. longum; lemma superius lineare integrum, 3·5 mm. longum; arista 13-16 mm. longa, columna minute scaberula, 5·0-6·5 mm. longa; paleae desunt; caryopsis ellipitica, 2·5 mm. longa. *Spiculae pedicellatae* masculae (vel neutrae?), lanceolatae, subacutae, 2-3 mm. longae; pedicelli filiformes 2·5-3·0 mm. longi, scabridi et pilis longis sericeis paucis praediti; gluma inferiora membranacea, 7-9-nervis, carinis superne scabrida nonnunquam parce glandulifera, ceterum laevis; gluma superior hyalina, 3-nervis; lemma inferius anguste oblanceolatum, hyalinum, usque ad 2·5 mm. longum.

Gregory North District: Marion Downs between Bedourie and Boulia on upper slopes of low stony hill ca. + 150 ft., 23-7-1936 *Blake* 12347. Gregory South District: Birdsville, on fine drift sand on gibber slopes 19-7-1936, *Blake* 12213 (type).

The species can be recognised by the complete absence of glands on culms, leaves and floral sheaths, the rather small long-bearded racemes, the pedicels of the involucral spikelets glabrous except at the very base, and the slightly hairly lower glume of the fertile spikelet.

Most interesting is the discovery of this species so far from the centre of concentration of the genus, and in a region of such low rainfall (5-8 in.). At Birdsville the plants were found on the slopes of the gravelly downs (Sturt's Stony Desert) at some few miles both to the east and to the north of the town in company with *I. vaginiflorum* and the hybrid swarm between them. In the former place the accompanying plants were chiefly *Bassia* spp. and *Stenopetalum lineare*. In the latter place they were associated with scattered trees of the peculiar almost *Pinus*-like "waddy" (*Acacia Peuce* F. Muell.), *Chenopodiaceae*, and scattered *Astrebla pectinata*. On Marion Downs the plants were found on the slopes of one of the flat-topped sandstone hills which are scattered over the gravelly downs in this region. Other annual plants were associated.

Iseilema fragile S. T. Blake sp. nov. affinis *I. vaginifloro* Domin, a quo differt inflorescentia fragillima, vaginis floriferis (induratis) subcylindricis convolutis, spathis inferne semicylindricis, spiculis involucralibus cum earum pedicellis semper ad squamas minutas redactis.

Gramen annuum fragillimum usque ad 20 cm. altum. *Culmi* caespitosi, obliqui vel erecti, graciles sed rigidi, admodum compressi, laeves, ramosissimi, ramis saepissime fasciculatis. *Folia* pallide viridia, vetera rubro-brunnea; vaginae compressae carinatae, nervosae, superne scabridulae; ligulae membranaceae, laceratae vel ciliatae, ca. 0·75 mm. longae; laminae lineares usque ad 7 cm. longae et ad 4 mm. latae, acutae utraque pagina plus minusve scabridulae. *Inflorescentia* foliacea, partes ultimae densae 1-3 cm. longae; internodia primaria 3-5, facillime disarticulantia, gracilia, usque ad 4 mm. longa, superiora gradatim breviora, trigona, glabra, laevia; foliorum vaginae vix vel haud carinatae, subcylindricae, cartilagineae, marginibus tenuiores convolutae, 5-7 mm. longae, ca. 1 mm. diam., plurinerves, laeves. *Racemi* (aristis exceptis) cum spathis fere omnino obtecti, anguste lineares 8 mm. longi.; spathae ambitu linearo-oblanceolatae, acutae, plurinerves, cartilagineae, albidae, apicem versus herbaceae vel subpapyraceae et nervis viridibus manifestis, marginibus anguste hyalinae, 8-12 mm. longae; pedunculi graciles 0·75-1·0 mm. longi, glabri laevesque; rhachis glabra ca. 0·75 mm. longa. *Spiculae involucrales* nullae, earum pedicelli ad squamas minutas semper redacti. *Spicula fertilis* feminea, anguste lanceolata, acuminata, 7 mm. longa; gluma inferior lanceolata, acuminata, breviter acuteque biloba, marginibus inferne incurvis apice versus bicarinatis, carinis hispidulis exceptis glabra, 8-nervis, tenuiter cartilaginea; gluma superior lanceolata acuminata, 3-nervis, marginibus inflexis hyalina; lemma inferius hyalinum, lanceolatum, obtusum apice laceratum, 4·0-4·2 mm. longum; lemma superius lineare, bilobum, lobis filiformibus 0·5-0·7 mm. longis, hyalinum, 1-nerve, 5 mm. longum; arista valde geniculata 16-18 mm. longa, columna scabridula, 7 mm. longa; caryopsis oblongo-elliptica, 3·75 mm. longa. *Spiculae pedicellatae* dimorphae, quarum una mascula vel neutra, una semper neutra, lanceolatae vel anguste lanceolatae, acutae, usque ad 4·2 mm. longae; pedicelli gracillimi, complanati, marginibus hispiduli, 3·0-3·5 mm. longi; gluma inferior tenuiter membranacea, 4-6-nervis, laevis, vel minuta; gluma superior hyalina, 3-nervis vel nulla; lemma inferius lineare, apice acute trilobum, hyalinum, enerve, usque ad 2·75 mm. longum vel nullum; lemma superius nullum; lodiculae lineares bilobae, vel nullum; antherae 1·3-1·6 mm. longae.

Burke District: Iffley Station, approx. 19° 25′ S., 141° 1′ E., on grassland (*Astrebla*, &c.) plain on heavy dark grey soil, 20-8-1936, *Blake* 12636; Rocklands Station, Camooweal, grassland plain on grey gravelly clay loam, 750 ft., 1-5-1935, *Blake* 8844A; Julia Creek, 3-1934, *Moodie*; comm. *Agric. Chemist* lab. 4747 (mixed with *I. vaginiflorum* Domin); Richmond, river flats and channels on heavy brown loam ca. 700 ft., 9-6-1936, *Blake* 11676; Hughenden, grassland downs on grey-brown clay loam ca. 1,100 ft., 19-5-1936, *Blake* 11545 (type). Mitchell District: Prairie, grassland plains on heavy dark soils, 1,400 ft., 22-5-1936, *Blake* 11616. Moreton District: Brisbane, cultivated on sandy soil from seed of type-collection, 11-4-1937, *Blake* 12924.

Easily recognised by its copiously branched habit, its extreme fragility, the hard and shining nearly terete floral sheaths with convolute margins, the spathes semicylindric and hardened in their lower part, and the absence of involucral spikelets, this distinctive and most interesting species exhibits the greatest amount of reduction in the genus. The involucral spikelets are constantly reduced to the merest rudiments of pedicels, one of the pedicellate spikelets appears to be constantly neuter and reduced, while one raceme was found bearing apparently perfect grain where *both* pedicellate spikelets were reduced to a more or less rudimentary glume.

In *I. vaginiflorum* Domin, which the species most resembles, the floral sheaths are rounded on the back with slightly convex sides and appressed margins and enclose two or more racemes of which the outermost has at least some of the involucral spikelets prominent though usually reduced to the lower glume. The others show increasing degrees of reduction and approach those of *I. fragile*. As in the other species, however, the spathe is acutely keeled.

In habit *I. fragile* resembles *I. macratherum*, but is a smaller and more slender plant. Because of the ease with which the plants break up, perfect herbarium specimens are difficult to prepare.

The species was fairly abundant in the neighbourhood of Hughenden where it appeared to be quite indifferent to variations in drainage conditions. Nothing is known as to its particular merits as a fodder grass.

KEY TO THE AUSTRALIAN SPECIES OF ISEILEMA AND THEIR HYBRIDS.

Racemes becoming laterally exserted and finally disarticulating from their peduncles; involucral spikelets abruptly contracted into their pedicels with a transverse furrow at junction, or if not, then the racemes bearded at base with hairs up to 5 mm. long; inflorescence not disarticulating at maturity, the floral leaf sheaths herbaceous, always sharply keeled.

- Racemes either glabrous at base or bearded with hairs 1-3 mm. long, or if up to 5 mm. long, then involucral spikelets at least 5 mm. long on short pedicels; involucral spikelets abruptly contracted into their pedicels and transversely furrowed at junction.
  - Involucral spikelets 4-6·5 mm. long on pedicels $\frac{1}{6}$-$\frac{1}{4}$ their length.
    - Racemes glabrous, lower lemma 1-3- nerved .. .. 1. *I. calvum*
    - Racemes bearded at base, lower lemma nerveless.
      - Leaf-blades with long tuberculate-based hairs; keels of involucral spikelets long-ciliate .. .. .. 2. *I. ciliatum*
      - Leaf-blades glabrous, keels of involucral spikelets pubescent or scabrous.
        - Floral leaf-sheaths glandular on keel, involucral spikelets flattened on back, densely pubescent.
          - Racemes bearded at base with hairs 2-3 mm. long .. .. .. 3. *I. Windersii*
          - Racemes bearded at base with hairs 4-5 mm. long .. .. .. 0. *I. trichopus*
        - Floral leaf-sheath eglandular, lower glume of involucral spikelets very convex on back .. .. 4. *I. convexum*
  - Involucral spikelets 3-4 mm. long, on pedicels $\frac{1}{3}$-$\frac{1}{2}$ their length, scabrous on back .. .. 5. *I. membranaceum*
- Racemes densely bearded at base with hairs up to 5 mm. long, involucral spikelets attenuate on to their pedicels which are $\frac{1}{3}$-$\frac{1}{2}$ their length and not or but slightly furrowed at the junction.
  - Pedicels of involucral spikelets bearded only at base; plants eglandular except for scattered glands on keels of spathes and sometimes of involucral spikelets 6. *I. eremaeum*
  - Pedicels of involucral spikelets bearded throughout; upper part of internodes and keels of floral sheaths closely glandular 7. *I. dolichotrichum*

Racemes either quite enclosed within the floral sheaths, or if more or less exserted, then glabrous or shortly bearded (hairs rarely up to 3 mm. long), the involucral spikelets attenuate on their pedicels which are about ⅓ their length, with no or only an indistinct transverse furrow, or the spikelets reduced or absent; inflorescence usually readily disarticulating at maturity, the racemes usually falling with their sheaths.

Floral leaf-sheaths herbaceous or somewhat indurated, keeled, racemes at length more or less exserted, sometimes disarticulating; involucral spikelets more or less developed, rarely absent.

Awn 2-3 cm. long; plant rather regularly glandular on edge and keel of leaf and on keel of floral sheath .. .. .. 8. *I. macratherum*

Awn rarely attaining 2 cm. long; plant eglandular or with few scattered glands.

Lower lemma 1-3-nerved .. 11. *I. vaginiflorum* x *I. calvum*

Lower lemma nerveless.

Racemes bearded at base with hairs 2-3 mm. long .. 12. *I. vaginiflorum* x *I. eremaeum*

Racemes glabrous or very shortly bearded.

Involucral spikelets faintly furrowed at junction 13. *I. vaginiflorum* x *I. membranaceum*

Involucral spikelets not furrowed at junction .. 14. *I. vaginiflorum* x *I. macratherum*

Floral leaf-sheaths becoming indurated and cartilaginous, rounded on back downwards; racemes almost wholly enclosed and tightly embraced by the spathes and floral sheaths; involucral spikelets usually reduced to a more or less hyaline lower glume or absent; plants entirely eglandular or with but few scattered glands on keel of sheath.

Each floral sheath with 2-3 spathes and racemes of which the lowest (outermost) at least has involucral spikelets; floral sheaths with slightly convex sides and appressed margins; spathes acutely keeled .. .. .. 9. *I. vaginiflorum*

Each floral sheath with one raceme, subcylindric with convolute margins; involucral spikelets constantly reduced to minute rudiments of pedicels .. .. 10. *I. fragile*

I. trichopus (No. 0 in the key) has not yet been found in Queensland.

In the following enumeration of species a vernacular name for popular usage has been suggested for each species. Two of these were proposed by Everist in Queensl. Agric. Journ. n.s. xliii., 382, 1935, but it must be admitted that in our present state of our knowledge of the genus the names are unfortunately chosen.

Unless stated to the contrary, all the collections cited were made by myself.

1. *I. calvum* C.E.H., Coarse Flinders Grass (in allusion to its habit) is pre-eminently a species of the channels and the deeper, damper depressions where it usually forms small patches. It is the coarsest species in the genus, the culms are more regularly erect, and the old leaves are of a paler, less reddish tint than usual. The large glabrous raceme and the unique 1-3-nerved lower lemmas are very characteristic.

The type comes from Jardine Valley about 12 miles east of Hughenden, and Hubbard records it also from Hughenden and Nonda in the Burke District and from the Gilbert River in the Cook District. I found it common between Hughenden and Jardine Valley (No. 11626) where it occupied depressions as described above, and at the following new localities:—

Burke District: Iffley Station, about 130 miles south of Normanton, grassland (*Astrebla*, &c.) plains on heavy dark grey soil 20-8-1936, No. 12635; Oorindi, 40 miles east of Cloncurry, on grassland plain on light brown gravelly sandy loam, 428 ft., 18-5-1936, No. 11626. Gregory North District: Frensham Station, near Kynuna, in stream channels, ca. 700 ft., 13-5-1936, No. 11498; Tranby Station, about 60 miles south-west of Winton, in stream channels, 9-5-1936, No. 11427.

Also seen but not collected at various places between Hughenden and Winton in depressions in the grassland in May, 1936.

2. *I. ciliatum* C.E.H., Hairy-leaved Flinders Grass, was based on a solitary specimen collected by Domin in February, 1910, near Hughenden, in grassy places towards Mount Walker. The Hughenden district has been well searched since without the species being rediscovered. I visited the locality in 1934 and twice in 1935, but it was not until May, 1936, that a small patch was finally located near the foot of Mount Walker towards the northern end. The plants were growing with *I. convexum* near the head of a small gully in scattered Gidgea country. It is a very distinctive species, very strongly scented in the living state. One of its most outstanding characters was not described by Hubbard. Scattered along the margins of the leaves, particularly near the base, are rather long, slender, tuberculate-based hairs, a character unknown in any other species. The grain, also hitherto undescribed, is elliptic and 3·5 mm. long. The densely long-ciliate keels of the involucral spikelets are a prominent character.

Burke District: Near Hughenden near Mount Walker, on yellowish brown gravelly sandy loam at head of small gullies in Gidgea (*Acacia Cambagei*) parkland, 1,250 ft., 24-5-1936, No. 11628. Moreton District: Brisbane, cultivated on sandy soil, 18-4-1937, No. 12932.

3. *I. Windersii* C.E.H., Scented Flinders Grass, occurs chiefly on open Mitchell grass plains and downs, not however in association with *Astrebla pectinata*. It is usually somewhat stouter and less spreading than the widespread *I. vaginiflorum*, while its strong sweetish smell is very pronounced in its native habitat, though less so on cultivated specimens. Hubbard records the species from near Camooweal, near Nonda and near Hughenden. Recent records are:—

Burke District: Normanton, in dried-out swampy *Eucalyptus microtheca* parkland on yellowish sandy loam—one dead plant 2 ft.

long—8-8-1936, No. 12493; near Camooweal on Rocklands Station, grassland plain on grey gravelly clay loam, 750 ft., 1-5-1935, No. 8843; Yelvertoft Station, between Mount Isa and Camooweal, on muddy edge of waterhole, 21-4-1935, No. 8624; Oorindi, 40 miles east of Cloncurry, grassland plain on light-brown gravelly sandy loam, 428 ft., 18-5-1936, No. 11538; Torver Valley Station ca. 30 miles north of Hughenden, on grassland tableland on grey-black clay ca. 1,300 ft., 24-8-1936, No. 12654. Gregory North District: Frensham Station, near Kynuna, in open *Astrebla* grassland on grey-brown clay silt, ca. 750 ft., 13-5-1936, No. 11495; Manuka Station, near Corfield, in channels, ca. 850 ft., 7-6-1936, No. 11666; Mitchell District: Prairie, grassland plain on dark-grey clay loam with fine gravel, 1,400 ft., 22-5-1936, No. 11612.

4. *I. convexum* C.E.H. Yellow Flinders Grass. In general habit this species closely resembles *I. Windersii,* but it is not or only very faintly scented. The bulging usually yellowish racemes serve to distinguish it. This grass has a tendency to restrict itself to depressions, forming a zone outside *I. calvum,* or else occupying the centre of depressions too shallow to support that species.

I. convexum was described chiefly from cultivated specimens, and the only natural habitats cited are in the neighbourhood of Hughenden. In May, 1936, I found it very common in the latter region (Nos. 11548, 11627, 11639), and also in the following localities:

Burke District: Iffley Station, 130 miles south of Normanton, in grassland (*Astrebla,* &c.) on heavy dark grey soil, 20-8-1936, No. 12634; Richmond, on river flats and channels on heavy brown loam, ca. 700 ft., 9-6-1936, No. 11672; Tarbrax Station, about 30 miles south of Maxwelton, on open grassland downs, 28-7-1936, No. 12406. Gregory North District: Tranby Station, about 60 miles south-west of Winton, in channels, 9-5-1936, No. 11428.

5. *I. membranaceum* (Lindl.) Domin. This species was called "Small Flinders Grass" by Everist, but it grows as tall as most other species though it is frequently rather more slender. The statement that it dries off to a pale straw colour is incorrect. Normally it becomes reddish brown. The best distinguishing characters of this very widely spread species are the very small racemes very shortly bearded or nearly or quite glabrous at the base, and the scabrous involucral spikelets. Though usually found on heavy soils it is occasionally to be found on sandy soils particularly on railway embankments, and an extreme and very interesting habitat cited below is the crest of a low desert sand-dune where it was behaving as a coloniser.

Among the very numerous localities from which this species was collected, the following are cited to indicate its geographical distribution or peculiarities in habitat. If a locality or a neighbouring locality has been cited by Hubbard, it is marked with an asterisk.

Burke District: Rocklands Station, *Camooweal, grassland plain on grey gravelly clay loam, 750 ft., 1-5-1935, No. 8845; Flinders River, lat. 19° 30′ S., "common on Iffley on black soil," 20-8-1936, No. 12644; Oorindi, 40 miles east of Cloncurry, in grassland on light brown gravelly sandy loam, 428 ft., 18-5-1936, No. 11537; Richmond, on banks and dry beds of channels, ca. 700 ft., 17-6-1934, No. 6281; Hughenden, grassland downs on grey-brown clay loam, ca. 1,100 ft., 19-5-1936: Mitchell District: *Prairie, grassland plains on heavy grey soils, 1,400 ft., 22-5-1936, No. 11617; Dundonald and Rodney Downs Stations, between

*Longreach and Aramac, on open grassland downs on greenish grey clay, 3-5-1936, No. 11361. Gregory North District: Frensham Station, near Kynuna, in open *Astrebla* grassland on grey-brown clay silt, ca. 750 ft., 13-5-1936, No. 11496; Manuka Station, near Corfield, in open grassland, ca. 850 ft., 7-6-1936, No. 11665; Tranby Station, ca. 60 miles south-west of Winton, in channels, 9-5-1936, No. 11425; near Boulia on grassy plain, 24-7-1936, No. 12370; 35 miles south of Bedourie on Eyre's Creek flood, 21-7-1936, No. 12302. Gregory South District: Birdsville, on Diamantina flood, 19-7-1936, No. 12214; on low sandhill, No. 12244; Betoota, in channels, 17-7-1936, No. 12168; near Windorah on flood-plain of Cooper's Creek, 11-7-1936, No. 12077; Mount Howitt Station, ca. 100 miles west of Eromanga, in channels of Cooper's Creek, 6-7-1936, No. 12020; Nockatunga Station, approx. 27° 30′ S., 143° 0′ E., on silt beds, 28-6-1936, No. 11876; Warrabin Station, between Quilpie and Windorah, near pools (crab-holes) in mulga country, 24-4-1934, No. 5503. Warrego District: Chesterton Station, approx. 25° 20′ S., 147° 20′ E., in mixed grassland on dark grey clay silt, ca. 1,750 ft., 9-4-1936, No. 11168; *Charleville, depressions in lightly timbered country, ca. 950 ft., 19-4-1934, No. 5334; Cunnamulla, grassland plain on light brown silt clay, 600 ft., 12-4-1936, No. 11199; Thargomindah, on creek bank, 400 ft., 24-6-1936, No. 11774; Morven, on grassland on dark brown silt clay, ca. 1,400 ft., 1-5-1934, No. 5668; and also associated with myall (*Acacia pendula*), 2-4-1936, No. 10989. Maranoa District: Roma, in open grassy places on heavy soils, ca. 1,000 ft., 29-3-1936, No. 10885; *Noondoo Station, south-east of Dirranbandi, on grassland with *Eucalyptus coolabah* on dark brown silt clay, 28-2-1936, No. 10571. Leichhardt District: Minerva, north of Springsure, grassland on dark grey clay loam, 800-1,000 ft., 7-3-1935, No. 7932. Darling Downs District: Dulacca to Palardo, in railway enclosure (very common at Palardo), on sandy soil, 15-2-1935, No. 7581; *Jondaryan, grassland on dark grey clay, 1,250 ft., 22-2-1935, No. 7581. Moreton District: —Brisbane, spontaneous beside pathway, 26-4-1937.

Also recorded from North Kennedy District (Pentland) and from Port Curtis District (Biloela, and between Rockhampton and Westwood).

6. *I. eremaeum* S. T. Blake. Bunch Flinders Grass—in allusion to its dense compact habit. See above.

7. *I. dolichotrichum* C.E.H. Rough-stemmed Flinders Grass is suggested as a vernacular on account of the stems (culms) being roughened by small glands just below the nodes. This species was described by Hubbard from a solitary plant collected by himself at Duchess in February, 1931, during a very dry period. As the result of excellent rains earlier in the year it was very abundant near that town in May, 1936, near one of the rugged ridges so characteristic of the region. Most of the plants were growing near the foot among *Triodia, Enneapogon,* and *Neurachne,* but quite a number ascended the ridge, growing in the little pockets of soil between the boulders. The plants formed small tufts mostly 3-4 in. high, with a distinct resinous odour. The old leaves were less reddish and paler than usual in the genus. At the base of the plants were small masses of "seed" held together by the long hairs at the base of the racemes.

Gregory North District: Duchess, in valleys on stony brownish red loam associated with *Triodia* and scattered *Eucalyptus leucophylla* at 1,200 ft., 18-5-1936, No. 11519. Moreton District: Brisbane, cultivated on sandy soil from seed from above, 11-4-1937, No. 12920.

8. *I. macratherum* Domin, Bull Flinders Grass (name recorded in *C. T. White* 1478 as the local name on the Gilbert River)[1]. This species is usually recognisable by its profusely branched habit and its faint but distinct odour similar to that of *I. Windersii*. It is however very closely allied to the following species and this relationship will be discussed below. Until recently known only from Chillagoe and the Gilbert River, its known range now extends into the region of greatest concentration of species. The new records are:—

Cook District: Koolatah Station, approx. 15° 50′ S., 142° 15′ E., on parkland to open grassland on yellowish silt clay, 16-8-1936, No. 12582. Burke District: Normanton, in dried-out swampy *Eucalyptus microtheca* parkland among tall grass on yellowish sandy loam, 8-8-1936, No. 12494; Magoura Station, west of Normanton, on river bank, 31-5-1935, No. 9191; between Normanton and Burketown on "black soil" plains, 31-5-1935, No. 9213; Burketown, in *Astrebla* grassland on yellow-brown clay loam, ca. 30 ft., 1-6-1935, No. 9250; Riversleigh Station, approx. 19° 0′ S., 138° 45′ E., old alluvial flats on grey-brown fine sand, 21-4-1935, No. 8702; Rocklands Station, near Camooweal, grassland plain on grey gravelly clay loam, 750 ft., 1-5-1935, No. 8844; Pymurra, 18 miles east of Cloncurry, on dark brown soil with scattered gidgea (*Acacia Cambagei*), 611 ft., 18-5-1936, No. 11534; Oorindi, 40 miles east of Cloncurry, in grassland on light brown gravelly sandy loam, 428 ft., 18-5-1936, No. 11535; Quarrel's Siding, near Julia Creek, in grassland on greenish grey fine silt, 496 ft., 18-5-1936, No. 11542; Hughenden, grassland downs on grey-brown clay loam, ca. 1,100 ft., 19-5-1936, No. 11543. Gregory North District: Manuka Station, Corfield, on grassland downs, 840 ft., 7-6-1936, No. 11664. Mitchell District: Morella, between Longreach and Winton, grassland on dark brown clay loam, 828 ft., 28-5-1936, No. 11640.

9. *I. vaginiflorum* Domin. Called Red Flinders Grass by Everist. When well grown this species has usually a loosely spreading habit, but small plants are more rigid and erect. Generally speaking, the culms and sheaths are of a rich purplish colour—often more highly coloured than in other species—but very rarely as in No. 11656 from near Longreach, these parts are very pale and not at all purplish. Such plants were very few and were growing with highly coloured plants. The species is further discussed below in dealing with hybridism. It is very widely distributed, and, as a rule, very common in any one locality, occurring under a variety of drainage conditions. Very rarely indeed is it found on light soils.

Distribution.—Burke District: Almost throughout the southern part as far north as Camooweal and Iffley (No. 12643). Mitchell District: Widely spread on the grasslands. North Kennedy District: Charters Towers (ex Hubbard). Gregory North District: near Boulia on grassy plain, 24-7-1936, No. 12369; Frensham Station, near Kynuna, in open *Astrebla* grassland on grey-brown clay silt, ca. 750 ft., 13-5-1936, No. 11497; Winton, grassland downs on stony light yellowish brown clay loam, 600 ft., 30-6-1934, No. 6536; Kalkadoon Station, approx. 22° 30′ S., 142° 25′ E., in channels of Diamantina River, 11-5-1936, No. 11463, tiny plants ca. 1 in. high; Tranby Station, ca. 60 miles south-west of Winton, in channels, 9-5-1936, No. 11426. Gregory South District: Birdsville, on fine drift sand on gibber slopes, 19-7-1936, No. 12212A;

[1] By some mistake Hubbard records this name as "Bull Mitchell Grass."

45 miles west of Windorah on stony hilly country in *Acacia* scrub, 14-7-1936, No. 12118; Warrabin Station, between Quilpie and Windorah, 24-4-1934; grassland plain on light grey silt loam, No. 5491; edge of pools (crab-holes) in mulga country, No. 5502; *Windorah, on flood plain of Cooper's Creek, 12-7-1936, No. 12080. Warrego District: West of Thargomindah on pale grey silt clay flats, ca. 400 ft., 25-6-1936, No. 11788; Cunnamulla, on sandy patch, 29-4-1934, No. 5629; on grassland plains on light brown silt clay, 12-4-1936, No. 11198. Leichhardt District: Minerva, north of Springsure, very common in mixed grassland on dark grey clay loam, ca. 800 ft., 6-3-1935, No. 7907; (cited by Hubbard from Emerald and Peak Downs). Port Curtis District: Rockhampton, a weed in sports ground on sandy soil, 2-3-1935, No. 7787.

10. *I. fragile* S.T. Blake. Brittle Flinders Grass. See above, p. 85.

All but two of the above species are very distinct and can be readily distinguished either in the herbarium or in the field. There is, however, a difficult series of forms apparently connecting *I. macratherum* and *I. vaginiflorum,* species which, when typically developed are readily distinguished as follows:—

I. macratherum.—Plant copiously branched, frequently sub-erect, distinctly scented when fresh; floral leaf-sheaths acutely keeled at least in upper half, herbaceous throughout or only slightly hardened near the base, glandular on the keel; margins and keel of the leaves also rather closely glandular, at least near the base; mature racemes partly exsert; involucral spikelets well developed with firm glumes and a lower lemma; awn 2-3 cm. long.

I. vaginiflorum.—Plant less branched, more slender, usually drooping or spreading, not scented; floral leaf-sheaths not keeled, becoming hardened and rounded on the back downwards at maturity, keel eglandular or with a very few scattered glands; leaves not glandular; racemes always almost completely enclosed; involucral spikelets usually reduced to a membranous lower glume or even still further reduced; awn rarely so long as 2 cm.

The other forms of the series vary in habit with more or less distinctly keeled and somewhat hardened floral sheaths and partially exsert racemes with shorter awns than in *I. macratherum.* Involucral spikelets are variable, even on the same specimen, but are usually better developed than in *I. vaginiflorum.* Glands are usually present, but few in number, and irregularly scattered. One or more frequently occurs on the keels of the lower glume of the involucral spikelets. It certainly seems probable that such forms are hybrids of which *I. vaginiflorum* is one of the parents. Such forms appear to be very rare; as a rule only isolated plants have been found, and then mostly in company with both suspected parents. In one case (No. 12 below) a hybrid swarm seems to have been detected, and it is in this collection alone that well-formed grain was found.

11. *I. vaginiflorum* x. *I. calvum.*—This form is only known from the two specimens collected by Hubbard and Winders at Jardine Valley where it was found growing in company with its supposed parents. One of these specimens is now in the Queensland Herbarium. With the habit of *I. calvum* the racemes look rather like those of *I. vaginiflorum,* but are somewhat exsert, and the lower lemma is 1-3-nerved.

12. *I. vaginiflorum* x. *I. eremaeum.*—Numerous specimens of this form were collected at Birdsville on fine drift sand overlying gibber

slopes in company with its supposed parents (19-7-1936, No. 12212). The three forms here occurred as small compact tufts, very similar to one another in appearance. The inflorescence disarticulates at the nodes as in the first species, but the racemes are subexsert and frequently fall before the inflorescence breaks up. The racemes approach those of *I. vaginiflorum* in general appearance, but the hairs at the base are up to 3 mm. long. The involucral spikelets are either male or neuter; when male they resemble those of *I. eremaeum*; when neuter, they are very similar to those of *I. vaginiflorum*.

13. *I. vaginiflorum* x *I. membranaceum*.—There are two distinct forms of this. In the original form described by Hubbard, the habit is that of *I. vaginiflorum*, but by reason of the thinner, more distinctly keeled floral sheaths, and the partly exsert racemes with better developed involucral spikelets, it resembles *I. macratherum* rather closely. But the awns are shorter, the involucral spikelets are furrowed at the junction with the pedicel, and glands are almost confined to a few scattered ones on the keels of the involucral spikelets. This form has only been found in the Leichhardt District. I have seen one of the three collections cited by Hubbard (*White* 3418 from Clermont) and my 8064 from Blair Athol on grassland, 16-3-1935, is the same form.

Another collection from Hughenden (on grassland downs on grey-brown clay loam, ca. 1,100 ft., 19-5-1936, No. 11547) appears also to be a hybrid between the same two species, but the habit is similar to that of *I. membranaceum*. Very few specimens were found though others were diligently sought for.

14. *I. vaginiflorum* x *I. macratherum*.—To this is referred a curious series of specimens from Prairie (grassland plains on heavy dark soils, 1,400 ft., 20-5-1936, No. 11614). In habit some specimens approach one species, some the other. Racemes are included to subexsert, the involucral spikelets mostly reduced to a thin lower glume, the floral sheaths hardened but strongly nerved, glands are numerous, few or absent, and leaves glandular or not. There is no degree of constancy, even on the same specimen.

EXPLANATION OF PLATES.*

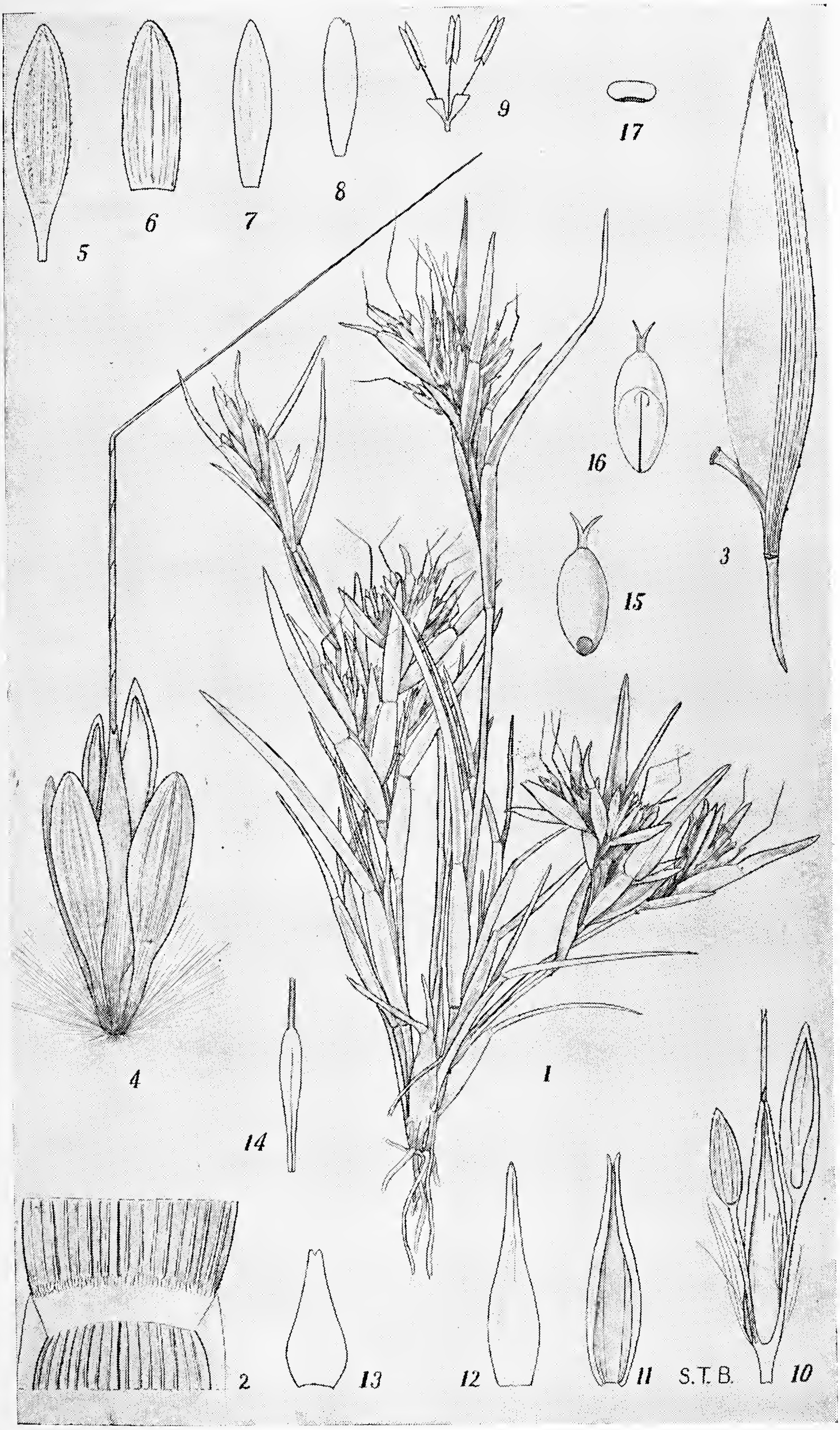
PLATE III.—*Iseilema eremaeum* S. T. Blake (from *Blake* 12213).

Fig. 1, plant, *natural size*; 2, ligule; 3, spathe; 4, raceme; 5, involucral spikelet; 6-9, details of involucral spikelet:—6, lower glume, from inside; 7, upper glume, from outside; 8, lower lemma; 9, male flower; 10, fertile and pedicellate spikelets; 11-17, details of fertile spikelet:—11, lower glume, from inside; 12, upper glume, from outside; 13, lower lemma; 14, upper lemma; 15 and 16, caryopsis; 17, transverse section of caryopsis. Figs. 2-17 x 6.

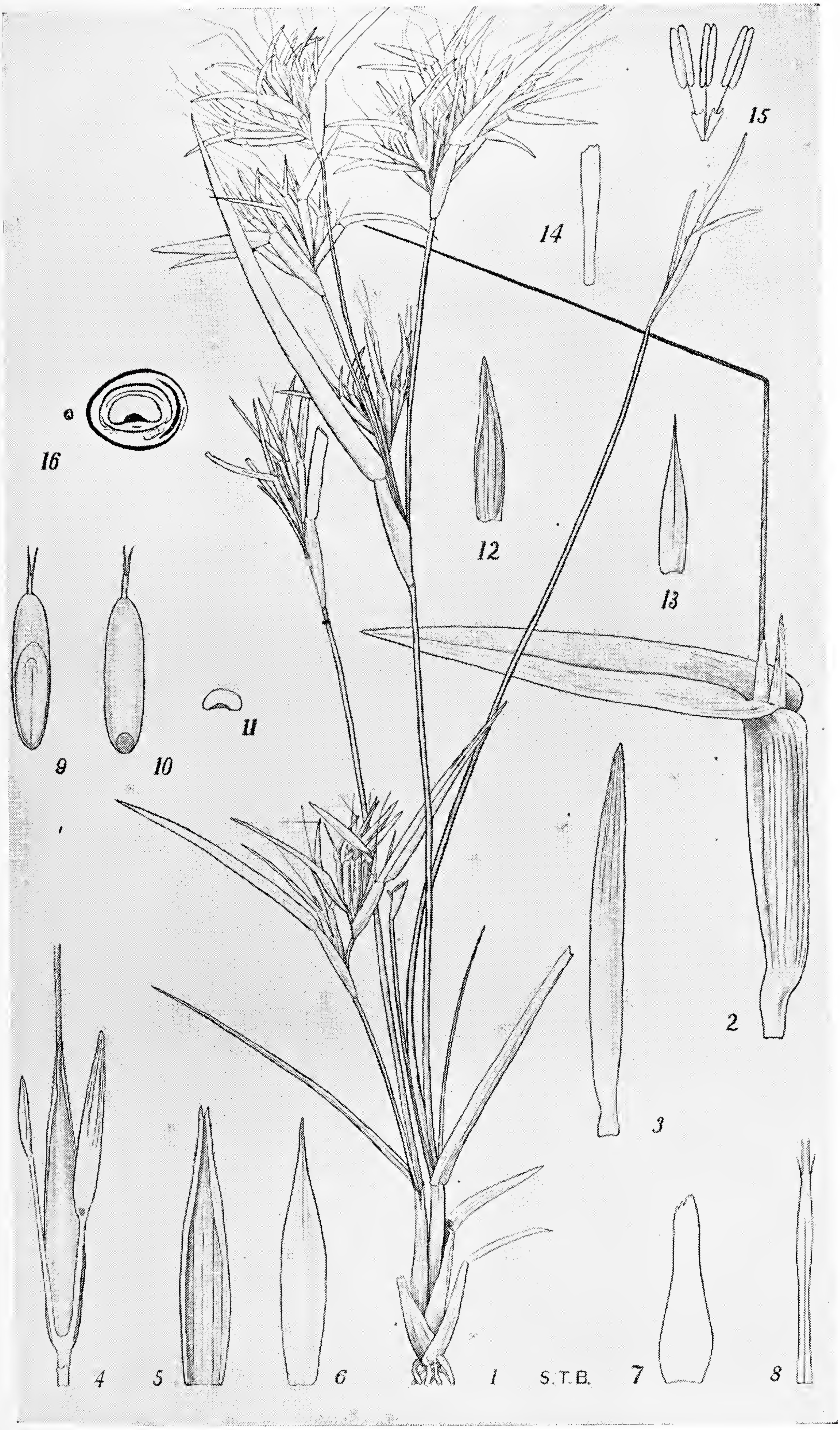
PLATE IV.—*Iseilema fragile* S. T. Blake (from *Blake* 11545).

Fig. 1, part of plant, *natural size*; 2, "seed"—disarticulated floral sheath with spathe and raceme enclosed; 3, spathe; 4, raceme; 5-11, details of fertile spikelet:—5, lower glume, from inside; 6, upper glume, from outside; 7, lower lemma; 8, upper lemma; 9 and 10, caryopsis; 11, transverse section of caryopsis; 12-15, details of male pedicellate spikelet:—12, lower glume, from inside; 13, upper glume, from outside; 14, lower lemma; 15, flower; 16, transverse section, partly diagrammatic, of "seed" (fig. 2). Figs. 2-15 x 6, fig. 16 x 9.

* Due to an error in the preparation of the plates, the magnification of the figures is slightly less than that stated in the Explanation.



Iseilema eremaeum S. T. Blake.



Iseilema fragile S. T. Blake.

Essential Oils from the Queensland Flora—Part XI. Melaleuca viridiflora, Part II.

By T. G. H. Jones, D.Sc., A.A.C.I., and W. L. Haenke, B.Sc., B.Sc. (App.).

(*Read before the Royal Society of Queensland, 30th August, 1937.*)

In a previous communication to the Society[1] it was stated that the essential oils of the broad leafed tea tree (*Melaleuca viridiflora*) were being examined and the existence of at least two varieties determined. The first variety already described was found to contain essentially linalol and nerolidol as principal constituents and to show certain resemblance with the essential oil of *M. Smithii*[2] with which there is some confusion of identity. It is noteworthy, however, that in the publication of Baker and Smith regarding *M. Smithii,* no record of the occurrence of linalol is mentioned and presumably this constituent was absent from the oils examined by them from materials obtained near Sydney in N.S.W.

The present communication deals with the essential oil from the more common cineol variety of the broad leafed Melaleuca. Other investigators[3] have examined this oil from time to time and various reports of its constituents have been published, particularly with reference to the cineol content, but examination of the result suggests that in most cases the leaves were mixtures and some of the constituents obtained by us were not recorded.

The oil to be described was all obtained from one tree, but similar results were obtained from other trees of the cineol variety, and there appears little doubt at present that there is a constancy of constituents with respect to that variety. Our samples were, however, all obtained from the neighbourhood of Brisbane and it is possible that examination of leaves from other centres may give different results.

The oil as examined by us was found to contain 45·6 per cent. of cineol (Cockings' method) together with d-α-pinene, 1-limonene, dipentene, α-terpineol, sesquiterpene, a crystalline alcohol apparently not previously described and traces of phenol. The crystalline alcohol isolated readily from the last distillation of oil appears to be distinct from eudesmol and to be related to the hydrocarbons of the blue azulene class. It readily loses water and the sesquiterpene obtained gives an azulene on dehydrogenation as well as a reduced hydrocarbon ($C_{15}H_{26}$) but no trace of eudalene or of cadalene. The investigation of this alcohol and the accompanying sesquiterpenes of the oil is being actively pursued and will form the subject of another communication. In the meantime the name "viridiflorol" is tentatively proposed for this alcohol.

In view of the cineol content and the readiness with which its percentage can be increased by distillation the oil can be regarded as a commercial source of cineol.

Experimental.

Three and a-half cwt. of leaves collected from one tree near Wynnum, Brisbane, were distilled and 2,040 ccs. of oil (1 per cent.) obtained. Towards the end of the distillation solid matter crystallised and was separated from the main oil supply.

The following constants were determined:—

$d_{15 \cdot 5}$	·929
N^D_{20}	1·4759
$[\alpha]D$	— 2·7
Ester Value ..	Nil
Acetyl Value ..	23
Cineol	45·6 per cent. (Cockings Method).

The oil was washed with (*a*) sodium carbonate and (*b*) sodium hydroxide solution. A trace of acid and ½ cc. phenol only were recovered from the alkaline liquors. The phenol gave a greenish colour with ferric chloride, but the small amount present precluded further examination.

As tests also revealed the absence of aldehydes the dried oil—1,420 ccs.—was submitted to fractional distillation under diminished pressure (3 mms.) and the following fractions collected:—

	Temp.	Volume.	$d_{15 \cdot 5}$	N^D_{20}	$[\alpha]D$
I. ..	0–30°C.	35 ccs.	·9003	1·4703	+ 7
II. ..	30–34°C.	130 ccs.	·9007	1·4652	+ 1·6
III. ..	34–36°C.	173 cc.	·9173	1·4653	— 1·2
IV. ..	36–66°C.	701 ccs.	·9178	1·4629	— 5·6
V. ..	66–68°C.	98 ccs.	·9379	1·4828	— 5·5
VI. ..	68–74°C.	34 ccs.	·9387	1·4850	— 4·5
VII. ..	74–88°C.	86 ccs.	·9348	1·4953	+ 10
VIII. ..	88–110°C.	5 ccs.	not taken	1·4985	not taken
IX. ..	110–114°C.	78 ccs.	·9472	1·4985	+ 19
X. ..	114–116°C.	42 ccs.	·9765	1·4990	0
XI. ..	Residue	12 ccs.			

As the earlier fractions 1-4 were rich in cineol they were washed with 50 per cent. resorcin solution and extraction of the terpene from the resulting solid cakes by petrol ether (b.p. below 60°C.) resorted to. The petrol ether solutions were repeatedly washed with resorcin solution until free from cineol. Considerable difficulty was experienced in removing the large amount of cineol in fraction 4. The cineol 400-500 ccs. was recovered from the resorcin compound and identified in the usual way.

The terpenes after removal of cineol were further fractionated and fractions possessing the following constants ultimately obtained:—

(*a*)	$d_{15 \cdot 5}$	·8735
	N^D_{20}	1·4700
	$[\alpha]D$	+ 7
(*b*)	$d_{15 \cdot 5}$	·8590
	N^D_{20}	1·4720
	$[\alpha]D$	— 38

The fraction (*a*) consisted largely of α-pinene.

The nitrosyl chloride prepared in the usual way melted at 108°C.

Fraction (*b*) gave a crystalline tetrabromide.

Fractional crystallisation gave—
dipentene tetrabromide M.P. 125°C.
and 1-limonene tetrabromide M.P. 105°C.

Fractions 5 and 6.—Further fractionation to remove diepentene and 1-limonene gave ultimately a pleasant smelling oil with the following constants:—

$d_{15 \cdot 5}$	·9394
N^{D}_{20}	1·4841
$[\alpha]D$	− 6

Identity with α terpineol was established by formation of the nitrosyl chloride M.P. 112°C. and the napthyl urethane M.P. 144·5°C.

Fractions 7 and 8, which gave strong colour tests for sesquiterpene with bromine acetic acid, were further fractionated and finally distilled over potassium.

The following constants were then recorded:—

$d_{15 \cdot 5}$	·9268
N^{D}_{20}	1·4990
$[\alpha]D$	+ 23·5
b.p.	95°–97°C. 2 mms.

Dehydrogenation with selenium gave a blue azulene hydrocarbon (M.P. of Picrate 118°C.) and at the same time a hydrocarbon possessing the following constants:—

$d_{15 \cdot 5}$	·916
N^{D}_{20}	1·4930
$[\alpha]D$	0

Combustion results [C =87·1 H = 12·1 per cent.] indicated $C_{15}H_{26}$ and it appeared obvious that some hydrogenation of sesquiterpene had accompanied the dehydrogenation to azulene. The reducing action of hydrogen selenide in the dehydrogenation of sesquiterpenes has been noticed by other workers and reviewed in the Annual Reports of the Chemical Society, 1936.

No trace of eudalene could be observed and it was concluded that eudesmene was not present.

Ozonisation gave a small yield only of aromadendrone (M.P. of oxime 103°C.) and this sesquiterpene is therefore not the main constituent of the fraction.

Investigation of the sesquiterpene fraction is being actively pursued, but as no solid derivatives have been obtained, and as there is evident relationship to the azulene class of hydrocarbon, it is clear that some more accurate knowledge of the constitution of azulene is a preliminary requisite.

Viridiflorol.—In the original steam distillation of the leaves crystalline material was obtained towards the end of the distillation and similarly the last higher boiling fractions of the oil solidified. The solid buttery material was collected, and spread on a porous plate to remove adhering oil and then repeatedly crystallised from methyl alcohol in which and other organic solvents it is rather soluble. It was eventually obtained as a white crystalline mass. M.P. 71°C.

It was at first thought that it was impure eudesmol, but the subsequent examination of the material indicated that it could not be identical with that substance.

The optical rotation in chloroform solution was + 5·4 (eudesmol + 33).

Treatment with formic acid on the water bath for half an hour gave a sesquiterpene with the following constants:—

$d_{15 \cdot 5}$	·9217
N^{D}_{20}	1·4972
$[\alpha]_D$	+ 9

A deep blue colour reaction was given in acetic acid with bromine vapour.

The alcohol itself under similar conditions developed only a purple colour after some time.

Attempts to prepare the acetate by heating with acetic anhydrice were unsuccessful, dehydration taking place. The resulting liquid possessed the following constants:—

$d_{15 \cdot 5}$	·9315
N^{D}_{20}	1·4978
$[\alpha]_D$	+ 32·2

Combustion results were only approximate for $C_{15}H_{24}$ and as the liquid possessed a small ester value, it appeared to be a mixture of sesquiterpene with a small amount of acetate. Its density was somewhat higher than that of the sesquiterpene obtained by the formic acid treatment and presumably indicated some admixture with the acetate. Dehydrogenation of the sesquiterpenes obtained by the formic acid and acetic anhydride treatments was accomplished by heating with selenium at 280°C.

In both cases an azulene (M.P. of Picrate 118°C.) was obtained together with a colourless liquid of molecular formula $C_{15}H_{26}$. The constants in the case of the hydrocarbons obtained in this way from the sesquiterpene derived by the formic acid treatment were as follows:—

$d_{15 \cdot 5}$	·9016
N^{D}_{20}	1·4929
$[\alpha]_D$	— 5
b.p.	135°C. 20 mms.

These results clearly indicate an alcohol apparently corresponding to a hydrocarbon of the azulene class, regarding which no precise constitutional knowledge is at present available, although formulae for azulene have been tentatively suggested.

It is hoped to investigate the constitution of this interesting alcohol and the accompanying sesqiterpenes further.

Our thanks are due to Mr. C. T. White, Government Botanist, for his usual generous assistance in connection with botanical problems. It should be stated that we have adopted the name *Melaleuca viridiflora* in this and the previous paper on his advice.

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[1] Jones and Haenke. Proc. Roy. Soc. Q., 1936, 41-44.
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[3] Cowley. Chem. and Drug., 1910, 76, 832.

Essential Oils from the Queensland Flora, Part XII.—Cinnamomum Oliveri.

By T. G. H. Jones, D.Sc., A.A.C.I., and F. N. Lahey, M.Sc.

(*Read before the Royal Society of Queensland, 25th October,* 1937.)

The oils from the bark and leaves of *Cinnamomum Oliveri* were investigated by Hargreaves (1) in 1916, who recorded the presence of pinene, camphor, saffrol, and methyl eugenol in the bark oil and camphor (65 per cent.), pinene, a trace of a phenol and an unidentified terpene possibly phellandrene, in the leaf oil. In view of the economic possibilities associated with this high percentage of camphor and the probability that the leaf oil would contain other constituents than those recorded, we have reinvestigated this oil. We were unable to confirm the percentage of camphor recorded by Hargreaves, as in both samples of oil distilled by us only 51 per cent. was present.

Other constituents of the oil were found to be α-pinene and a trace of phenol, as recorded by Hargreaves, but we have also determined the presence of dipentene, d-limonene, myrcene, methyl eugenol, an unidentified acid, bornyl formate, a sesquiterpene and a sesquiterpene alcohol.

The terpene regarded by Hargreaves as being probably phellandrene and yielding a nitrosite has not been identified by us. We obtained a similar nitrosite (M.P. 84° C.), but this does not appear to be identical with either α-phellandrene nitrosite (M.P. 112° C.) or β-phellandrene nitrosite (M.P. 97° C.). The small proportion of this constituent present in the oil and the difficulty of separating it from associated terpenes prevented our identification of this terpene.

It is noteworthy that the leaf oil contains no saffrol, although this is an important constituent of the bark, and pinene, camphor, and methyl eugenol are present in both.

No oil was obtained from a sample of wood investigated by us.

EXPERIMENTAL.

Leaves of *Cinnamomum Oliveri* (130lb.) collected from the Beechmont district yielded on steam distillation oil equal to 1·23 per cent. of the weight of leaves. On cooling camphor crystallised out. The oil was further cooled to —10° C. and the camphor filtered off at the pump.

Two hundred pounds of leaves from the Montville district yielded 1·1 per cent. of oil. This was treated in the same way as the first oil. The residual oils were then found to have the following constants:—

	Sample A. (Beechmont.)	Sample B. (Montville.)
$d_{15\cdot5}$	·9322	·9239
N^{D}_{20}	1·4755	1·4722
$[\alpha]_D$	+ 40·2	+ 41·1
Ester value	17·9	10·3
Acetyl value	42·5	32

Each oil was then shaken with the following solutions in turn:—(*a*) Sodium carbonate, (*b*) dilute sodium hydroxide, (*c*) saturated sodium bisulphite. The residual oil was washed and dried and submitted to fractional distillation under reduced pressure (2 mm.), when the following fractions were collected:—

SAMPLE A.

	Temp.	$d_{15\cdot5}$	N^D_{20}	$[\alpha]_D$
I.	.. Oil from liquid ammonia trap	·8614	1·466	+ 34·8
II.	.. 30–35°C.	·8554	1·469	+ 35·1
III.	.. 35–37°C.	·852	1·469	+ 36·3
IV.	.. 37–41°C.	·8677	1·4695	+ 41·4
V.	.. 64–92°C.	·9722	1·4793	+ 14·4
VI.	.. 92–98°C.	1·0099	1·5000	+ 5·5

SAMPLE B.

	Temp.	$d_{15\cdot5}$	N^D_{20}	$[\alpha]_D$
I.	.. Oil from liquid ammonia trap	·8625	1·469	+ 31·3
II.	.. 28–38°C.	·8584	1·469	+ 32
III.	.. 38-41°C.	·8693	1·4710	+ 33·3
IV.	.. 68–78°C.	·9456	1·4741	+ 19·3
V.	.. 78–82°C.	·9379	1·4893	+ 10·6
VI.	.. 82–88°C.	·9411	1·5000	+ 9
VII.	.. 88–92°C.	·9570	1·4992	+ 11·7
VIII.	.. 92–99°C.	·9610	1·5000	+ 14·6

When the distillation of the terpenes was completed (41° C. at 2 mm.) camphor commenced to distil. The oil in the still was then cooled to —10° C. and filtered. The last trace of camphor was removed by distilling it into the column and from there removing it with petrol ether. All the camphor was then recrystallised from petrol ether, the final mother liquor yielding some oil which was returned to the main bulk after removal of the dissolved camphor by freezing and distillation. The camphor was further purified by sublimation, after which a melting point of 176° C. was obtained. It readily formed an oxime m.p. 118° C. After rigorous purification of the total yield of camphor it was found to be present to the extent of 51 per cent. in both oils. This is not in agreement with Hargreaves' observations, who recorded 65 per cent. camphor.

Terpenes.—(*a*) *d α-pinene.* The first fraction of each oil consisted mainly of d α-pinene as shown by oxidation with permanganate to pinonic acid, the semicarbazone of which melted at 205° C. No sodium nopinate was obtained, indicating the absence of β-pinene.

(*b*) *Dipentene* and *d-limonene.* Fraction 3 (B) gave on refractionation a sample B.P. 30-31° C. at 1 mm.

$d_{15\cdot5}$	·8693
$[\alpha]_D$	+ 38.5

It was thought that the high density and rotation might be due to dissolved camphor. A portion of this fraction was consequently treated with semicarbazide under reflux for two hours. The solution was then neutralised and steam distilled. The resultant oil had $[\alpha]_D$ +34·5 and $d_{15\cdot5}$ ·8408. A similar portion with specific rotation +38·5 submitted to phenyl hydrazine treatment by the method recommended by Simonsen (2) yielded an oil with $[\alpha]_D$ +38 and $d_{15\cdot5}$ ·8615. The semicarbazide method was thus found more effective for removing traces of camphor than the phenyl hydrazine method.

The fraction now with density ·8408 and $[\alpha]_D$ +34·5 had the characteristic odour of limonene. On treatment with bromine in cold amyl alcohol-ether solution it yielded a tetrabromide. By fractional crystallisation using alcohol, crystals melting at 125° C. and 108° C. were obtained. Further recrystallisation was prevented by lack of material. However, the evidence available indicates the presence of dipentene and d-limonene.

(*c*) *Myrcene.* By repeated fractionation of fraction 2 (B) an oil was obtained with—

B.P.	27–28°C.	@ 1 mm.
$d_{15\cdot5}$	·8330	
$[\alpha]_D$	+ 31·8	
N^D_{20}	1·4758	

This contained a large percentage of dipentene and limonene, as shown by the ready production of tetrabromide from it. However, the low density and high refractive index seemed to indicate the presence of an olefinic terpene. On reduction with sodium and alcohol the characteristic odour of dihydromyrcene could readily be detected. The density and refractive index of the reduced product showed a marked decrease due to reduction of myrcene present in the oil. The reduced oil had—

$d_{15\cdot5}$	·8262
N^D_{20}	1·4684

The isolation of dihydromyrcene tetrabromide was prevented by the presence of dipentene and limonene.

Although ocimene also yields dihydromyrcene on reduction, it would have been readily rcognised by its strong odour and tendency to absorb oxygen.

Although the evidence above is not absolutely conclusive, there appears little doubt that myrcene is present in the oil. It is worthy of note that myrcene occurs in the oil from the leaves of the sassafras tree —a similar type of oil to the one under discussion.

(*d*) *Unidentified terpene.*—Fraction 3 (B), besides containing dipentene and limonene, contained a terpene which yielded a nitrosite m.p. 84° C. The yield of this nitrosite was extremely small, as previously mentioned by Hargreaves, who thought it was possibly phellandrene nitrosite. After recrystallisation from chloroform and methyl alcohol, however, the melting point could not be raised. It did not behave like phellandrene nitrosite, for even in an impure state it was found to be quite stable. Camphene was tested for by the isoborneol method, but could not be detected.

Bornyl formate.—Fractions 4 and 5 (B) had ester values of 91 and 54° respectively. From these on fractionation a sample with ester value 103 was obtained. This was hydrolised with alcoholic potash and the recovered oil allowed to stand at 0° C. A solid soon separated which, when filtered, dried and recrystallised from petrol ether, melted at 204° C. A mixed melting point with pure borneol showed no depression.

The alkaline solution from the hydrolysis of the ester was acidified with dilute sulphuric acid and steamed distilled. The aqueous distillate was exactly neutralised and silver nitrate added. The silver salt formed was very rapidly reduced to metallic silver, indicating the presence of formic acid. No trace of acetic or other acids was found. The ester present was thus bornyl formate.

Methyl eugenol and *sesquiterpenes.*—The remainder of the oil showed the characteristic colour reactions of the sesquiterpenes. At this stage the only difference in the two samples of oil was observed. Fraction 6 (A) had density 1·0099, and finally on refractionation yielded an oil which had—

B.P.	84–90°C.	@ 1 mm.
$d_{15\cdot5}$	1·0263	
$[\alpha]_D$	+ 1	
N^{D}_{20}	1·5000	

This was readily recognised as methyl eugenol by the preparation of monobrom-methyl eugenol dibromide M.P. 79° C.

In sample B, although methyl eugenol was found present, it was there in smaller quantities, and the sesquiterpenes in larger quantities than in sample A. It was found impossible to effect the separation of these substances by fractional distillation. Three fractions were obtained—

(*a*) 92–100°C. @ 3 mm.
$d_{15\cdot5}$ ·9615
$[\alpha]_D$ + 13·5

This contained 26 per cent. methyl eugenol estimated by methoxy determinations—

(*b*) 100–104°C. @ 3 mm.
$d_{15\cdot5}$ ·9644
$[\alpha]_D$ + 15
27·5% methyl eugenol.

(*c*) 107–108°C. @ 3 mm.
$d_{15\cdot5}$ ·9696
$[\alpha]_D$ 17·8
24% methyl eugenol.

In an attempt to remove the methyl eugenol fraction (*b*) was treated with Ziesel's hydriodic acid, followed by extraction with caustic soda to remove the eugenol. The oil recovered had a light blue colour and contained iodine, apparently due to the addition of hydrogen iodide to a double bond in the sesquiterpene.

Fraction (*a*), after treatment with selenium at 280° C. for two hours, yielded a deep blue oil (azulene) and a colourless oil of density ·958. Azulene was identified by its picrate M.P. 119° C. The other oil failed to yield a picrate, and could not be identified as cadalene or eudalene.

Attempts at forming a solid hydrochloride of the original sesquiterpene were unsuccessful, but this may have been due to the presence of methyl eugenol.

With bromine vapour on a glacial acetic acid solution of the sesquiterpene a violet colour was formed.

A drop of concentrated sulphuric acid in a solution of the sesquiterpene in acetic anhydride immediately gave a bright green colouration.

Caryophyllene could not be detected by the characteristic blue nitrosite method.

Fraction (*c*) was probably a sesquiterpene alcohol, for on treatment with formic acid its density was lowered to ·9661 and its rotation altered from + 17·8 to 0.

Unidentified acid and phenol.—The sodium carbonate wash on acidification and extraction yielded about one c.c. of an acid of a light yellow colour which did not solidify at the temperature of liquid ammonia.

Combustion results—

C	71·59 per cent.
H	9·69 per cent.
O	18·72 per cent.

$C_{11}H_{18}O_2$ requires C 71·9 per cent., H 9·89 per cent., O 18·21 per cent.

Titrations with alcoholic potash indicated a molecular weight of 184, the duplicate being 182. $C_{11}H_{18}O_2$ has molecular weight 182.

The acid thus appeared to be an open-chain unsaturated monocarboxylic acid. A more thorough investigation was prevented by lack of material.

The phenol recovered from the sodium hydroxide washing was a yellow oil of density 1·0945. With ferric chloride it gave a green colouration, thus resembling creosol ($d_{15 \cdot 5}$ 1·0956).

The phenol behaved as a mixture, for on benzoylation a portion of it was converted into a solid benzoyl derivative M.P. 73° C. The combustion of this gave—

C	73·84 per cent.
H	6·2 per cent.

The phenol itself gave—

C	68·86 per cent.
H	7·53 per cent.

$C_8H_{10}O_2$ requires C 69·56 per cent., H 7·24 per cent.

The corresponding benzoyl derivative $C_{15}H_{14}O_3$ would require C 74·38 per cent., H 5·78 per cent. These results are in moderate agreement with those of creosol, the benzoyl derivative of which melts at 74° C. A mixed melting point, however, of the above benzoyl derivative and benzoyl creosol showed they could not be identical, as the mixture melted at 58° C. As no sample of the corresponding isocreosol was available, we were unable to prepare its benzoyl derivative for comparison, and in any case only about 1 c.c. of phenol was available for identification, so that the problem could not be finalised.

Our thanks are due to the Queensland Forestry Department for assistance in the collection of leaves; to Mr. S. B. Watkins, M.Sc., for permission to collect leaves on his property at Montville; and to Mr. C. T. White, Government Botanist, for the identification of the samples.

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(1) Hargreaves, J.C.S., 1916, 751.
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Vol. XLIX., No. 9.

The Establishment of a Seismological Station in Brisbane, Queensland.

By W. H. Bryan, D.Sc., Department of Geology, University of Queensland.

(*Read before the Royal Society of Queensland, 25th October,* 1937.)

During the past there has existed very little local interest in seismology. This lack of enthusiasm for a science that elsewhere has many ardent students is almost certainly due to the fact that perceptible earthquakes are of rare occurrence in Queensland. Thus since the establishment of the University of Queensland twenty-seven years ago there have been only two noteworthy earthquakes within the State. The first of these occurred in 1918, and was investigated by Hedley[1] some years later. The second, which took place on 12th April, 1935, and which has been described by Bryan and Whitehouse,[2] was of sufficient intensity to arouse considerable popular interest. In a statement made in the public press at this time, the writer deplored the fact that there was no seismograph in operation within the State and urged the necessity of establishing a seismological station in this part of Australia.

Following this appeal a gentleman who wishes to remain anonymous, but who was an early student at the University of Queensland, generously offered to provide the money necessary to purchase a Milne-Shaw Seismograph (No. 58).

Subsequent to the acceptance of this generous offer the Council for Scientific and Industrial Research was approached with the request that a second similar Milne-Shaw instrument be obtained in order to make the proposed station of greater value and more self-contained. This request was favourably received and a second instrument (No. 60) thus secured.

THE SITE.*

The temporary site selected for the station in which these instruments are housed is in the basement of the new University Library. This position has many things to recommend it, the principal being its convenience, for it is closely adjacent to the Department of Geology, from which the station is controlled. The chief adverse factors are the absence of solid rock on which to base the foundations (the Library building having been erected on a relatively unconsolidated river terrace alluvium), and the nearness to the city. But since many excellent stations are successfully operating under somewhat similar conditions these objections were not thought sufficiently strong to warrant the selection of a less convenient site.

The most suitable part of the basement having been selected, it was bricked off to form a light-proof and draught-proof room with a reasonably equable temperature.

The exact position of the site was carefully fixed by Mr. F. James. M.Sc., Lecturer in Surveying at the University of Queensland, as Latitude 27° 28′ 41″ S., Longitude 153° 1′ 52″ E., Elevation 15 metres.

Mr. James was also responsible for fixing the direction of the meridian within the seismograph cellar.

[1] Trans. Roy. Geog. Soc. Qld. Vol. 1, p. 151, 1925.

[2] Proc. Roy. Soc. Qld. Vol. 49, pp. 106-119.

* The permanent site of the station will be within the University of Queensland grounds at St. Lucia, where eminently suitable conditions should be found when the University is finally established there.

THE FOUNDATIONS.

The two instruments are set up on a single foundation designed bv the writer in co-operation with Mr. N. L. Thomas, of the Government Architect's Department.

The foundation consists of a solid monolith of concrete weighing approximately $9\frac{1}{2}$ tons. It is not reinforced in any way, and the concrete was poured as one continuous operation. The foundation is L-sharped, one side of the L being carefully aligned on the meridian and the other side at right angles to this. The whole concrete monolith is sunk 2 feet into the earth, is independent of and free from the foundations of the building, and is separated from the concrete floor of the cellar by a dry moat 5 inches wide and 8 inches deep.

THE SEISMOGRAPHS.

The instruments consist of a pair of Milne-Shaw horizontal pendulum seismographs with electro-magnetic damping. Each instrument has been adjusted to a period of 12 seconds, a damping ratio of twenty to one, and a magnification of 250.

Of the instruments as set up No. 58 registers the north-south component and No. 60 the east-west component.

The recording system is an optical one, the record being received on special Bromide B paper secured to a drum which is operated by a clockwork mechanism.

THE TIMING ARRANGEMENTS.

The time signals appearing on the record are controlled by a synchronome clock with half-minute impulses, alternate pulses of which are selected by another synchronome mechanism to give minute breaks on the record, each with a duration of 3 seconds. The hour is recorded as the first of three half-minute signals. The daily error in the station time is determined by comparing it by means of a radio receiving set with Eastern Australian Standard Time as broadcast by Station 4QG.

Corrected times are finally converted to Greenwich Mean Time for purposes of record.

CONCLUSION.

The trials already conducted have on the whole been most satisfactory. Local disturbances obtrude themselves only when heavy hammering is being done on the floors and walls of the still incomplete building that houses the station. On the other hand, those records of earthquakes that have been recorded are very satisfactory on account of their clarity, and more particularly in the ease with which the initial impulse of the preliminary waves can be marked off from the microseisms.

The station is in touch with other earthquake observatories in Australasia and elsewhere, both directly and indirectly, through the Seismological Research Committee of the Australian and New Zealand Association for the Advancement of Science.

Situated as it is on the margin of the actively seismic Pacific basin, this new observatory should play an important part in international seismology, more particularly as it helps to bridge the large gap in the chain of circum-Pacific stations that hitherto has existed between Sydney and Java.

The Gaydah Earthquake of 1935.

By W. H. BRYAN, M.C., D.Sc., and F. W. WHITEHOUSE, Ph.D., M.Sc., Department of Geology, University of Queensland.

(Text figures 1 and 2.)

(Read before the Royal Society of Queensland, 25th October, 1937.)

1. INTRODUCTION.

Queensland has been remarkably free from earthquakes, at least from those that can be readily appreciated by the human senses.

Although slight local tremors and occasional rumbles that may represent earth noises have been reported from time to time, only two shocks of notable magnitude have occurred within the last twenty-five years.

The first of these occurred on 7th June, 1918, and has been recorded by Hedley.[1] The second, with which this paper is particularly concerned, took place on 12th April, 1935.

Other than notices in the public Press the only account that has yet been published is a short note by Ball.[2] Bryan[3] has briefly referred to the main features in so far as they affect another problem.

2. TIME OF OCCURRENCE.

The Gayndah earthquake occurred towards noon on 12th April, 1935. The exact time could not be determined from local evidence, for there were no clocks of the required exactitude within the meizoseismal area. Nor were prompt observations made of the times shown by those clocks that were available.

Information obtained by courtesy of the Deputy-Director of Posts and Telegraphs shows that—1. The Post Office clock at Gayndah stopped at 11.35 a.m., and 2. The shock reached the Post Office at Wondai (50 miles south of Gayndah) at 11.35 a.m.

The Port Master at Maryborough (70 miles east of Gayndah) reported the shock as having reached there at 11.34½ a.m., but did not check his time against Eastern Australian Standard.

In the absence of more satisfactory local evidence as to the time of the disturbance, recourse was made at a later stage of the investigation to less direct methods. Thus, the position of the epicentre having been determined by local evidence, the several seismological stations in Australia were notified. With the knowledge which they then had of (*a*) the position of the epicentre, (*b*) the distance of the epicentre from their particular recording station, and (*c*) the precise time of arrival of the preliminary phase of the earthquake at that station, calculations as to the time of the disturbance were possible. Estimates arrived at on this basis are as follows:—Riverview College 11 hours 32 minutes 00 seconds, Sydney 11 hours 34 minutes 45 seconds, Melbourne 11 hours 34 minutes 08 seconds, and Adelaide 11 hours 35 minutes 03 seconds. The reason for the considerable discrepancies shown in these results is

[1] Trans. Roy. Geog. Soc. Qld., Vol. 1, No. 16, 1925, p. 151.

[2] Qld. Govt. Min. Jour., Vol. 36, No 419, 1935, p. 133.

[3] Proc. Gt. Barrier Reef Committee, Vol. IV., Pt. 2, 1936, p. 50.

almost certainly to be found in the difficulty of determining on the records of small earthquakes the precise moment when the first of the preliminary waves arrive, as these are frequently masked by microseisms.

It will be seen that the indirect method of determining the epicentral time was no more successful than that based on direct local evidence. Averaging the results from Sydney, Melbourne, and Adelaide, we get 11 hours 34 minutes 39 seconds Eastern Australian Standard, or 1 hour 34 minutes 39 seconds Greenwich Mean Time. This corresponds reasonably well with the local estimates, but shows a marked discrepancy from the estimate of Riverview College Observatory, which, it must be remembered, is the best equipped station in Australia.

3. SEISMOLOGICAL RECORDS.

Any attempt at an accurate study of the Gayndah earthquake was made impossible by the fact that at the time there was no seismograph in Queensland itself* or in any adjacent regions to the east, north, or west, the five Australian stations then in operation all lying to the south of a line joining Sydney and Perth. Thus, although each of these stations recorded the earthquake, satisfactory intersections of the individual results were not obtained.

The nearest seismographs are situated at Sydney, New South Wales. Of these that at the Sydney Observatory, although it responded to the tremor at 1 hour 37 minutes G.M.T., does not allow of recording of individual phases of disturbances such as that under consideration, the rate of the machine being too slow.

The other Sydney station (at Riverview College) is better equipped, having Wiechert instruments recording all three components, in addition to a Mainka and a Galitzin.

The following records are extracted from the relevant portions of the Riverview College Seismological Bulletin:—

No.	Date.	Phase.	Time. (Greenwich).	Period.	Amplitude.				Remarks.
					An	Ae	Az		
	1935.		h m s		mm	mm	mm	km	
49	12 April	ePZ	01 34 20	1			0·1	1,080	
		eSZ	36 19	2			0·3	(9·7°)	On N–S and E–W Comp. S in minute mark.
		iNEZ	36 42	2	+ 6·5	+ 8·0	+ 0·8		
		iNZ	36 52	2	+ 12·4		+ 2·0		
		mN	36 55	2	12·4				
		iZ	37 04	2			+ 3·6		Felt in Queensland.
		iNE	37 08	2	− 13·2	+ 21·0			
		mZ	37 09	3			5·1		
		iE	37 12	2		+ 18·7			
		LZ	37 33	5					
		iN	37 42	4	− 13·2				
		iME	37 51	4		− 15·3			
		MZ_1	37 52	4			3·5		
		ME_1	37 59	6		21·8			
		iN	38 02	4	+ 26·0				
		MN	38 06	5	19·4				
		ME_2	38 16	5		27·5 +			F 01 55
		MZ_2	38 24	3			4·9		

* Fortunately this serious deficiency has now been rectified through the generosity of a gentleman, who wishes to remain anonymous, who has presented a Milne-Shaw Seismograph to the University of Queensland. This, and a second similar instrument provided by the Council for Scientific and Industrial Research, are housed in the newly-established University of Queensland Seismological Station. See the preceding article in this volume.

The seismograph at Melbourne Observatory (a Milne-Shaw registering the East-West component) recorded the tremor, but the P waves were rather obscure owing to microseisms. The exact time of the emergence of the S waves is also somewhat doubtful, but the L waves are more definitely recorded at 1 hour 39 minutes 41 seconds. At 40 minutes 06 seconds the maximum showed an amplitude of 6·4 mm. and a period of 4 seconds.

At Adelaide Observatory a Milne-Shaw instrument registering the North-South component recorded the arrival of the P waves at 1 hour 38 minutes 59 seconds, the S at 1 hour 41 minutes 04 seconds, and the L at 1 hour 41 minutes 20 seconds, with a maximum disturbance of 1·9 mm. of waves of 7·5 seconds period at 1 hour 42 minutes 40 seconds. The calculated epicentral distance based on these observations was 1240 kilometres.

At Perth is a Milne-Shaw instrument recording the North-South component. The time of arrival of the P and PP waves is somewhat doubtful owing to their traces being mixed with microseisms as large as themselves, but may be 1 hour 38 minutes 07 seconds and 1 hour 39 minutes 25 seconds respectively. The S waves are more confidently placed at 1 hour 43 minutes 55 seconds. The L waves arrived at 1 hour 48 minutes 05 seconds. The epicentral distance based on the times of arrival of S and L was calculated at 2390 miles (3848 kilometres).

The Dominion Observatory at Wellington, New Zealand, reported that no records of the tremor were recorded by any instrument in New Zealand.

The authors are most grateful for this information, which has been supplied by the officers in charge of the respective stations, but these records, although of great interest, could not be used as a basis for exact work, as they are somewhat discordant. Thus it would be impossible to fix the position of the epicentre even approximately from a correlation of the data contained in the several reports.

4. COLLECTION OF EVIDENCE.

The authors early realised the possibility of obtaining some light on the nature and origin of the earthquake if a sufficient number of reliable reports could be gathered from the personal experience of people situated within the area perceptibly affected. In view of this possibility, an immediate appeal for information was made through the Brisbane press and by means of the Australian Broadcasting Stations at Brisbane (4QG) and Rockhampton (4RK).

These appeals brought forth a most gratifying response in the shape of numerous replies. Most of these appeared to be thoroughly reliable, while very few were worthless. Some contained information collected by the sender from a number of different sources, and several were prepared with a scientific precision and exactitude that must have involved a great deal of patient work.

In addition to these replies there were available the numerous messages sent in to the Brisbane newspapers by country correspondents and the more localised details set out in those country newspapers published in the affected area.

In order to fill the numerous gaps in our knowledge that remained after these replies had been received, a questionnaire was drawn up based on the Rossi-Forel Scale and despatched to school masters and others likely to be in a position to help. Nearly all of the forms were completed and returned, thus affording a great deal of additional information. As a result of these various methods reports have been collected from nearly 200 localities.

5. INTERPRETATION OF DATA.

The information thus obtained was summarised and placed on numbered cards on which the names of the localities did not appear. The intensity represented by each summarised account was then assessed independently by each of the authors and the localities *afterwards* ascertained by reference to a key. In this way it was hoped to ensure a more complete detachment in the investigation, and in particular to prevent the overemphasis of geologically "likely" districts.

6. USE OF THE ROSSI-FOREL SCALE.

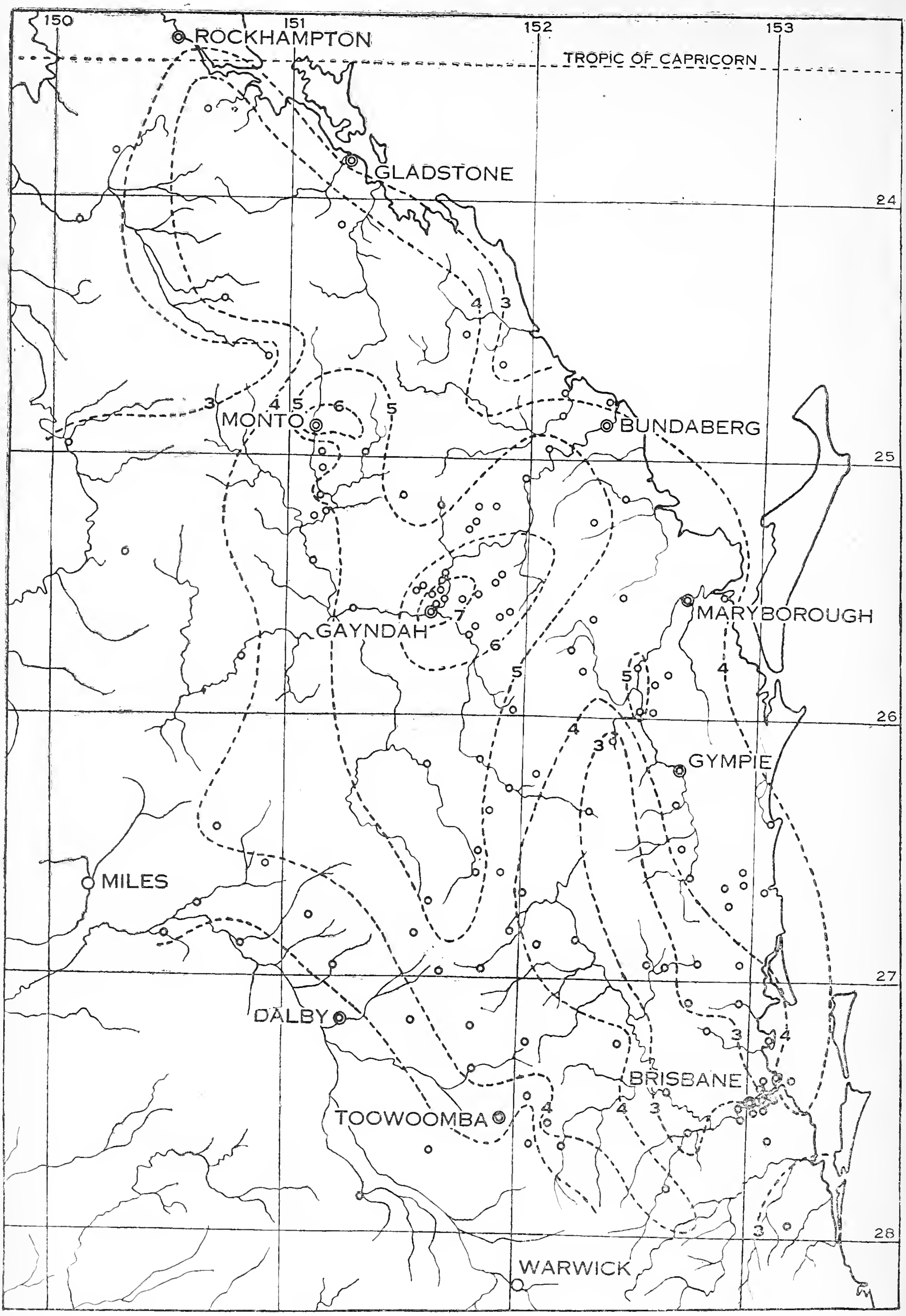
The intensity assessed for each locality was expressed in terms of the Rossi-Forel scale. Although this has long been used internationally and has met with general acceptance, it is not easily applied to conditions in Queensland.* Originally constructed for use in investigating earthquakes in Italy, it is particularly suitable for a country where the people are largely concentrated into towns, where they live in brick and rubble houses that are in many cases not soundly constructed, and where brick chimneys are numerous. Thus intensity No. 8 on the Rossi-Forel scale is based solely on " fall of chimneys, cracks in the walls of buildings." It is obviously impossible to apply these criteria in the smaller country towns of Queensland, where the vast majority of people live in wooden ("frame") houses which have no brick chimneys. Again, intensity No. 7 is based in part on ". . . general panic, without damage to buildings." But is the panic point the same in a Sicilian slum and on an Australian farm? It is doubtful. In view of the relatively scattered population, the absence of brick houses and chimneys, and the somewhat phlegmatic character of the average Australian country man, it may be that the absolute intensities in this paper have been somewhat underestimated in terms of the Rossi-Forel scale. With regard to the estimation of relative intensities the authors feel considerably more confidence.

7. DISTRIBUTION OF APPARENT INTENSITY.

One of the maps accompanying this paper (text figure 1) shows a series of isoseismal lines, each based on the assessed intensity in terms of the R.F. scale. It should be noted that such a map shows the distribution of *apparent intensity*, not of intrinsic intensity, the distribution of which should be far more regularly concentric.

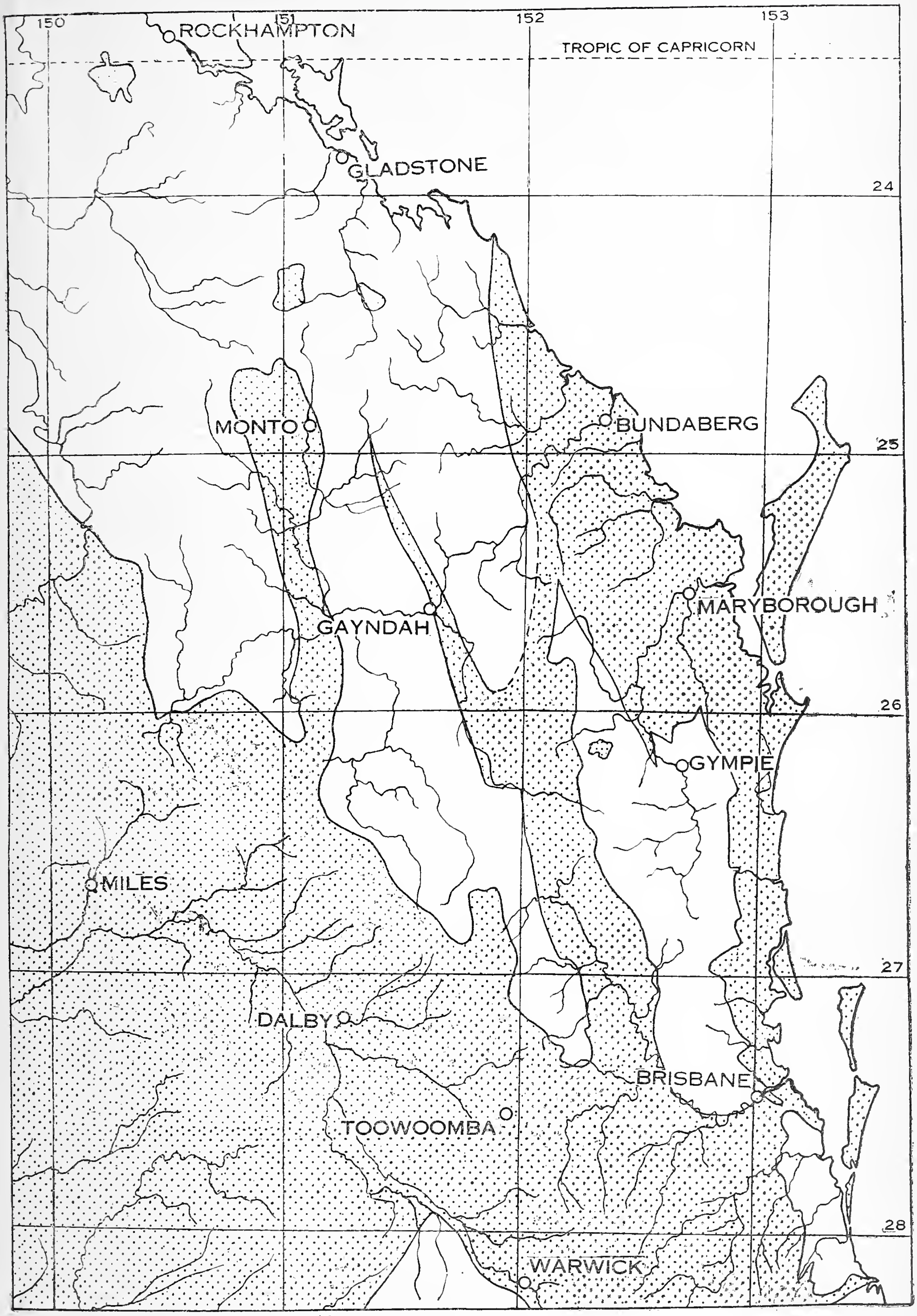
Concerning this question of "apparent" intensity Wood,* who made a detailed study of San Francisco after the earthquake of 1906, writes:— "It is a general fact of observation that strong earthquakes are far more destructive on loose, water-soaked soil, or made ground, than where fresh, crystalline rock outcrops at the surface. This has been observed over and over again. Also, intermediate grades of destructiveness are generally found on ground of intermediate degrees of firmness. . . . It seems obvious that the relationship is one of cause and effect, and the

* An analysis of the records obtained has suggested certain adaptations that may be used for local conditions. Some of these are set out on pages 113 and 114.



Text Fig. 1.

Map of South-Eastern Queensland, showing distribution of Isoseismals. (The small circles represent localities from which detailed reports of the tremor were received.)



Text Fig. 2.

Map of South-Eastern Queensland, showing the distribution of (1) palaeozoic and earlier rocks (plain), and (2) mesozoic and later rocks (stippled areas).

mechanism is considered to be well understood. 'Apparent' seismic intensity, therefore, is in part a function of the geologic materials and structures at or near the surface in the epicentral region. This has long been known. . . ."

In many areas from which numerous reports were received there was a noticeable variation in intensity that quite patently was related to the different geological structures. For instance, in the Brisbane area, nearly 200 miles from the epicentre and towards the limit of the perceptibly affected region, the following examples illustrate this point:—

A. The Pile Light in Moreton Bay near the mouth of the Brisbane River is a structure supported on steel piers. The piers themselves are embedded in blocks of concrete which are not attached to a solid rock foundation but "float" in incoherent sand. Here the earthquake was felt more violently than anywhere else in the Brisbane area. Although the occupants were accustomed to vibrations of the building as a result of the buffetings of heavy seas, nothing like this experience had occurred in many years. Heavy furniture was moved, crockery rattled, water in the rainwater tank slopped over, and a man in bed was almost thrown to the floor. The structure was shaken so severely that an inspection of the foundations by a diver was deemed necessary and was carried out the following day.

B. At Cribb Island (a small settlement built on sand just above tide level on the shores of Moreton Bay) seaside cottages were so violently shaken that some people rushed out into the streets in alarm.

C. In some of the suburbs to the south of the City, which are on fresh water shales and sandstones of Triassic age, the tremor was felt by many people at rest and by some in action.

D. In those parts of the city built on metamorphosed sediments of ?Ordovician age the tremor was noticed only by people at rest in the upper portions of tall buildings, and then not very strongly.

The apparent intensity within the Brisbane area thus varied from at least 5 in the R-F. scale to as low as 2, the variation depending upon the compactness of the underlying rock, which in this case was directly related to the age of the geological formation.

When viewed broadly, there are certain interesting inferences that may be drawn from a study of the distribution of apparent intensities. In south-eastern Queensland the strike of the palæozoic rocks is almost constantly a few degrees west of north. Ten degrees west of north may be taken as perhaps the average. Text figure 2 shows the distribution of palæozoic and mesozoic rocks. If this map is compared with Text figure 1, a map of the isoseismals, the following features will be noted:—

i. Adjacent to the epicentral region the isoseismals are elongated in a north-easterly direction—that is, quite independent of the geological "grain."

ii. In spite of this the isoseismals generally in the province are grouped around areas elongated in the direction of the trend lines of the palæozoic rocks. Two such elongated areas are well shown—a zone of low intensities along an axis N.N.W. from Brisbane, and a N.N.W. zone of relatively high intensities between Toowoomba and Rockhampton.

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* "Physics of the Earth—VI. Seismology," Nat. Res. Council, U.S.A., Bull. 90, 1933, Chapter VII., p. 67.

iii. In the south-west of the province, where the greatest development of the mesozoic sediments occur and where the palæozoic rocks are completely covered, the isoseismals seem to lose this N.N.W. relationship and are developed parallel to the palæozoic-mesozoic junction.

It would appear, therefore, that in the major portion of the province, where both palæozoic and mesozoic rocks occur, the trend of the palæozoic series has been the dominant control in the alignment of the isoseismals. In this portion of the region the apparent intensities do not diminish concentrically from the epicentre, but have maxima and minima along certain belts of these older rocks. In contrast to this, in the south-western part of the area, where the palæozoic rocks are completely buried, the intensities seem to diminish in a normal way.

8. POSITION OF EPICENTRE.

The exact positon of the epicentre has not been found, but the evidence points to its being approximately 10 miles north-east of the town of Gayndah at about 25° 30′ S., 151° 40′ E. The area within the innermost isoseismal is somewhat elongate and encloses a number of places where the apparent intensity reached R.F. 7, and it is possible that higher unrecorded intensities may have occurred within this sparsely settled area. This zone of greatest intensity is elongate in a direction E.N.E.-W.S.W. In addition to the main epicentral area near Gayndah there is another smaller area of equal or almost equal intensity at Monto, some 60 miles to the north-west. Somewhat surprisingly the intensity in this latter area seems disconnected from that of the Gayndah area, for, although it has been difficult to obtain information on account of the thinly populated nature of the intervening country, such records as have been obtained all tend to separate the two. The simplest explanation is that the Monto tremor was a subsidiary sympathetic disturbance practically synchronous with the Gayndah shock.

No reliable quantitative estimate can be made on the data available as to the depth of the movement that produced the earthquake, but the fact that the disturbance was clearly recorded at Perth (some 2,220 miles away), and yet unrecorded at Wellington (less distant by 400 miles), suggests a comparatively shallow origin, the Thomson Deep apparently acting as an effective barrier to the propagation of the earthwaves in a south-westerly direction.

9. SELECTED REPORTS.

There was a wealth of pertinent detail in the 200 reports that the authors received.

A survey of these has brought to light certain features that may be useful in future in adapting the Rossi-Forel scale to local conditions. In order to appreciate these it should be noted that in Queensland the usual type of residence is a wooden "frame" house set high on wooden stumps. Water tanks are corrugated, galvanised iron cylinders placed unanchored on wooden platforms supported by wooden blocks. These tanks hold, as the usual maximum, 1,000 gallons of water. The usual type of cooking stove is an iron structure, about 3 feet by 2 feet by 2 feet, supported on small legs.

In areas of intensity 3, of the Rossi Forel Scale, residents reported that the effect was similar to that of a horse rubbing itself upon one of the house stumps. This statement was made so frequently and by so many independent observers that it is worthy of record for future correlation. When the intensity was R.F. 4 water became agitated in the tanks. In the zones of intensity 6 and 7 tanks developed cracks, and leaks were set up in the seams. Two observers in the meizoseismal area (intensity 7) have noted that their tanks of water moved on the platforms. Stoves were shifted in several houses where the intensity was at least 6.

Three reports from residents within the meizoseismal area may be quoted—

(1) Mr. R. T. Netterfield, living some 7 miles north-west of Wetheron, reported that "about 11.30 a.m. and without warning the first and main 'quake of two connected spasms occurred, accompanied by a heavy 'booming' detonation comparable only to a deep-seated heavy charge of explosive, and too continuous to be placed to any particular point of the compass. The rapid horizontal play (fully a foot) of the ground and surface being on a line south-west to north-east. . . . Green foliage 'tangled' but did not sway. Dead, pliant limbs 'clacked' together like sawn pine on a moving waggon and fell in showers. Cow-dung and light sticks hopped back and forth off the ground, while queer little jets of dust spurted from around tree butts. As nearly as could be judged 8 seconds would be about the duration of this shock. . . . Despite eighteen anchor-bolts my 28 by 36 pine and weather-board house moved an inch on some of its unanchored blocks. All tanks were somewhat damaged. A 5-foot cast-iron separator drew its three large anchoring coach screws. All yard and shed posts were joggled loose, and the rubble in the stock yards shook down level and smooth. . . . Crockery from northern and eastern shelves suffered severely."

(2) "Mount Lawless is a rocky region, and cliffs rise abruptly from the river bed to the height of some 70 feet. Small rocks and stones fell from these cliffs. I noticed that one gum tree of a diameter about 8 inches had fallen from the cliff side. Houses at the foot of Mount Lawless were shifted 1 inch on their blocks, and a stove was moved 1 or 2 inches. Fishermen [in the river] under the cliffs declare that the water rose between 1 and 2 feet. Numerous tanks started leaking. One tank shifted about 9 inches, blocks and all. Trucks on the railway line swayed. Books fell from shelves in the houses, many clocks stopped, and small cracks developed in two cement buildings." (Mr. F. T. Borchardt, Ideraway.)

(3) "At the Bymingo School books and other articles fell from the shelves. Unsound timber fell from a shed. . . .Beams spanning the roof showed that the walls had been displaced for $\frac{1}{8}$ to $\frac{1}{4}$ inch. Marks on stumps after the shock showed that the school had been raised about $\frac{1}{2}$ inch. . . . Several cement floors [in neighbouring buildings] were cracked, and a tank burst. Clocks stopped. . . . Two terrific explosions were followed by the loose earth, twigs, leaves, &c., being raised from 10 inches to 1 foot above the ground. Dead limbs fell from the trees, and buildings shook violently." (Miss M. Pittman, Bymingo.)

The most impressive evidence seen by the authors of the paper on their visit to the area was on the south-western slopes of Mount Lawless, where great masses of trachyte many tons in weight had fallen from the mountain sides. From the trachyte cliffs of the Burnett River near Mr. Netterfield's residence other large blocks had been dislodged. They were informed that these falls took place during the tremor of 12th April.

It may be of value to note some of the effects in localities a little further removed from the epicentre. The head teacher of the Abbeywood school (where the intensity was interpreted as 6) reported that "pictures were shaken from the rail that supported them, and the school clock was moved fully an inch from its centre level mark, but did not stop. Children reported seeing the tree guards in motion. . . . It is reported by others that the ground was seen to move in three small waves. . . . Workers picking corn a short distance from the school reported feeling sick after the shock."

Mr. C. Realf, of Childers (in an area of intensity 6) stated that—"My garage is 60 feet long, with the apex of the roof about 26 feet high running almost north and south. I observed a very pronounced sway of the whole roof from east to west. The movement was enough to cause me to bolt for the open air, and I can state that almost every person in the district left his house. A large quantity of moveable objects leaning against the inside walls of the workshop were overthrown; and from the movement of a 12-foot piece of 2-inch-by-1-inch pine leaning against a beam I estimated the sway to be at least 1 foot. . . . It was comparable to the effect of earth movement caused by heavy shell fire falling too close for comfort."

A report from Yenda, typical of many in isoseismal region 6, stated among other evidence that cattle and horses ran startled in mobs.* A stove shifted an inch out of place. Dead limbs fell from trees, and plaster fell from roofs, and several tanks leaked.

An observer at Goomeri (intensity 5) noted in his report that "motorists while travelling felt the shock by the rear of their cars leaving the ground similar to bumping over some solid object."

From Aramara (intensity 4) Miss M. Bange wrote that—"People in the open, working in the garden or drilling in the school ground, did not notice the shock; but men working with heavy logs on railway trucks and with timber in the scrub felt it. Butchers' hooks danced on the rod. Water in barrels was agitated, and continued so for a few minutes afterwards. Some commodities fell from the shelves in the general store, and doors and windows rattled."

Such are a few reports typical of those from various isoseismal zones.

10. AFTERSHOCKS AND SYMPATHETIC DISTURBANCES.

Although this account is concerned primarily with the earthquake of 12th April, 1935, it would be incomplete without some reference to the long train of less intense disturbances which followed. Some of these may be regarded as aftershocks in the strictest sense, and all may be assumed to be more or less directly related to the main shock, although some occurred as long as eight months after the initiation of seismic activity and others were well outside the original meizoseismal region.

The seismic history for the Gayndah area for 1935 may be set out as follows:—

1. The shock of 12th April came without any warning fore-shocks, but was followed by—
2. A large number of after-shocks, each with its accompanying detonation. These occurred intermittently but with declining frequency until 4th May. Then after an interval of eleven days came—

* Several observers noted that cattle and horses were not disturbed by the earth sound, but became very nervous during the period of the tremor.

3. A series of earth tremors occurring intermittently until 23rd May. About a week later there was felt—
4. The relatively strong disturbance of 1st June. The following short account of the tremor is taken from the "Maryborough Chronicle" of 3rd June, 1935:—

   "Between 10.15 and 10.30 on Saturday night Gayndah experienced an earth tremor almost as severe in intensity as that which occurred on 12th April. On this occasion many residents had retired to bed, and received a rude awakening. The shock set houses swaying. Crockery rattled on shelves, and doors swung. No reports of damage were received, but the shock caused alarm to many. . . . Fortunately the shock only lasted a few seconds at the most. . . . Several outlying centres experienced the tremor. Reid's Creek and Ideraway, 10 and 5 miles away from Gayndah respectively, noticed the shock, and Coalstoun Lakes also reported having felt the tremor."

   This shock was not recorded at Riverview College Observatory, nor was it followed by any pronounced system of aftershocks. The fact that it occurred at night may have caused some exaggeration of its intensity.
5. Occasional tremors were recorded during the next five weeks, but became more frequent from 8th July. These ushered in—
6. The relatively strong shock of 19th July, which the "Maryborough Colonist" described as follows:—

   "The Burnett district experienced an earthtremor about 5.30 this morning. The shock in parts was as severe as the tremor of April last. At Mundubbera houses shook violently and tanks on high stands swayed."

   This was not recorded at Riverview College.
7. Further tremors were reported from time to time until 14th December, 1935.*

Consideration of the reports on which these items are based shows that the seismic disturbances of 1935 continued intermittently for eight months† and covered a considerable area, of which the region to the east of Gayndah appears to have been the most sensitive locality and to have been most consistently affected. In the important initial shock Monto appears to have been a subsidiary centre, but at a later date Mundubbera was strongly affected.

11. GEOLOGICAL SIGNIFICANCE.

As geologists the authors were naturally interested in the possible geological significance of the Gayndah earthquake from the announcement of the first sharp shock, and this interest grew with the growth of the long train of aftershocks and sympathetic disturbances reported from the region.

Two questions appeared to be worth investigation. The first concerned the possibility of detecting some unstable geological structure in or adjacent to the epicentre of the initial shock. Was the Gayndah

* As recently as 7th October, 1937, another severe tremor was felt in the area.

† Detailed records during the period from 12th April to 22nd July were kept by Miss M. Pittman, of the Byminge State School. Seventy-three tremors of varying intensity were felt during this period.

earthquake caused, for example, by a renewal of movement along an old fault plane? The second question was of a more general nature, and was concerned with the reason for the prolonged seismic activity of the year 1935, and the virtual restriction of this activity to the Burnett region. Why should the valley of the Burnett be more susceptible to earthquakes than other parts of the State?

The first attempt to answer these questions was based on an examination of such geological accounts and maps of the area as were in existence. These were not sufficiently detailed to warrant confident conclusions. They were, however, very suggestive. Thus the epicentral area seemed to lie quite close to a major structural line, namely, that separating a great palæozoic terrain to the east, and a narrow strip of mesozoic rocks to the west. Moreover, this junction marked the northern extension of a tectonic feature of the first importance, which was best known in the heavily faulted strip of country between Ipswich and Northbrook. This great system of faults had first been recognised by Cameron.* Its importance and significance was later emphasized by Reid† when he wrote: "In Southern Queensland there appears to be a sharp boundary to the coastal folding of Tertiary age. This boundary takes approximately a regular N.N.W.-S.S.E. line, and passes from Gayndah, through Ipswich, to Beaudesert. Faulting and intense folding mark this line, and west of it the Mesozoic strata are scarcely disturbed; to the east they are, in some cases, only slightly disturbed, but are frequently heavily folded."

At about the same time Bryan,‡ independently, and as the result of a different line of approach, arrived at a similar conclusion with regard to the significance of the Ipswich-Gayndah line, which he regarded as the most important of the four great "anticlinal axes" of Southern Queensland. Bryan tentatively extended this tectonic feature to the north-north-west of Gayndah, and Reid§ subsequently established the presence of heavy faulting near Monto on the line as thus extended. Writing of this he states: "Just to the east of the [Mulgeldie] coal basin lies the junction of Lower Carboniferous and Lower Mesozoic rocks. This junction is marked by great disturbance in both series on the Monto road. . . . This fault line is one of major structural importance, whereby the coalfield was dropped down and overthrust from the east by Lower Carboniferous rocks. This fault line bears approximately 35° west as plotted over a few miles to the north-east of Monto."

A few miles south of this fault but not in alignment with it (being somewhat further west) Reid describes another important structure as "a fault and crush line which has been mapped in detail from Abercorn to the south-west corner of the coalfield, a distance of eight miles. . . . This fault line is apparently not one of very great displacement, but consists of a linear strip perhaps only 10 to 20 chains wide, in which the strata are broken and crushed into postures approaching the vertical, while on either side the rocks are only very gently folded." The inset map accompanying Reid's report shows springs emerging from two points on this second fault line. One of these, called "Soda Springs," is

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* Qld. Geol. Sur. Pub. No. 147, p. 2.

† Aust. Assoc. for Adv. of Sci., Vol. 17, 1924, p. 310.

‡ Proc. Roy. Soc. Qld., Vol. 37, p. 35, 1925.

§ Qld. Govt. Min. Jrnl., Vol. 28, p. 185, 1927.

shown where the railway line to Monto crosses the fault line just to the north of Abercorn. (It was at this point that a crack 120 feet long running in the direction of the fault and an accompanying subsidence of 12 inches were discovered on the permanent way by the railway authorities on the day following the earthquake.)

With regard to the Burnett region in general the only significant geological fact that might be related to its seismic sensitivity was that it contained the most striking evidence of recent volcanic action to be found in the southern half of Queensland. In particular the extinct volcano Mount Le Brun,* with its twin crater lakes (The Coalstoun Lakes), might possibly be regarded as a related phenomenon.

The facts enumerated above were all of them suggestive and warranted a closer examination of the geology of the area. Consequently at the first opportunity, which occurred during the University vacation in August, 1935, the authors made a hurried visit to the area accompanied by Dr. D. A. Herbert.

The results of this excursion were most satisfactory, in as far as they provided a clear picture of the geological structure of the critical area, but were disappointing in that they did not reveal any evidence as to the immediate cause of the earthquake.

The authors were not so sanguine as to expect to find newly formed scarps or any other marked disturbance of the surface—the earthquake was not nearly so intense as to warrant such an expectation—but they did hope to find other geological evidence that would enable them to locate the epicentre more definitely and that might throw some light on the origin of the shock.

It is true that the anticipation that the epicentre would be found to be near the junction of the Palæozoic and Mesozoic terrains was justified by an examination in the field, but it is equally true that (1) No part of the meizoseismal area was actually on this junction, (2) The long axis of the meizoseismal area was discordant both with the direction of the junction as locally developed and with the general trend of the Ipswich-Gayndah line, (3) The junction is locally sealed by the presence of a large granitic intrusion.

The only suggestive geological relationship was one that was not anticipated. It concerns the rough coincidence in both size and direction of a large mass of biotite trachyte with the epicentral area as finally determined. The outcrop of the trachyte extended for 7 miles in an E.N.E. direction.

This mass is particularly well developed at its south-western extremity, where it forms the prominent feature known as Mount Lawless. There it is seen to be intrusive into conglomerates of the Upper Esk (Triassic) Series. Another notable exposure is on the banks of the Burnett River where this passes Mr. Netterfield's property.

It is probably very significant that it was at these points that those heavy rock falls occurred that have been noted in an earlier section.

While in the Burnett area the authors took the opportunity of investigating the evidence of recent volcanic activity.† The perfect and, as yet, unmodified form of the cone and craters of Mount Le Brun, and the large quantities of relatively unweathered slaggy material still

* First described and named by N. W. Broun. See Proc. Roy. Soc. Qld., Vol. X., p. 44, 1894 and Vol. XI., p. 88, 1895.

† See Proc. Roy. Soc. Qld., Vol. 47, p. xv., 1935.

lying upon the surface, together with the clear evidence that basaltic lava streams have flowed down the present valleys of the Burnett River, Barambah Creek, and several tributary streams, all clearly demonstrate that important volcanic eruptions have occurred within the present cycle of denudation, and at no distant date.

These facts at first appear to be full of significance when it is borne in mind that the Burnett area is one relatively sensitive to seismic activity—at least as compared with the rest of Queensland—but a more detailed examination of the position in the field showed that Mt. Le Brun, which must be regarded as the focal point of the recent volcanic activity, is situated well outside the meizoseismal area.

There is certainly no direct evidence for regarding the Gayndah disturbance as a volcanic earthquake. But it is equally certain from the shallow depth of the focus that it cannot be considered as a plutonic earthquake. There is then no alternative but to place it in the only remaining category and class it as a tectonic earthquake, in spite of the fact that no close correlation with earlier tectonic phenomena has been established in the field.

12. ACKNOWLEDGEMENTS.

The authors are deeply indebted to the many correspondents who responded to their appeal for help, and many of whom went to considerable trouble in providing carefully prepared accounts of the main shock and the many succeeding tremors. They also thank the officers of the several Australian and New Zealand seismological stations for the information and copies of seismograms that they so readily supplied. Lastly they would express their deep appreciation of the hospitality and help provided by Mr. R. T. Netterfield, of Wetheron.

Studies in Oriental and Australian Trypaneidae—Part II.

Adraminae and Dacinae from India, Ceylon, Malaya, Sumatra, Java, Borneo, Philippine Islands, and Formosa.

By F. A. Perkins, B.Sc.Agr., Lecturer in Entomology, University of Queensland.

(*Read before the Royal Society of Queensland, 25th October,* 1937.)

(Plate IVa.)

After having worked for several years on the Trypaneidæ of Australasia, it was with great pleasure that a collection of about 500 specimens was received from Dr. H. M. Pendlebury, Curator of the Selangor Museum, F.M.S., for study and identification. Subsequently additional material was received from the British Museum, Macleay Museum, Sydney, Australian Museum, Council for Scientific and Industrial Research, Canberra, F.C.T., South Australian Museum, and the Queensland Museum. A total of over 3,000 specimens was received, the additional material prolonging but at the same time simplifying the task. Owing to difficulties of publication it is not possible to deal with the whole of the material in one paper.

Most of the species can be divided into three distinct groups—

(*a*) Species from India, Ceylon, Malaya, Sumatra, Java, Borneo, Philippine Islands, and Formosa.

(*b*) Species from Celebes, Aru Island, New Guinea, and the islands of the South Pacific.

(*c*) Species from Australia.

Groups (*a*) and (*b*) are the countries east and west of Wallace's Line. No special significance is attached to this, the grouping being merely one of convenience.

I wish to express my sincere thanks to those who have assisted me in this work, and in particular to Mr. H. K. Munro, B.Sc., Dr. H. M. Pendlebury, Curator of the Selangor Museum, Dr. J. Smart and the Trustees of the British Museum, Mr. A. Tonnoir and Dr. A. J. Nicholson, C.S.I.R., Mr. A. Musgrave, Australian Museum, Mr. Salter, Macleay Museum, Dr. Walther Horn, Deutsches Entomologisches Institut, Berlin, and Dr. C. H. Curran, American Museum of Natural History, and Mr. H. M. Hale, Director, South Australian Museum.

With regard to the subdivision of the family, the classification adopted is that proposed by Bezzi (1924), in which the family is divided into six sub-families. Five of these sub-families are represented in the material before me; and two, *Adraminæ* and *Dacinæ,* from countries under group (*a*) are considered in this paper.

Sub-family *ADRAMINAE.*

This sub-family is represented by only one species—*Adrama determinata* Walk.

Of this widely distributed and well-known species there are fourteen males and eleven females from the following localities:—Larut Hills, Perak, February, 1932 (H. M. Pendlebury); Kuala Lumpur, Selangor, October, 1921 (H. M. Pendlebury); Fraser's Hill, Pahang, January, 1929; Bukit Kutu, Selangor, September, 1929 (H. M. Pendlebury); Bettotan, near Sandakan, N. Borneo, July and August, 1927; Kedah Peak, March, 1928; Djampang Tinggh, Preanger, West Java, March, April, September, October, 1935; Moenia, N. Java, 2-4,000 feet, November, 1935.

Sub-family *DACINAE.*

This sub-family is well represented, and 10 genera are considered in this paper. The genera found in India and the oriental region west of Wallace's Line can be separated by means of the following table:—

1.	One pair of *sc.* bristles	2.
	Two pairs of *sc.* bristles	9.
2.	Thoracic suture complete	*Monacrostichus* Bez.
	Thoracic suture incomplete	3.
3.	Basal segment of ovipositor longer than abdomen ..	*Leptoxyda* Macq.
	Basal segment of ovipositor shorter than abdomen ..	4.
4.	Ovipositor cylindrical throughout	*Callantra* Walk.
	Ovipositor flattened distally	5.
5.	No *pr. sc.* bristles	6.
	One pair of *pr. sc.* bristles	7.
6.	Two *a. sa.* bristles	*Tetradacus* Miyak.
	One *a. sa.* bristle	*Daculus* Speis.
	No *a. sa.* bristles	*Nesodacus* F.A.Perk.
7.	One *a. sa.* bristle	8.
	No *a. sa.* bristle	*Afrodacus* Bez.
8.	Third abdominal tergite of male ciliated	*Strumeta* Walk.
	Third abdominal tergite of male not ciliated ..	*Asiadacus* F.A.Perk.
9.	*Pr. sc.* absent	*Paradacus* n.g.
	Pr. sc. bristles present	10.
10.	Third abdominal tergite of male ciliated	11.
	Third abdominal tergite of male not ciliated ..	*Paratridacus* Shir.
11.	Supernumerary lobe present in wing of male ..	*Zeugodacus* Hend.
	No supernumerary lobe present in wing of male ..	*Parazeugodacus* Shir.

Genus **STRUMETA** Walk. 1856.

Syn. *Chaetodacus* Bezzi 1913.

In a previous paper (Perkins, 1937) it was pointed out that there is no definite evidence to justify making *Strumeta umbrosa* F. (syn. *conformis*) a synonym of *Bactrocera longicornis* Guér. Certainly they both have banded wings, but the figure of the wing of *B. longicornis* is quite different from that of *S. umbrosa*. Moreover, the description of the two species differs in other respects (*see* Bezzi, 1928; Perkins, 1937). Unfortunately the type of *B. longicornis* is missing, and it is impossible to fix its generic characters until it has been rediscovered. Consequently *Bactrocera* (type *longicornis*) and *Strumeta* (type *umbrosa*, which is well known) must be regarded as distinct genera. Bezzi (1913) thought the two species were the same, and then assumed that they were, for he certainly had no proof. Sinking *Strumeta*, he put into *Bactrocera* all the species of *Dacinae* with banded wings, and erected a new genus, *Chaetodacus*, for those species with only a costal band and anal streak. The recent discovery of new species, and the rediscovery of several old species, all with banded wings, have demonstrated very definitely that such a character has very little generic value. Species with banded wings are placed in at least five different genera. Ignoring the banding of the wings, *Strumeta* (type *umbrosa*) and *Chaetodacus* (type *ferrugineus*) have exactly the same generic characters; and *Strumeta* Walk. has priority.

If, eventually, *Bactrocera longicornis* Guér, and *Strumeta umbrosa* F. are proved to be congeneric, then both *Strumeta* and *Chaetodacus* will become synonyms of *Bactrocera*.

KEY TO SPECIES FOUND IN INDIA, MALAYA, JAVA, BORNEO, SARAWAK, &c.

1.	Mesonotum with median longitudinal yellow stripe ..	3.
	Mesonotum without median longitudinal yellow stripe	7.
3.	Scutellum with black median longitundinal band ..	4.
	Scutellum entirely yellow	5.
4.	1st and 2nd femora fulvous, with black apical ring	*tappanus* Shir.
	1st and 2nd femora almost entirely black, only the base slightly yellowish	*scutellarius* Bez.
5.	Three *i. or.* bristles	*cucurbitæ* Coq.
	Two *i. or.* bristles	6.
6.	A large apical spot at apex of wing	*apicalis* de Meij.
	Costal band normal, no apical spot	*diaphorus* Hend.
7.	Wings with markings in addition to costal band and anal streak	8.
	Wings at most with costal band and anal streak ..	11.
8.	With only one transverse band on wing	9.
	With more than one transverse band	10.
9.	Costal band beyond stigma represented by only a faint yellow tinge; scutellum marked with black in middle	*frauenfeldi* Sch.
	Costal band normal	*albistrigatus* de Meij.
10.	Three *i. or*; scutellum with black markings	*biguttatus* Bez.
	Two *i. or.*; scutellum yellow	*umbrosa* F.
11.	Humeral and notopleural calli joined by a broad yellow band	*continuus* Bez.
	Humeral and notopleural calli not joined as above ..	12.
12.	Scutellum entirely yellow	17.
	Scutellum not entirely yellow	13.
13.	Face without usual black markings	14.
	Black facial markings present	15.
14.	Yellow lateral post-sutural stripes absent	*tillyardi* n. sp.
	Yellow lateral stripes present	*McGregori* Bez.
15.	Mesonotum entirely ferruginous	*versicolor* Bez.
	Mesonotum mostly black	16.
16.	Costal band discontinued beyond stigma; small apical spot	*hyalinus* Shir.
	Costal band normal; no apical spot	*incisus* Walk.
17.	Mesonotum entirely ferruginous	18.
	Mesonotum with definite black pattern	19.
18.	Costal band incomplete; anal streak wanting ..	*zonata* San.
	Costal band and anal streak normal	*ferruginea* F.
19.	Fore and middle femora entirely dark brown or black	20.
	Fore and middle femora not as above	21.
20.	Costal band broad, extending to R4 + 5	*nigrotibialis* var. *lata* nov.
	Costal band normal, not extending to R4 + 5 ..	*nigrotibialis* n.sp
21.	Facial markings in form of black band	22.
	Facial markings normal, circular spots	23.
22.	Abdomen black	*cilifer* Hen.
	Abdomen pale with black markings	*correctus* Bez.
23.	Costal band extending to R4 + 5	24
	Costal band narrow, not extending to R4 + 5 ..	25.
24.	Occiput, femora, fore and middle tibiæ fulvous ..	*bryoniæ* Tryon.
	Occiput dark brown or black with yellow border; femora with black apical bands; all tibiæ dark brown or black	*pedestris var. limbiferus* Bez.

25. Facial spots absent	*impunctatus* de Meij.
Facial spots present	26.
26. Costal band absent, only stigma yellow	*tuberculatus* Bez.
Costal band present	27.
27. Wings with distinct apical spot; frons broad; hind tibiæ yellow	*latifrons* Hend.
Wings without distinct apical spot; frons narrow; hind tibiæ dark brown or black	28.
28. Lateral post-sutural yellow stripes absent	*obscuratus* de Meij.
Lateral stripes present	29.
29. Small species; 3rd, and nearly all 4th, abdominal tergites black; femora with conspicuous apical ring	30.
Medium size species; fore-margin only of 3rd abdominal tergite black	31.
30. 3rd antennal segment about 4 times as long as wide ..	*parvulus* Hend.
3rd antennal segment about 3 times as long as wide..	*antennalis* Shir.
31. Costal band extending into cell R3 in middle of the wing	*pedestris var. occipitalis* Bez.
Costal band not extending into cell R3 in middle ..	32.
32. Occiput, coxæ, trochanters, fore and middle tibiæ fulvous	*dorsalis* Hend.
Occiput dark brown or black, with yellow border; coxæ, trochanters dark brown; tibiæ dark brown or black	*pedestris* Bez.

Assuming that *ritsemae* Weyen., *figuratus* Walk., *strigifinis* Walk., *tau* Walk., and *nebulosa* Walk., should be placed in the genus *Strumeta*, it is not possible to place them in the key because of the inadequacy of the available descriptions.

The following species—*scutellarius* Bez., *frauenfeldi* Sch., *albistrigatus* de Meij., *apicalis* de Meij., *continuus* Bez., *tillyardi* n.sp., of which the generic characters of the male have not been recorded—are placed in *Strumeta* on the assumption that the male has a supernumerary lobe in the wing, and the third abdominal tergite ciliated.

Strumeta ferruginea F.

The identification of this species, the first of the sub-family to be described, has caused more confusion than all the other species combined. It was originally described in 1794; and transferred to the genus *Dacus* in 1805.

During the nineteenth century several workers included in this species most of the species of *Strumeta* which have no outstanding character, such as—banded wings, spotted scutellum, median post-sutural yellow stripe. It was usually said that the species was very variable. For example, Froggatt (1908) wrote as follows:—"If my determination is right, it is in regard to colouration and size a very variable species, running from black in the thorax, and even the body, to reddish-brown." Bezzi (1913, a), after repeating the remarks made by Froggatt with regard to the variation in size and colour, indicated that he was by no means convinced that they were correct, by the following statement:—"This is a widely spread species, since we have records from India, Ceylon, Java, and Amboina; but *it is very doubtful if the species has ever been exactly recognised.*"

Bezzi (1916), for the first time, defines *ferruginea*, and makes the following admission:—"In my paper of 1913, under the name *ferrugineus* are comprised the present and the following three forms—

dorsalis, incisus, and *versicolor;* they may be considered as varieties of a single species, inasmuch as all are to be found living at the same time in the same fruits.'' Bezzi had the advantage of examining a series of specimens from Bengal, the type locality of *ferruginea,* and his definition appears to be quite valid. The chief characters of *ferruginea* as defined by him and subsequently by Shiraki (1933) are as follows:—Bristles of the head, thorax, and scutellum yellow; complete absence of any black pattern on the mesonotum; reddish occiput with yellow border; poorly developed frontal spots; narrow costal band, not extending to cell R3; hyaline costal cells; and the fulvous legs with only the hind tibiae darkened. So defined, *S. ferruginea* is easily recognised, and should be regarded as a distinct species with a rather restricted range.

At different times the following have been described as varieties of *S. ferruginea*:—*dorsalis* Hend., *incisus* Walk., *versicolor* Bez., *occipitalis* Bez., *limbiferus* Bez., *obscuratus* de Meij., *okinawanus* Shir., and *tryoni* Frogg.

In considering some of the above forms to be varieties, Bezzi was influenced by the fact that they were often bred from the same fruits. Experience gained in Australia during the last few years indicates that such a deduction is quite unsound. Over 15,000 specimens comprising fifteen to twenty species have been bred from over 120 different hosts. It is quite usual to breed two, three, and even four distinct species from one tree, and even from one individual fruit. Moreover, the study of a large number of series of bred specimens, the number of individuals in the series varying from 50-300, has demonstrated that marked variation in size and colouration is the exception rather than the rule. In most series of bred specimens the following characters are particularly constant:—

1. The presence of facial spots. In some species the shape of the spots varies slightly. 2. The fronto-orbital spots, the central frontal blotch, and the vertical cross band. These markings can be seen in freshly emerged specimens even before the ptilinum has been retracted. 3. The yellow thoracic markings. These are constant both in position and shape. 4. The black pattern of the mesonotum and the pleural region is surprisingly constant. 5. The median black longitudinal line on the third, fourth, and fifth abdominal tergites is very constant. 6. The colour of the round or oval shining areas on the fifth abdominal tergite. 7. The colour of the legs, particularly the femora and the tibiae. 8. The fulvous or dark brown markings of the wings, the colour of the costal cells, and the width of the costal band.

N.B.—When breeding *Dacinæ*, I examine the specimens alive a few hours after emergence, and then keep them alive for ten-fifteen days, exposing them to direct sunshine for several hours each day, and providing them with a diet of mixed fruit, dates, &c. After such treatment they have their true colours; the body, especially the abdomen, is not shrivelled and misshapen; and the markings of the wings are particularly constant.)

Of the above so-called varieties, *versicolor* is the only one which might be a variety. Bezzi (1916) separates it from *ferruginea* on the grounds that the anal streak is wanting, the costal band is incomplete, and the scutellum has definite brown markings. If these characters are constant, and not due to immaturity, then *versicolor* Bez. would appear to be a distinct species. Like *ferruginea,* it breeds in the mango, and the breeding and examination of a long series of specimens would decide this point. None of the other forms agree even closely with the description of *ferruginea,* and should be regarded as distinct species.

In spite of the fact that there are over 500 specimens of *Dacinae* in the material which is being studied, there is not one which agrees with the description given above. Shiraki (1933) states that it is very rare in Formosa, where he bred it from mangoes. The evidence suggests that *S. ferruginea* is confined to India, and perhaps Formosa; and that the numerous forms from the Indo-Malayan region, identified as *S. ferruginea,* belong to one or more of the following species:—

Strumeta dorsalis Hend. 1912.

The description of this species was based on a large series of specimens from Formosa. Thanks to Dr. Walther Horn, of the Deutsches Entomologisches Institut, it has been possible to examine a pair of Hendel's paratypes. It appears to be quite a distinct species, the very pronounced black pattern of the mesonotum separating it from *ferruginea* F. In *dorsalis* the mesonotum is black, with the following reddish-brown patches:—

1. A triangular patch above each humeral callus. 2. A small patch surrounding the thoracic suture, and extending from the notopleural callus to the end of the suture. 3. A short strip connecting 1 and 2 and surrounding the anterior *npl.* bristle. 4. The whole of the supra-alar region below, and posterior to, the post-sutural yellow stripes.

Other details worth repeating are:—

(*a*) The propleura are reddish-brown; (*b*) the occiput fulvous, with a couple of faint black streaks; (*c*) the legs are fulvous, with the exception of the hind tibiae, which are darkened dorsally; (*d*) the colouration of the abdomen is ill-defined, the ground colour being dark fulvous speckled with brown, but the anterior border of the third visible tergite is definitely black, the black pattern extending on to the fourth and fifth tergites at the sides; (*e*) the median longitudinal black stripe on the third, fourth, and fifth tergites is very conspicuous; (*f*) the central portion of the postscutellum reddish-brown, remainder black; (*g*) bristles of the head and thorax dark brown, almost black; (*h*) costal band does not extend even faintly into cell R3 below R2 + 3; (*i*) ovipositor dark fulvous.

None of the specimens from Indo-Malaya, Java, Borneo, New Guinea, Pacific Islands, and Australia agree with this species, suggesting that it has not the wide distribution other authors have claimed for it. In the material before me it is only represented by the two paratypes from Formosa.

Strumeta pedestris Bezzi 1913.

This species was first described by Bezzi (1913, b) as a variety of *ferruginea* F. In 1919 he added to his original description, but still regarded it as a variety of *ferruginea.* Actually it is much more closely related to *dorsalis* Hend., with which it agrees in having the mesonotum almost entirely black, the cephalic and thoracic bristles almost black, well-developed frontal spots, narrow costal band, and conspicuous median longitudinal black stripe on the third, fourth, and fifth abdominal tergites. It differs from both *dorsalis* and *ferruginea* in having the occiput black, or very dark brown, with a narrow fulvous border, the propleura mostly black, the coxae and trochanters either dark brown or black, fore and hind tibiae either dark brown or black, usually an oval black patch on the outside of the fore-femora, and the postscutellum entirely black.

Strumeta pedestris appears to be the commonest species in the East Indies; and probably most of the records of *S. ferruginea* and *S. dorsalis* should be referred to it. It is of definite economic importance, and infests a wide range of fruits. Represented by the following specimens:—9 ♂♂ and 2 ♀♀, Bukit Kutu, Selangor, Malay Peninsula, September, 1929 (H. M. Pendlebury); 3♂♂, Kedah Peak, Malay Peninsula, March, 1928; 1 ♂ and 3♀♀, West Coast, Angoa Lighthouse, at light, October, 1926 (E. Seimund); 1♀, Bettotan, near Sandakan, North Borneo; 1 ♀, Kuala Lumpur, July, 1921 (H. M. Pendlebury); 2 ♂♂, Buitenzorg, Java, January (A. M. Lea); 5 ♀♀, Java (Dr. Roepke), 1912; 2 ♂♂, 1 ♀, Bangalore, India; 2♂♂, 1♀, Federated Malay States (B. A. R. Gater); 2♀♀, Ceylon, 1908—oil lure—(W. W. Froggatt); 1 ♂, Moenia, North Java, 2—400 feet, November, 1935; 1 ♂, 1 ♀, Kuala Lumpur, Federated Malay States, March and May, 1926 (G. H. Corbett), from *Baninca cerifera* (3164) and Cucurbit pips (3239); 1 ♀, Kuala Lumpur, Federated Malay States, May, 1921, on rotting pomelos (Dr. W. A. Lamborn); 3 ♂♂, 7♀♀, Penang, Selana, Seramban, Kuala Lumpur, Federated Malay States, bred by officers of Department of Agriculture from *Psidium guajava, Citrus aurantium, Solanum verbascifolium, Averrhoa carambola* (Nos. 8671, 4703, 7729, 5223, 8834, 8723); 4 ♀,♀ Ceylon, 8101, from *Mangifera* sp., 6752 from *Citrus aurantium,* Lindila; 8169 and 4097 from *Anona cherimolia,* Haptuale, and Bandarawela.

Strumeta pedestris var. **occipitalis** Bez.

Bezzi regarded this form as a variety of *ferruginea* F., but judging by a specimen from Batbatan Island, collected by McGregor, and labelled *occipitalis* in what appears to be Bezzi's writing, it is very closely related to *pedestris.* It differs from *pedestris* in having a costal band which extends into the middle of cell R3 in the middle of the wing, the middle tibiae are dark brown or black like the other tibiae, whereas in *pedestris* the middle tibiae are lighter. In all other respects it resembles *pedestris.* Represented by 2 ♂♂ and 2 ♀♀, Bukit Kutu, Selangor, Federated Malay States, March, 1931, and September, 1932 (H. M. Pendlebury); 1♂ and 2♀♀, Kedah Peak, Federated Malay States; 1♀ Larut Hills, Perak, February, 1932 (Pendlebury); 1 ♀, Taiping, Federated Malay States, W. B. Orme, 1911.

Strumeta pedestris var. **limbiferus** Bez.

Although this form is not represented in the collections before me, from Bezzi's description it is obvious that it is very closely related to *pedestris,* from which it differs in having a much wider costal band. It may be a distinct species, but, until a long series has been examined, it seems preferable to regard it as a variety of *pedestris.*

Strumeta umbrosa F. 1805.

Synonyms—

Dacus umbrosus F. 1805.
Dacus fascipennis Wied. 1819.
Bactrocera fasciatipennis Dolesc. 1856.
Strumeta conformis Walk. 1857.

This widely distributed species is represented by 1 ♂ and 5 ♀♀ from Kuala Lumpur, Federated Malay States, August, 1921, October, 1922, August, 1923, July and August, 1926 (H. M. Pendlebury); 6 ♂♂, Buitenzorg, Java (A. M. Lea); 1 ♂ (Dr. Roepke), Java, 1910, ex *Artocarpus integrifolia;* 18 ♂♂ from Kuala Lumpur, January, 1921, on falling and rotting pomelos (Dr. W. A. Lamborn); 2 ♂♂ from Singapore (R. Hamilton and H. N. Ridley); 1 ♂ from Selangor, 1902 (Dr. H. E. Durham).

Strumeta cucurbitae Coq. 1899.

Another economic species with a wide distribution. Represented by 4 ♀♀ (unlabelled) and 2 ♂♂ from Kuching, January, 1907 (J.H.); 1 ♂, 3 ♀♀, India, 1908 (W. W. Froggatt); 1 ♀, Kuala Lumpur, Federated Malay States (A. M. Lea); 1 ♀, W. Ghats, India (R. L. Barringer); 1 ♂, Buitenzorg, Java (A. M. Lea); 2 ♂♂, 1 ♀, Sungei Besi, Federated Malay States, December, 1923, ex cucumber (729); 1 ♀, Pusa, India, 1909 (W. W. Froggatt); 3 ♀♀, Bengal; 2 ♂♂, 3 ♀♀, from Kuala Lumpur, Federated Malay States, May, 1926, from *Cucumis sativis* and *Endiospermum malaccensis* (G. H. Corbett), Nos. 3207, 3239, 3184; 2 ♂♂ from Preanger, West Java, September, 1935; 1 ♂ from Cameron Highlands, Federated Malay States, October, 1928, from *C. sativus* (G. H. Corbett).

Strumeta latifrons Hend. 1915.

This species, previously only known from Formosa, is represented by 3 ♂♂ and 1 ♀ from Kudat, North Borneo, September, 1927; 1 ♂ from Bengal; and 1 ♂ from Peradenyia, Ceylon, March, 1924, from *Solanum melongenae* (6310).

The broad frons is very noticeable, the proportions in one specimen being—width of eye to width of frons, 17 : 20, and the width in proportion to the length, when measured from, but not including, the lunule to the median ocellus being 20 : 22.

Strumeta cilifer Hend. 1912.

Another species previously only known from Formosa; represented by 2 ♀♀ from Bettotan, near Sandakan, North Borneo, July and August, 1927; 1 ♀, Singapore, 1903 (H. N. Ridley).

Thanks to the kindness of Dr. Walther Horn, of the Entomologisches Institut, Berlin, it was possible to check these specimens with a paratype of *S. cilifer* Hend.

Strumeta correctus Bezzi.

Represented by 1 ♂ from Bangalore, India, 1908 (W. W. Froggatt).

Strumeta bryoniae Tryon 1927.

Synonymy—

Chaetodacus bryoniae Tryon, 1927.
Chaetodacus costalis Shir., 1933.

Tryon described *C. bryoniae* in 1927 from specimens bred from *Bryonopsis laciniosa* Naudin. in Queensland. Shiraki described *C. costalis* in 1933 from specimens bred from the same host in Formosa, and his description agrees in every detail with specimens of *bryoniae* Tryon. I feel certain that the synonymy quoted above is correct.

The species is not represented in the collection before me, but this is not surprising, the adult flies being rarely collected in the field in spite of the fact that the fruit of *Bryonopsis laciniosa* is usually heavily infested. It is most probable that the fly occurs in most places where the host plant is to be found.

Strumeta frauenfeldi Schiner.

Two specimens from Singapore have been identified as *S. frauenfeldi* in spite of the fact that Schiner's specimens came from Stuart's Island, which is understood to be a small island south of Fiji. If so, the distribution is rather remarkable, but no characters were observed which do not agree with Schiner's description. Hendel (1932) states that *albistrigatus* de Meijere is the same species. It is probable that he is right, in spite of the fact that in the figure of *albistrigatus* the costal band is shown to be dark and conspicuous, whereas in *frauenfeldi* only a faint yellowish tinge is noticeable. De Meijere also fails to mention the black markings of the scutellum which Hendel states are variable. The following description is included to supplement that of Schiner:—

Female.—Length of body, 7-7·5 mm.; wing, 6-7 mm.

Head.—Frons fulvous, paler beside the eyes and above the lunule; frontal spots very faint, longer than wide, the proportion, when measured from the lunule to the median occellus, being 19 : 13, and narrower than an eye, the proportion being 18 : 13; ocellar triangle black; no transverse black vertical cross-band; lunule brownish-orange; antennae about as long as face; fulvous; the outer side of third segment darker; third segment bilaterally flattened, and more than twice as long as the second, the proportion being 19 : 8; a short dorsal bristle on second segment; face fulvous, with two large subcircular black spots; antennal grooves distinct; a slight transverse furrow in carina; palps bright fulvous, the upper edge straight, and the lower slightly curved; occiput black, with a narrow yellow band which expands towards the lower part of the head.

Chaetotaxy.—*Vt.* 2, *s.or.* 1, *i.or.* 2, genal bristle, occipital row distinct, all black.

Thorax.—Shining black with a broad hoary median longitudinal band extending to the scutellum; the following yellow markings;—two thirds of the humeral calli; post-sutural lateral stripes which are sharply pointed behind, and terminate well before the upper post-alar bristle; no median yellow stripe; notopleural calei; a large mesopleural stripe, the latter extending on to the sternopleura, the upper anterior corner reaching as far as the anterior *n.pl.* bristle; hypopleural spots with the posterior two-thirds of the lower, and the posterior sixth of the upper black; rest of thorax black. Scutellum yellow; a distinct basal black band which is pointed posteriorly, the apex extending backwards nearly to the middle of the scutellum; a brown spot at the apex between the bristles; convex above and rounded at the sides.

Chaetotaxy.—*Scp.* 4, *n.pl.* 2, *a.sa.* 1, *p.sa.* 2, *pr.sc.* 2, *mpl.* 1, *pt.* 1, *sc.* 2 (apical) all black.

Legs.—Yellow, with the middle and hind coxae, half the middle and hind femora, and the hind tibiae very dark brown or black.

Wings.—Hyaline, with the following brown bands;—a transverse band which starts at the stigma, and includes the two cross veins, which are close together, it is nearly as wide as the stigma, but tapers posteriorly and is quite narrow when it reaches the inner margin; an anal streak which barely reaches the inner margin; the usual costal band is lacking, but there is a faint, indistinct, yellowish tinge along the costal border. The proportion of the second costal cell to stigma is 19:22; the sections of M1 + 2 before and after the *r-m* cross-vein are in the proportion of 34:10; the extension of cell Cu is constricted basally, and the proportion of the extension to Cu1 + 1A measured along 1A is 19:12; the last section of R4 + 5, and the last section of M1 + 2 are distinctly curved.

Abdomen.—Dark brown or black, with a faint yellow posterior margin of the first tergite, a broader, very distinct, yellowish posterior band on the second tergite, and then a distinct longitudinal yellowish-brown band on either side of a thin black median stripe; oval patches on fifth tergite distinct, and brown in colour. Ovipositor dark brown in colour, and very short and broad; from above, the basal segment is twice as wide as long, from below the proportion of length to terminal width is 25 : 10. Two females from Singapore, June, 1926.

Strumeta nigrotibialis n.sp.

Male and Female.—Length of body, excluding ovipositor, 7·5 mm.; of wing, 6 mm.

Head.—Frons nearly as wide as long, the proportion when measured from, but not including, the lunule to the median ocellus being length to width, 17 : 13 in the male, and 19 : 15 in the female; width of frons to eye, 13:16 in male, and 15:18 in female; very dark fulvous mottled with brown; frontal spots black; ocellar triangle black, and connected on either side to the eyes by a narrow black transverse band; vertical calli distinct, shining, fulvous. Lunule dark brown. Antennae extending to bottom of antennal grooves; third segment bilaterally flattened, rounded at the tip, darkened distally, and covered with fine white pubescence; arista longer than third segment, black; third segment three times as long as second, the proportion when measured along the lower margin being 17:6; a short black dorsal bristle on the second segment. Face dark brown, nearly black, with an elongated black spot extending backwards along two-thirds of the inner side of the antennal grooves; carina with a transverse furrow. Palps fulvous, bilaterally flattened, with rounded tips. Occiput black with a narrow fulvous margin. A dark spot beneath each eye.

Chaetotaxy.—*Vt.* 2, *s.or.* 1, *i.or.* 2, genal bristle, occipital row distinct, all bristles dark brown or black.

Thorax.—General colour black, with a narrow hoary stripe on either side of the median line, diverging slightly after passing the thoracic suture. With the following yellow markings:—humeral calli; notopleural calli; on each side a mesopleural stripe, whose front margin is slightly curved, and hind margin straight; about the width of the notopleural callus above and half that width below, continued on to the sternopleuron; on each side a short narrow post-sutural stripe which is rounded in front, only the extreme tip reaching the suture, sharply pointed posteriorly, ending some distance before the upper post-alar bristle; no median post-sutural stripe; hypopleural calli with the exception of the posterior fourth of the lower, and the extreme tip only of the upper, which are black. Scutellum yellow with a very distinct black curved basal band, whose greatest width is about one-quarter the length of the scutellum; convex above, and rounded at the sides, and between the bristles.

Chaetotaxy.—*Scp.* 4, *n.pl.* 2, *a.sa.* 1, *p.sa.* 2, *pr.sc.* 2, *mpl.* 1, *pt.* 1, *sct.* 2 (apical), all black.

Legs.—Very dark brown or black, with basal two-thirds of the hind femora, and all the tarsi, fulvous.

Wings.—Hyaline with brown costal band and anal streak. The costal band includes the stigma, all of cell R1, starts to extend to cell R3 just before the end of R2 + 3, and terminates on the margin between R4 + 5 and M1 + 2, about one-quarter of the distance from R4 + 5; definitely no apical spot. R-m cross-vein oblique and slightly curved, the sections of M1 + 2 before and after it being in the proportions of 30 : 21 in the male, and 39 : 21 in the female. The proportional lengths of the 2nd costal cell and the stigma measured along C. are 18 : 21 in the male and 21 : 33 in the female. Anal streak short, not reaching beyond the extension of cell Cu., and definitely not reaching the wing margin. Extension of cell Cu. somewhat narrowed basally, definitely not parallel-sided, its length measured along 1A in proportion to Cu.1A being 22 : 8 in the male and 20 : 14 in the female. Last section of M1 + 2 slightly curved. Supernumerary lobe in male very distinct, but not excessive.

Abdomen.—General colour black with fine white hairs. First visible tergite black; 2nd tergite variable—in some almost entirely black, in others with an extensive transverse pale-brown area on each side towards the posterior part of the tergite. 3rd, 4th, and 5th tergites mostly black with a pale-brown longitudinal marking on either side of the black median longitudinal stripe on the 4th and 5th. These pale-brown areas are variable; in some they are very faint, and in others very distinct. The shining oval areas of the 5th tergite very distinct, and dark-brown or almost black in colour; 3rd tergite of male with a row of black cilia on the postero-lateral margin. Base of the 1st segment of the ovipositor slightly swollen and black in colour, the apex very flat and dark-brown in colour. Its proportions measured from beneath, length: greatest width: apex: being 30 : 21 : 8. Described from 5♂♂ and 5♀♀ from the following localities:—Larut Hills, Perak, Feb., 1932 (H. M. Pendlebury); Bukit Kutu, Selangor, Sept., 1929 (H. M. Pendlebury); Kedah Peak, Malay Pen., March, 1928; Malay Pen., West Coast, Pulan Lighthouse, Oct., 1926 (E. Seimund). Types returned to Selangor Museum.

This species is distinguished from nearly all other species in the genus by the entirely dark-brown, or black, fore, and middle femora, the peculiar elongated facial markings, and the very dark-brown colour of the frons and the face. The short sharply-pointed post-sutural lateral yellow stripes are also unusual.

Strumeta nigrotibialis var. **lata**. nov.

In the collection are two specimens which agree in most respects with *S. nigrotibialis*, particularly in the colour of the legs. They differ in having a broad costal band which extends almost to R4 + 5 throughout its whole length; the occiput is fulvous; the post-sutural lateral yellow stripes are broader, square in front and extend to the upper post-alar bristle, and they are definitely larger in size. This may be a distinct species, but in the absence of a longer series, it is preferable to regard it as a variety.

Length of body, excluding ovipositor, 9 mm.; of wing 7·5 mm.

Two ♀♀ from Kedah Peak, Malay Pen., March, 1928, and 1 ♂ from Singapore, 1904 (H. N. Ridley).

Strumeta tillyardi n.sp.

Female.—Length of body, 6-6·5 mm.; of wing, 5-5·5 mm.

Head.—Frons reddish-brown with a narrow fulvous border just above the lunule; vertical calli very distinct, slightly raised, smooth, shining, black; no frontal spots; ocellar triangle black, and connected to the eyes by a narrow transverse black vertical band; frons parallel-sided, its proportions being—length (measured from, but not including, the lunule to the median ocellus) to width, to width of eye 18: 15: 16. Antennae, basal segment brown the same as the lunule; 2nd segment paler; 3rd segment pale fulvous on the inner side, and dark-brown on the outer; bilaterally flattened, and round at the tip; the proportion of the 3rd and 2nd segments is 14 : 6 measured along the ventral border; arista about twice as long as the 3rd antennal segment, pale at the base, otherwise black. Face uniform, pale fulvous; no black markings; antennal grooves distinct; carina slightly concave. Occiput black with a small dusky fulvous triangle about the size of the scutellar triangle and immediately behind it. Palps orange; bilaterally flattened; the upper edge slightly concave, the lower edge correspondingly convex.

Chaetotaxy.—*Vt.* 2, *s.or.* 1, *i.or.* 3 (lower two pairs close together and well separated from the third), genal bristle, occipital row distinct, all black.

Thorax.—General colour shining black with unusually long, fine, silvery hairs, with the following yellow markings:—humeral calli, except the anterior corners, black or dark-brown; notopleural calli; parallel-sided mesopleural stripes, about as wide as the notopleural calli above, and slightly narrower below, not extending on to the sternopleura; hypopleural calli, except the posterior two-fifths of the lower, and the posterior sixth of the upper, which are black; no post sutural median and lateral yellow stripes. Prosternum fulvous. Remainder of the thorax black. Scutellum convex with rounded sides, yellow with a very distinct curved black basal band which at its apex is about half the length of the scutellum.

Chaetotaxy.—*Scp.* 4, *n.pl.* 2, *a.sa.* 1, *p.sa.* 2, *pr.sc.* 2, *mpl.* 1, *pt.* 1, *sc.* 2, all black.

Legs.—Fulvous, with the hind coxae and the outer side of the hind tibiae dark-brown.

Wings.—Hyaline, with the following brown markings:—the stigma, a short narrow costal band which starts at the end of R2 + 3 and terminates half-way between R4 + 5 and M1 + 2; a narrow band along each of the cross-veins, these bands not being connected, the band along the posterior cross-vein extends to the margin of the wing; a short anal streak which barely reaches the margin of the wing. The two cross-veins are distinctly approximated, the proportion of M1 + 2 in the 1st M_2 before and after the r-m cross-vein being 40 : 14. Last section of R4 + 5 sligthly curved, and the last section of M1 + 2 practically straight. The length of the 2nd costal cell in proportion to that of the stigma, measured along the C. is 20: 25. Extension of the cell Cu narrowed basally, and definitely not parallel-sided, the proportions of the extension, measured along 1A, and Cul + 1A being 16: 16.

Abdomen.—Black, with the following fulvous markings:—Posterior borders of the 2nd, 3rd, 4th, and 5th tergites uniting in the middle in the 3rd, 4th, and 5th, to form a median fulvous stripe. Oval areas on 5th tergite brown and distinct. Basal segment of the ovipositor approximately an equilateral triangle, convex above and below, and fulvous in colour, the portion of the basal segment seen from above being as long as the 5th tergite.

Described from 2 females from Bukit Kutu, Selangor, F.M.S., 11/9/29 (H. M. Pendlebury); and Fraser's Hill, Pahang, 29/1/29.

This species is placed in the genus *Strumeta* on the assumption that the male has the 3rd abdominal tergite ciliated, and a supernumerary lobe in the wing. It is distinguished from other species of the genus, and from species in closely-allied genera, by the peculiar markings of the wings, the unspotted face, absence of lateral and median post-sutural yellow stripes, and the presence of three *i.or.* bristles.

This species is named in honour of the late Dr. R. J. Tillyard, whose tragic death was reported to me while working on this particular species. It is only fitting that, the name of one who has done so much for Australian entomology, should be perpetuated in a group, which already contains the names of well-known Australian entomologists such as Froggatt, Tryon, Gurney, and Bancroft.

Genus **AFRODACUS** Bezzi.

In the collection from the British Museum there is one female which appears to belong to this genus. Until the male has been described, it is impossible to say so definitely. It has no *a.sa.* bristles, 2 *pr.sc.* bristles, 2 scutellar bristles, and a flattened ovipositor. The only other species found in the Oriental and Australian region with this combination of characters is *Afrodacus jarvisi*, Tryon, from Australia. Tentatively, until the male has been described, this new species is placed in this genus.

Afrodacus javanensis. n.sp.

Female.—Length of body, excluding ovipositor, 7·5 mm.; of wing, 6 mm.

Head.—Frons dark, fulvous; no frontal spots; two black spots on the vertex adjacent to the upper corner of the eyes, these spots not connected to the black ocellar triangle by a transverse band; vertical calli distinct, shining, fulvous; very wide, wider than an eye, the proportion being width of frons to width of eye, 18 : 14, slightly wider than long, the porportion being, width to length, measured from lunule to median ocellus, 18 : 17. Lunule brown. A black spot on each side of the lunule, level with the basal segment on the antennae. Face fulvous, with a short black transverse band on the lower margin, not extending to the antennal grooves at the sides. Antennae dark reddish-brown, with the 3rd segment darkened along the upper margin and at the tip; not extending below the lower corners of the face; apparently the short bristle on the 2nd segment absent; 3rd segment bilaterally flattened, and distinctly pointed; arista fulvous at base, remainder black; 3rd segment two and a-half times as long as 2nd, the proportion being 15 : 6. Occiput mostly dark-brown or black with a fulvous border, centre also fulvous; a reddish subocular spot.

Chaetotaxy.—*Vt.* 2, *s.or.* 1, *i.or.* 3, occipital row very weak, a distinct but weak pair of ocellar bristles, all black; genal bristle very pale and weak.

Thorax.—Black, covered with short pale hairs; lower part of propleura, and prosternum reddish-brown. With the following yellow markings:—humeral calli, except the extreme anterior angle; notopleural calli; a mesopleural stripe which is very broad above, extending from the posterior corner of the humeral callus to the base of the wing, the anterior border sinuous, the lower border slightly less than the notopleural callus in width, and extending on to the sternopleura; a median post-sutural stripe which starts just about level with the suture, and terminates just in front of the *pr.sc.* bristles, pointed anteriorly and rounded behind; on each side a very broad post-sutural stripe which commences just in front of the suture, and extends to the upper post-alar bristle, the anterior portion in front of the suture about twice the width of the remainder of the stripe, posterior end slightly narrower, and rounded; hypopleural calli except the posterior 5th, which is black. Scutellum yellow with a narrow black basal band whose posterior border is straight; very slightly convex above, rounded at the side and between the bristles.

Chaetotaxy.—*Scp.* 4, *npl.* 2, *mpl.* 1, *pt.* 1 (weak), *p.sa.* 2, *pr.sc.* 2, *sc.* 2 (apical), all black. No *a.sa.*

Legs.—Fulvous but very brightly and distinctly marked as follows:—Middle and hind coxae brown; apical third of the fore-femora, the apex only of the middle, and the apical quarter of the hind-femora; the base of the fore-tibiae, the whole of the middle and hind tibiae, and the whole of the distal segments of all the tarsi black.

Wings.—Hyaline, with dark-brown costal band, anal streak, and infuscation of the posterior cross-vein. The costal band includes the stigma, the whole of cell R1, the end of cell R3, and the upper corner of cell R5; it does not extend to cell R3 until just before the end of R2 + 3, continues without widening for a short way, and then suddenly becomes enlarged to form a large distinct apical spot; it terminates about half-way between R4 + 5 and M1 + 2. Stigma nearly twice as long as the 2nd costal cell, the proportion being 37 : 20. The *r-m* cross-vein oblique, the sections of M1 + 2 before, and after it, being in the proportion of 32 : 25. Anal streak short, not reaching the wing margin. Extension of cell Cu. narrowed basally, definitely not parallel-sided, its length measured along 1A in proportion to Cul + 1A being 15 : 19. Last section of M1 + 2 distinctly curved. Posterior cross-vein broadly and distinctly infuscated.

Abdomen.—Bright fulvous with the following distinct black markings:—The anterior border of the 1st, 2nd, and 3rd, visible tergites; the antero-lateral border of the 4th and 5th tergites; and a median longitudinal stripe on the 3rd, 4th, and 5th tergites. Oval areas on the 5th tergite, distinct, shining, fulvous. Ovipositor flat, dark-brown, the proportions of the basal segment measured from below being—length; greatest width; apex: 40 : 20 : 12. Sternites dark-brown, almost black.

Described from 1 ♀ from Mt. Ardjoena, East Java, 6,000 feet, Jan., 1936. Type returned to British Museum.

This very distinctive species can be separated from other species of the genus, and from other species of the subfamily,.by the following combination of characters—the short transverse facial band; the very broad mesopleural stripe; the black thorax; yellow markings of the mesonotum; the apical spot on the wings; the broadly-infuscated posterior cross-vein; and the colour of the legs and abdomen.

Genus **ASIADACUS** F.A.Perk. 1937.

It was necessary to erect this genus for *diversus* Coq. and *bakeri* Bez., two species which differ from species in other genera with two scutellar bristles, in having no ciliation on the 3rd abdominal tergite of the male. The two species are easily distinguished by means of the following key:—

KEY TO SPECIES OF *ASIADACUS*.

Wings with a very pronounced apical spot	*bakeri* Bez.
Wings with normal costal band, no apical spot	*diversus* Coq.

Asiadacus diversus Coq.

This species is represented by 1 ♂ and 2 ♀♀ from Pusa, India, and Ceylon, 1908 (W. W. Froggatt), caught with oil; 2 females from Bihar, Pusa, Jan., 1915.

Genus **NESODACUS** F.A.Perk. 1937.

Nesodacus ablepharus Bez. 1919.

This species previously only known from the Philippine Islands, is represented by 1 ♀ from Bettotan, nr. Sandaken, North Borneo, Aug., 1927. Bezzi (1919) suggests that either *N. ablepharus* or *Strumeta cilifer* Hend. might be *terminifer* Walk. This is not so, for Dr. Smart, of the British Museum, who very kindly examined the type of *terminifer*, informed me that it has 4 *sc.* bristles, whereas *ablepharus* and *cilifer* have only 2.

The following description is included to supplement that of Bezzi.

In the head the vertical calli are very distinct, and shining brown in colour; the frons is perfectly flat, and its proportion when measured from the lunule to the median ocellus is—length to width 17 : 14; width of frons to an eye being 14 : 14. Face with the antennal grooves black, and the carina brownish-yellow. Third segment of the antennae not quite twice the length of the second, the proportion being 13 : 8. Mesonotum behind the suture very flat, not slightly convex as in most *Dacinae*. Scutellum conspicuously flattened above, and the hind margin between the bristles noticeably straight. Legs black, except the extreme base of the middle femora, the basal half of the hind femora, and all the tarsi, which are yellow. In the wing the stigma is definitely longer than the 2nd costal cell, the proportion being 25 : 18, the two sections of M1 + 2 before and after the r-m cross-vein are in the proportion of 23 : 21; length of extension of cell Cu. to Cul + 1A measured along 1A being 12 : 13.

It is surprising that Bezzi did not mention the conspicuous flattening of the thorax and the scutellum, for they are most striking.

Nesodacus ? longicaudatus n.sp.

Female.—Length of body, 7·5-8·5 mm.; of wing, 6·5-7·5 mm.

Head.—General colour fulvous. Frons nearly as wide as long, the proportion when measured from, but not including, the lunule to the median ocellus being length to width 20 : 17; width of frons to eye

17:19; spots at the base of the orbital bristles very faint; ocellar triangle black, and connected on either side to the eyes by a narrow black vertical transverse band. Lunule dark-brown. Antennae not quite reaching the lower lateral angles of the face; 3rd segment bilaterally flattened, thickly covered with fine white pubescence; darker than other segments; arista longer than the 3rd segment, orange at the base, the remainder being black; 3rd segment nearly three times as long as the 2nd, the proportion being 19:7; a short black dorsal bristle on the 2nd segment. Face with a slight bulge below the base of the antennae, beneath which is a shallow transverse furrow; antennal grooves distinct; large triangular black facial spots, one side of the triangle being the lower margin of the antennal groove, and the apex being about halfway up the groove. Palps orange; bilaterally flattened; the upper edge straight and the tip and lower edge distinctly curved. A small black spot immediately beneath each eye. Occiput very dark reddish-brown, almost black, with an orange border whose width is about that of the ocellar triangle.

Chaetotaxy.—*Vt.* 2, *s.or.* 1, *i.or.* 2, genal bristle, all black. Occipital row entirely absent.

Thorax.—General colour black, with a narrow hoary stripe on either side of the median line, diverging slightly after passing the thoracic suture. With the following yellow markings:—humeral calli; notopleural calli; on each side a mesopleural stripe whose front and hind margins are fairly straight, about the width of the notopleural callus above, and a little narrower below, continued on to the sterno-pleuron, where it becomes slightly wider, on each side a post-sutural stripe which is fairly wide, round behind, extending as far as, and including, the upper post-alar bristle, connected with a small rectangular spot which is immediately in front of suture; no medium post-sutural stripe; hypopleural spots, with the exception of the posterior third of the lower and the posterior sixth of the upper, which are dark reddish-brown, almost black. Remainder of the thorax brown or black, except the prosternum, which is brownish-yellow, but not very conspicuous. Scutellum yellow with an extremely narrow black basal band. It is convex above, and rounded at the sides, and between the apical bristles.

Chaetotaxy.—*Scp.* 4, *n.pl.* 2, *a.sa.* 1, *p.sa.* 2, no *pr.sc.*, *mpl.* 1, *pt.* 1, *sct.* 2 (apical), all black.

Legs.—Dark reddish-brown or black with the extreme base of the front femora, the basal half of the middle femora, and the basal three-quarters of the hind femora, and all the tarsi, orange-yellow.

Wings.—Hyaline with brown costal and anal bands. The costal band includes the stigma, all of cell R1, starts to extend to cell R3 immediately beneath the end of R1, then gradually widens, and beneath the end of R2 + 3 it reaches R4 + 5 and then encroaches on cell R5, the lower margin curving round and terminating on the margin halfway between R4 + 5 and M1 + 2, forming a definite apical spot. R-m cross-vein very oblique, and slightly curved, the sections of M1 + 2 before and after it being in the proportion of 37:30. Anal streak short, extending very little beyond the extension of cell Cu, and definitely not reaching the wing margin. Extension of cell Cu. somewhat narrowed basally, and definitely not parallel-sided, its length measured along 1A in proportion to Cu1 + 1A being 21:17. Last section of M1 + 2 distinctly curved. The proportional lengths of the 2nd costal cell and stigma measured along C. are 17 : 38.

Abdomen.—General colour dark reddish-brown, covered with long fine white hairs. First visible tergite black with a narrow pale-brown posterior border; 2nd tergite with the fore-border almost black, the middle pale-brown, and the hind border almost white; 3rd, 4th, and 5th tergites reddish-brown, slightly darker at the sides, with a few indistinct specks of dark-brown or black. Oval areas on 5th tergite of the same colour as the rest of the abdomen, and are only distinguished by the different texture of the exocuticula. Ovipositor a uniform reddish-brown and very long. Viewed from above it is almost parallel-sided, somewhat convex above, and concave below; the proportion of the length of the abdomen, the basal segment of the ovipositor, the 2nd segment of the ovipositor, and the width of the basal segment are 82 : 55 : 23 : 13. When viewed from below, the base of the 1st segment of the ovipositor is distinctly bulbous, and twice the width of that portion which projects beyond the 5th tergite.

Described from one female from Bettotan, nr. Sandakan, Nth. Borneo, 4th Aug., 1927. Types returned to Selangor Museum.

Until the male of this species has been described, its exact generic position is uncertain. In the Oriental and Australasian regions three genera are found in which the species have 2 *sc.*, and no *pr.sc.* bristles. It cannot be placed in *Callantra* Walk. because of its short antennae and ovate abdomen. It might belong to either of the other genera—*Neodacus* F.A.Perk., and *Nesodacus* F.A.Perk., and for the present it is placed in the latter, because it appears to be more closely related to the two species of that genus—*N. atrichus* Bez. and *N. ablepharus* Bez. It differs from them only in the black markings of the face, the abdominal markings, the wing pattern, and the size and shape of the ovipositor.

Genus **CALLANTRA** Walk. 1860.

Callantra splendida n.sp.

Female.—Length of body, excluding ovipositor, 8·5 mm.; of wing, 7 mm.

Head.—Frons fulvous, with a dark-brown central blotch and distinct frontal spots; ocellar triangle black, vertical cross-band reddish-brown; vertical calli distinct; slightly longer than wide, the proportion being length, measured from median ocellus to lunule, to width 23 : 19; lunule brown. Face dark fulvous; an elongated black spot in each antennal groove extending from the mouth border to well past the middle of the groove; a small brown spot in the centre at the mouth border; transverse furrow in carina very distinct. Antennae dark-brown with the third segment darkened distally and externally, 2nd segment long, nearly twice as long as 1st, and 3rd about two and a-half times as long as the 2nd, the proportion being:—first, second, third, 6 : 9 : 23; a short black bristle on 2nd segment; arista longer than 3rd segment, brown at base and black distally. Occiput fulvous with a pale-yellow border, genal spot reddish-brown.

Chaetotaxy.—*Vt.* 2, *pvt.* absent, *s.or.* 1, *i.or.* 2, genal bristle, occipital row distinct, all black.

Thorax.—Mostly black with pale-pubescence; a broad hoary stripe on each side of the median line; reddish-brown above the humeral calli, in front of the suture, above the wings, and on the propleuron and prosternum. With the following yellow markings:—humeral calli; notopleural calli; a strip connecting the humeral and notopleural calli; a median post-sutural stripe, sharply pointed at both ends, the anterior point just in front of the suture, and almost reaching the scutellum behind; on each side a post-sutural stripe, bordered by the suture in front and rounded behind, extending to the upper post-alar bristle; a mesopleural stripe which is about the width of the notopleural callus above, and half that width below, the fore-border straight, extending on to the sternopleuron below; hypopleural calli, except the posterior fourth, which is black. Scutellum yellow with a narrow slightly-curved black basal band.

Chaetotaxy.—*Scp.* 4, *npl.* 2, *p.sa.* 2, *mpl.* 1, *pt.* 1, *sc.* 2 (apical), all black. *A.sa.* and *pr.sc.* absent.

Legs.—Dark-brown or black, except the base and apex of the fore-femora, the basal third of the middle femora, the whole of the hind femora, and all the tarsi, which are fulvous.

Wings.—Hyaline with a broad costal band. No anal streak. The costal band starts at the base of the wing, includes the costal cells, the stigma, the whole of cells R1 and R3, and extends as a small but distinct apical spot into the upper corner of cell R5; the extreme tip the costal band is very pale, and terminates just past the end of R4 + 5. The *r-m* cross-vein, the posterior cross-vein, and the last section of M1 + 2 all distinctly curved. Extension of cell Cu. narrowed basally, its length measured along 1A in proportion to Cul + 1A being—female 24 : 21 and male 32 : 15. The proportional lengths of the 2nd costal cell and stigma, measured along C., are 26 : 37. The sections of M1 + 2 before, and after it, are in the proportion of 42 : 28.

Abdomen.—Definitely club-shaped. First visible tergite black, second tergite with four bands, a fulvous band along the fore-border, then a black transverse band which becomes more extensive at the sides; behind this another fulvous band, and along the whole of the posterior part of the tergite a pale-fulvous band; 3rd tergite mostly black, only the posterior border with a narrow fulvous band, which is widened in the centre; the sides only of the 4th and 5th tergites black, the rest fulvous. The oval areas on the 5th tergite black. No median black stripe. Ovipositor characteristic, dark-fulvous or brown, long, cylindrical; the basal half of the first segment of uniform diameter, becoming constricted about halfway and then tapering; in profile, convex dorsally, and concave beneath. Proportions—length: greatest diameter: diameter of tip—60 : 20 : 11, measured from below. Male similar to female. Wings with no supernumerary lobe. Third abdominal tergite ciliated.

Described from one male and two females from Djampang Tenggah, Preanger, West Java, Feb. and Sept., 1935. Types returned to British Museum. This species agrees with *Strumeta continuus* Bez., *Afrodacus jarvisi* Tryon, and *Zeugodacus tetrachaetus* Bez., in having the humeral and notopleural calli joined by a broad yellow stripe, but differs generically.

Genus **ZEUGODACUS** Hend. 1927.

In the Oriental and Australasian regions *Zeugodacus,* which is represented by a number of large handsome species, is the dominant genus with four scutellar bristles. It contains over twenty species which can be separated by the following key. Certain species like *terminifer* Walk., *pendleburyi* n.sp., &c., are included tentatively, pending the discovery and description of the males. It is assumed that in the male the wing has a supernumerary lobe, and the third abdominal tergite is ciliated. *Z. caudatus* has been included twice because in all East Indian specimens the infuscation of the posterior cross-vein is so faint that it is very difficult to decide whether it is present or not.

KEY TO SPECIES OF *ZEUGODACUS* HEND.

1.	At least one cross-vein infuscated ..	18.
	Neither cross-vein infuscated ..	2.
2.	Median post-sutural yellow stripe absent ..	3.
	Median post-sutural yellow stripe present ..	6.
3.	Face black ..	*terminifer* Walk.
	Face yellow with black markings ..	4.
4.	Face yellow with double black band ..	*duplicatus* Bez.
	Face yellow with usual round spots ..	5.
5.	Anal streak absent ..	*pendleburyi* n.sp.
	Anal streak wide and distinct ..	*quadrisetosus* Bez.
6.	Scutellum yellow with black apical spot ..	7.
	Scutellum yellow with no apical spot ..	11.
7.	Three *i.or.* bristles ..	8.
	Two *i.or.* bristles ..	10.
8.	Costal band incomplete between stigma and apical spot ..	*scutellaris*.
	Costal band complete beyond stigma ..	9.
9.	Humeral calli surrounded with reddish, femora entirely yellow ..	*pubescens* Bez.
	Humeral calli surrounded with black, femora with brown apical ring ..	*caudatus* var. *maculatus* nov.
10.	Face with two black spots ..	*scutellinus* Bez.
	Face with three short longitudinal black bands ..	*lipsanus* Hend.
11.	Three *i.or.* bristles ..	16.
	Two *i.or.* bristles ..	12.
12.	Face shining black with yellow lateral margins ..	*limbipennis* Macq.
	Face mostly yellow ..	13.
13.	Face entirely yellow, no spots ..	*okunii* Shir.
	Face with two black spots ..	14.
14.	Humeral and notopleural calli joined by a broad yellow band ..	*tetrachætus* Bez.
	Humeral and notopleural calli not joined by yellow band ..	15.
15.	Costal band dilated to form a distinct apical spot ..	*hageni* de Meij.
	Costal band not so dilated ..	*gavisus* Mro.
16.	Face yellow with anterior transverse band ..	*maculipennis*
	Face yellow with usual round black spots ..	17.
17.	Lateral frontal spots absent ..	*nubilus* Hend.
	Lateral frontal spots present ..	*caudatus* F.
18.	Both cross-veins infuscated, face black ..	*nigrifacies* Shir.
	Only posterior cross-vein infuscated ..	19.
19.	Scutellum yellow ..	20.
	Scutellum yellow with black or brown apical spot ..	24.
20.	Costal band dilated to form an apical spot ..	21.
	Costal band not dilated ..	*tibialis* Shir.
21.	Face entirely yellow, no spots ..	*mundus* Bez.
	Face with black spots ..	22.
22.	Median post-sutural yellow stripe surrounded by reddish-brown ..	*synnephes* Hend.
	Median post-sutural yellow stripe surrounded by black ..	23.

23. Apical spot extending below M1 + 2	*chrysotaxus* Hend.
Apical spot not extending to M1 + 2	*caudatus* F.
24. All tibiæ black, facial markings two oblong spots and median line	*arisanicus* Shir.
Middle tibiæ yellow or fulvous	25.
25. Anterior part of mesonotum entirely black ..	26.
Anterior part of mesonotum not entirely black ..	27.
26. Face with 2 pairs of black spots	*scutellatus* Hend.
Face with 2 triangular spots which meet in the centre of the transverse furrow	*caudatus* var. *maculatus* nov.
27. Face with 3 black spots, scutellum with a definite apical spot	*ambiguus* Shir.
Face with 2 black spots, scutellum with only brown tinge at apex	*depressus* Shir.

Of the above species, *terminifer* Walk., *chrysotaxus* Hend., and *quadrisetosus* Bezz., have not yet been recorded from the group of countries dealt with in this paper.

Zeugodacus caudatus F. 1805.

This common species is represented by 18♂♂ and 26 ♀♀ from the following localities:—Kedah Peak, F.M.S., March, 1928; Bukit Kutu, Selangor, F.M.S., April, 1926, October, 1929, September, 1920 (H. M. Pendlebury); Pahang, F.M.S., July and November, 1921, and January, 1929 (H. M. Pendlebury); Larut Hills, Perak, F.M.S., February, 1932 (Pendlebury); Samaway, near Sandakan, North Borneo, July, 1927, Langkawilis, West Coast, F.M.S., April, 1928; Cameron Highlands, October, 1928 ex *C. sativus* (G. H. Corbett, No. 5358); Mount Tangamoes, Lampong, South Sumatra, 1,500 feet, July, 1935 (H. M. Ridley) Singapore, 1900; Malay, ex *Achras sapota* (G. H. Corbett); Kuala Lumpur, May, 1926, Cucurbit Tips No. 3239 (Dr. Roepeke), Java, 1912; Buitenzorg, Java, November, 1929 (G. L. Windred); Djampang, Tenggah, Preanger, West Java, May, June, and July, 1935, Mount Ardjoeno, East Java, 6,000 feet, January, 1936; Mount Tanggamoes, Lampong, South Sumatra, 1,500 feet, July, 1935.

Thanks to the kindness of Dr. Walther Horn, of the Deutsches Entomologisches Institut, it was possible to examine a specimen from Formosa identified by H. K. Munro as *Z. caudatus*. In this specimen the ovipositor is certainly long and cylindrical, like that described by Shiraki (1933). In every one of the series of twenty-six females listed above, the ovipositor is flat and triangular, and not as long as in the specimen from Formosa. Moreover, the series is from Malaya, Borneo, Sumatra, and Java, and it must be remembered that the type of *Z. caudatus* came from Java. If the ovipositor is described by Shiraki is constant, it is quite possible that the species found in Formosa is not *Z. caudatus*. A careful examination of a long series would decide this question. In the series listed above, a very constant character is the reddish-brown area on the anterior part of the mesonotum. It is difficult to describe, but looks like a narrow, irregular patch on either side of the median line, extending from the anterior border of the mesonotum to the suture. The two patches practically fuse posteriorly.

Zeugodacus caudatus var. **maculatus** var. nov.

In the collection from Selangor there is one specimen which resembles *Z. caudatus* F., but differs very noticeably in five ways:—

1. The scutellum has a large black apical spot. 2. The costal band does not extend to cell R3 in the middle, whereas in *Z. caudatus* it does so throughout its whole length. 3. The costal band does not become dilated to form a pronounced apical spot as in *caudatus*. It becomes slightly enlarged after passing the end of R2 + 3, but there is no distinct round spot as in *caudatus*. 4. The reddish-brown patches on the anterior part of the mesonotum, so characteristic of *Z. caudatus*, are absent, the whole of the mesonotum being black. 5. The facial markings are in the form of two triangular black spots, whose apices reach the oral margin, and whose bases run along the transverse furrow of the carina, meeting in the middle.

In all other respects this variety resembles typical specimens of *Z. caudatus*. It may be a distinct species, but until a long series is available for examination it seems better to regard it as a variety.

One female from Bukit Kutu, Salangor, F.M.S., 3,000 feet, September, 1932 (H. M. Pendlebury). Type returned to Selangor Museum.

Zeugodacus maculipennis Doles. 1856.

This handsome and easily recognised species is represented by 1 ♂ in poor condition from Pahang, F.M.S., December, 1921 (H. M. Pendlebury); 2 ♀♀ from Djampang, Tenggah, Preanger, West Java, March and November, 1935.

Zeugodacus limbipennis Macq. 1843.

In the collection from the Selangor Museum there is one specimen which was at first considered to be a new species, and a description was prepared. Subsequently it was found to agree very well with Macquart's description of *limbipennis*. The outstanding character is the shining black face with yellow margins. Macquart's description is very brief, and it is possible that the two species are distinct, in which case the name *atrifacies* is suggested. A full description is included.

Male.—Length of body, 5½-6 mm.; of wing, 5-5½ mm.

Head.—Frons fulvous, paler at the sides, with brown spots at the base of the bristles, and a central biloped brown spot; vertical calli distinct; ocellar triangle black; transverse vertical band black; slightly concave, and a little longer than wide, the proportion when measured from the lunule to the median ocellus being 18:14; a little narrower than an eye, the proportion being 16:14. Lunule shining brown. Face shining black with a narrow yellow band at each side on the outer slope of the antennal groove. Antennae dark brown, nearly black, and shorter than the face; second segment a little longer than the first; third segment only twice as long as the second; a short black dorsal bristle on the second segment. Palps yellow, bilaterally flattened, the upper edge almost straight and the lower edge distinctly curved. Genal spot brown and very large. Occiput black with a narrow yellow border about the width of the ocellar triangle.

Chaetotaxy.—*Vt.* 2, *s.or.* 1, *i.or.* 2 (very widely separated, the lower of the two being level with the lunule), genal bristle, occipital row distinct, all black.

Thorax.—Black, punctulate, covered with short white pubescence, and with a broad hoary band on either side of the median line. With the following yellow markings:—humeral calli; notopleural calli; a small triangular spot in front of the suture which is connected with a long narrow lateral post-sutural stripe, which terminates at the upper post-alar bristle; a broad triangular mesopleural stripe which is wider than the notopleural callus above, and which terminates on the sterno-pleura below; the anterior margin distinctly curved; three-quarters of the anterior, and five-sixths of the posterior hypopleural calli; a long narrow median post-sutural stripe which terminates at about the level of the *pr.sc.* bristles. Scutellum yellow with a very narrow slightly-curved black basal band.

Chaetotaxy.—*Scp.* 4, *n.pl.* 2, *mpl.* 1, *pt.* 1, *a.sa.* 1, *p.sa.* 2, *pr.sc.* 2, *sc.* 4, all black.

Legs.—Fulvous, with the coxae, front femora, distal two-thirds of the middle femora, half the hind femora, the base of the front tibiae, and about half the hind tibiae, dark brown or black.

Wings.—Hyaline with a very narrow costal band, and a rather broad anal streak. The costal band starts at the end of Sc. and terminates half-way between R4 + 5 and M1 + 2; it extends to cell R3 at the end of R2 + 3, and then becomes slightly wider, forming a small but distinct apical spot. The stigma is nearly twice as long as the second costal cell, the proportion when measured along C. being 33:19. The sections of M1 + 2 before and after the *r-m* cross-vein are 36:24. A very pronounced supernumerary lobe at the end of Cul + 1A. Extension of cell Cu. slightly curved, and practically parallel-sided basally, its length in proportion to Cul + 1A being 18:6. *R-m* cross-vein very oblique; R1 and R4 + 5 bristly.

Abdomen.—Punctulate; covered with long pale pubescence; black, except the posterior margin of the second tergite, which is reddish-brown, and the two oval areas on the fifth tergite, which are fulvous. A row of post-lateral cilia on the third tergite. One male from Bukit Kutu, Selangor, F.M.S., Sep., 1929 (H. M. Pendlebury). This species is very close to *terminifer* Walk., which also has a black face, and four scutellar bristles. In *terminifer*, however, there is no median post-sutural yellow stripe, the lateral yellow post-sutural stripes are very short, and the colour of the legs is slightly different.

Zeugodacus pendleburyi n.sp.

Female.—Length of body, 7-7½ mm.; of wing, 5·5-6 mm.

Head.—Frons dark fulvous, somewhat lighter at the sides, and above the lunule; frontal spots distinct; vertical calli distinct, shining brown in colour; no transverse vertical cross-band; ocellar triangle black; above the lunule a slightly raised area sparsely covered with short black hairs; slightly longer than wide, the proportion when measured from the lunule to the median ocellus being 18:14; and narrower than an eye, the proportion being 17:14. Lunule shining brown. Face fulvous, with a large black spot in the lower part of each antennal groove; carina with a distinct, but shallow, transverse groove. Antennae about as long as face; first and second segments fulvous; third segment dark brown, lighter on the inner side, covered with white pubsecence; second segment slightly longer than the first; third segment a little more than twice as long as the second, the proportion being 15:7; a short black dorsal bristle on the second segment; arista longer than antennae. Palps pale fulvous, bilaterally flattened, distinctly concave above, and convex below. A dark brown genal spot.

Occiput black with a narrow yellow border about the width of the ocellar triangle.

Chaetotaxy.—*Vt.* 2, *s.or.* 1, *i.or.* 2, genal bristle, occipital row distinct, all black.

Thorax.—Black, coarsely punctulate, covered with pale pubescence; a hoary band on either side of the median line. With the following yellow markings:—humeral calli; notopleural calli; post-sutural lateral stripes, which are round in front, pointed behind, and very short, about half the usual length, terminating just past the *a.s.a.* bristle; a parallel-sided mesopleural stripe which is about as wide as the notopleural callus above, and slightly narrower below, which extends on to the sternopleura below; the upper two-thirds of the anterior, and the upper five-sixths of the posterior hypopleural calli. Scutellum yellow with a very distinct, fairly wide, curved, basal, black, band; convex above; apex slightly curved.

Chaetotaxy.—*Scp.* 4, *n.pl.* 2, *mpl.* 1, *p.t.* 1, *a.sa.* 1, *p.sa.* 2, *pr.sc.* 2, *sc.* 4, all black.

Legs.—Dark brown, almost black, with the basal two-thirds of the femora fulvous, and the tarsi paler, the basal segment being almost white.

Wings.—Hyaline with a very narrow costal band, which starts at the end of Sc. and terminates just past the end of R4 + 5; it does not extend into cell R3 until it reaches the end of R2 + 3, and is very little wider at the apex of the wing. There is no anal streak. The stigma is nearly twice as long as the second costal cell, the proportion measured along C. being 32 : 18. The sections of M1 + 2 before and after the *r-m* cross-vein are in the proportion of 34 : 27. The extension of cell Cu. is very narrow, and slightly restricted basally, its length in proportion to that of Cul + 1A when measured along 1A being 17 : 18. The *r-m* cross-vein in very oblique, and the lower cross-vein slightly wavy.

Abdomen.—First tergite black; 2nd tergite with a faint dark fulvous anterior border, and a wide posterior fulvous border, the anterior border of the latter being wavy; 3rd tergite black; 4th and 5th tergites black with dark fulvous patches on either side of the dark median line; oval areas distinct, and dark reddish-brown in colour. Ovipositor reddish-brown; when measured from below, the proportions of the basal segment, length to greatest width, to width of apex, to width of second segment, are 40 : 20 : 5 : 10. From above, the length of the 5th tergite to the whole ovipositer—19 : 28.

Described from 3 ♀♀ from Bukit Butu, Selangor, F.M., Sep., 1929 (H. M. Pendlebury); and Larut Hills, Perak, Feb., 1932 (H. M. Pendlebury). Types returned to Selangor Museum.

This species is named after Dr. H. M. Pendlebury, who collected the 3 specimens on which the description is based.

This species comes very close to *terminifer* Walk., with which it agrees in having very short post-sutural lateral yellow stripes, the black curved basal band on the scutellum, and four scutellar bristles. In *terminifer*, however, the tibiae of the 1st and 2nd pairs of legs are fulvous, the face is black, and there is an anal streak present. It is placed in the genus *Zeugodacus* on the assumption that the 3rd tergite of the male is ciliated, and that there is a supernumerary lobe present in the wing of the male.

Genus **PARADACUS** n.g.

The characters of this genus are:—*Dacinæ* with four scutellar, one anterior supra-alar, two posterior supra-alar, no humeral, and no pre-scutellar bristles; a row of post-lateral cilia on the 3rd abdominal tergite of the male: a supernumerary lobe in the wing of the male at the end of Cul + 1A; and antennae not longer than the face. The only other genus with four scutellar and no prescutellar bristles is *Austrodacus* F.A.Perk., in which, however, there is no anterior supra-alar bristle, no cilia on the 3rd tergite of the male, and no supernumerary lobe in the wing of the male. Included in this genus is *perplexus* Walk., and the following new species: (The generic characters of *perplexus* Walk. were sent to me by Dr. Smart, of the British Museum, who very kindly examined the type on my behalf.)

Genotype, the following new species.

Paradacus fulvipes n.sp.

Male.—Length of body, 6-6½ mm.; of wing, 5½-6 mm.

Head.—Frons fulvous, paler above the lunule, with some indistinct darker markings in the centre; frontal spots pale brown, but distinct; vertical calli distinct, but not differently coloured; vertical cross-band dark brown; ocellar triangle black; a slight bulge or swelling just above the lunule; slightly longer than wide, the proportion measured from the lunule to the median ocellus being 19:16; and very little narrower than an eye, the proportion being 17:16. Lunule shining brown. Antennae fulvous with the 3rd segment darker on the outer side; 2nd segment a little longer than the 1st; 3rd three times as long as the 2nd; short black dorsal bristle on 2nd segment. Face fulvous, with an elliptical spot in the lower part of each antennal groove. Dark brown genal spot present; occiput fulvous.

Chaetotaxy.—*Vt.* 2, *s.or.* 1, *i.or.* 2, genal bristle, occipital row absent, all black.

Thorax.—Black with reddish-brown patches above the insertion of the wings, and below the humeral calli; punctulate; and covered with pale pubescence. With the following yellow markings:—humeral calli; notopleural calli; a small rectangular mark in front of the suture connected with the long wide lateral post-sutural stripe, which terminates behind the upper post-alar bristle; a triangular mesopleural stripe which extends on to the sternopleuron below; four-fifths of the anterior and practically all the posterior hypopleural calli. Scutellum yellow with a very narrow black basal band; convex above; apex between the bristles practically straight.

Chaetotaxy.—*Scp.* 4, *n.pl.* 2, *mpl.* 1, *pt.* 1, *a.sa.* 1, *p.sa.* 2, no. *pr.sc.*, *sc.* 4, all black.

Legs.—Fulvous with the fore and hind tibiae slightly darker.

Wings.—Hyaline with a broad costal band, which widens as it reaches the apex, so that the whole of the apical portion of the wing is of a pale brown tint, the apical blotch extending a little below M1 + 2; posterior cross-vein slightly infuscated; a very broad anal streak which extends to the margin of the wing. Second costal cell much smaller than the stigma, the proportion when measured along C. being 22:34. The sections of M1 + 2 before and after *r-m* cross-vein in the proportion of 35:24. The extension of cell Cu. only slightly restricted at the base, and its length in proportion to that of Cul + 1A measured along 1A is 23:11. R-m cross-vein very oblique. R1 and R4 + 5 bristly.

Abdomen.—Pale reddish-brown with the anterior margin of the 2nd and 3rd tergites black; 3rd tergite darker at the sides, and indistinct small darker marks on the 4th and 5th tergites. Oval areas on 5th tergite dark fulvous. No median black stripe. Third tergite with a row of post-lateral cilia.

Described from one male from Bettotan, nr. Sandaken, North Borneo, Aug., 1927. Type returned to the Selangor Museum.

This species is easily distinguished from the only other species in the genus, *perplexus* Walk., by the wing pattern.

P. perplexus Walk. has a very complex wing pattern, something like that of *Neodacus curvifer* Walk., and also a median post-sutural yellow stripe.

Genus **PARATRIDACUS** Shiraki, 1933.

Paratridacus garciniae Bez. 1913.

Synonymy.—*Bactrocera garciniæ* Bez. 1913.

This species is represented by 2 ♀♀ from Fraser's Hill, Pahang, F.M.S., Jan., 1929, and West Coast, Malay Pens., Pulan Angoa Lighthouse at light, Oct., 1926 (E. Seimund). They are darker than the specimens described by Bezzi, the mesonotum being nearly black, but the markings of the face, abdomen, legs, and wings, as well as other characters, agree so exactly, that there is little doubt about the identification. Bezzi's material was bred from the host plant *Garcinia*, and naturally would be lighter in colour than field-collected specimens. It seems to be remarkably close to the other species of the genus *P. yayeyamanus* Mats., the main difference being the general lighter colour; but this again might be due to the difference between bred and field-collected material.

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EXPLANATION OF PLATE IVa.

1. *Callantra splendida* n. sp. Wing of female (photographed from type).
2. *Zeugodacus limbipennis* Macq. Wing of male.
3. *Strumeta nigrotibialis* var. *lata* nov. Wing of female, anal lobe folded (photographed from type).
4. *Zeugodacus pendleburyi* n. sp. Wing of female (type), anal lobe slightly folded.
5. *Afrodacus javanensis* n. sp. Wing of female (type).
6. *Strumeta tillyardi* n. sp. Wing of female (type), anal lobe folded.
7. *Strumeta nigrotibialis* n. sp. Wing of female (type), anal lobe out of focus.
8. *Paradacus fulvipes* n. sp. Wing of male (type), anal lobe slightly folded and out of focus.
9. *Strumeta frauenfeldi* Schiner. Wing of female, apex and inner margin slightly broken.
10. *Nesodacus longicaudatus* n. sp. Wing of female (type). Unfortunately it was impossible to avoid including the legs in the photograph. They partially obscure the anal streak, which, however, is very short.
11. *Callantra splendida* n. sp. Ovipositor of type photographed from the side.
12. *Nesodacus longicaudatus* n. sp. Ovipositor of type photographed from above.

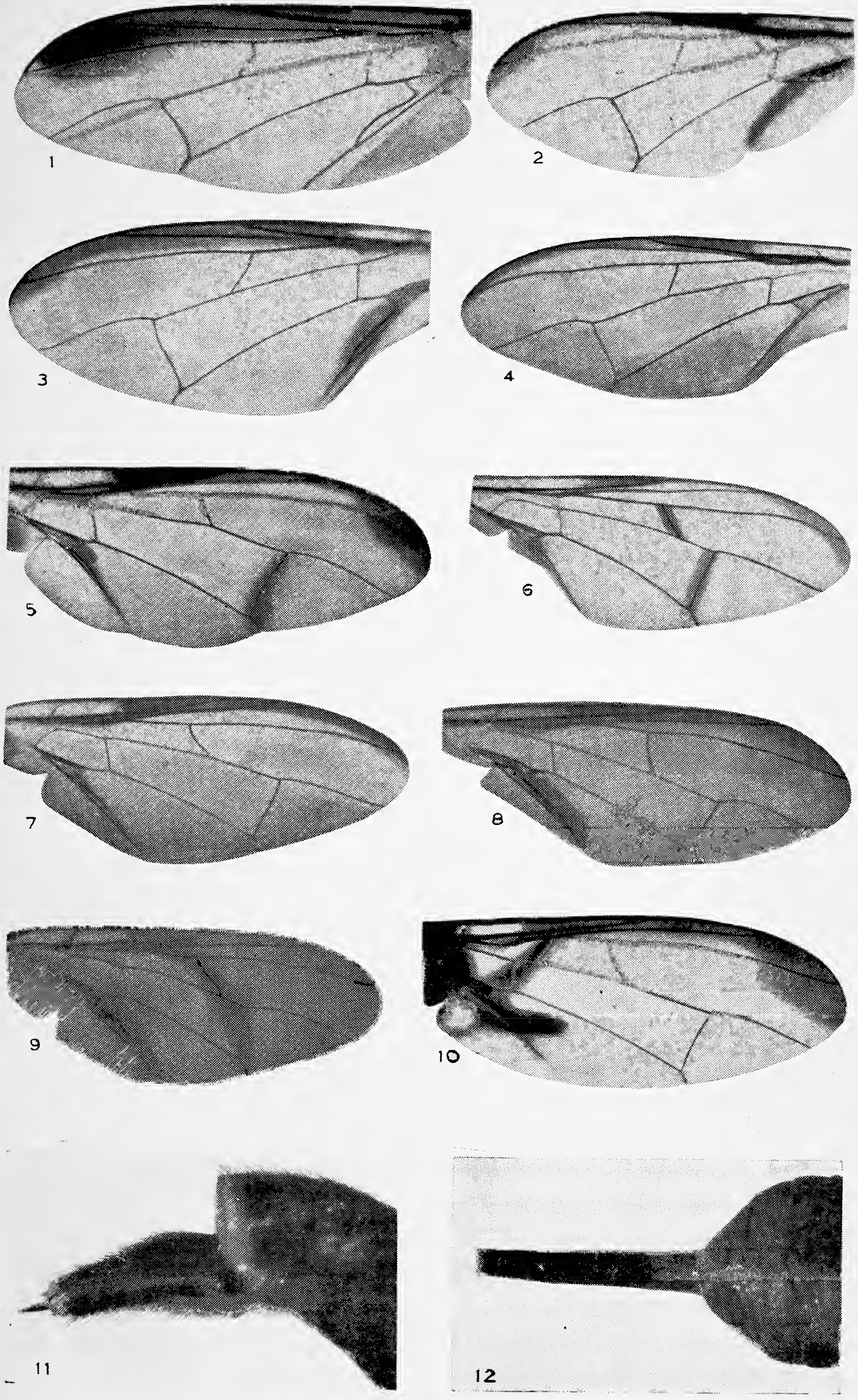

Fig. 1.

The Upland Savannahs of the Bunya Mountains, South Queensland.

By D. A. Herbert, D.Sc., University of Queensland.

(*Read before the Royal Society of Queensland, 25th October,* 1937.)

(Plate V.)

About thirty miles to the north-east of Dalby, the Bunya Mountains rise up from the low foothills and reach their greatest height on the bald summit of Mount Mowbullan, 3,611 feet. A general account of the vegetation, and a list of species collected at an altitude of 2,000 feet or over, is given by C. T. White (1). He points out that there are four main types of vegetation, all very sharply defined from each other; they are open grasslands, open eucalyptus forest, rain forest, and swamps—the open grassland being on the slopes and tops of bald hills and backed up by a solid wall of rain forest. Treeless patches are one of the most conspicuous features as the mountains are approached from the plains that stretch away to the south and west. From a distance they contrast strongly with the dark rain forest dominated by Bunya Pines (*Araucaria Bidwillii*), and are reminiscent of the blady grass-covered clearings in the rain forests of the Malayan Islands. They commence about 800 feet from the top of the range, and often run up the steep western slopes to the ridges and about a hundred yards down the other side, where the rain forest suddenly rises up like a dark wall. The patches are mainly found on the steep western slopes, but isolated balds may be found on almost any exposure. Usually they are on spurs, and the creeks and gullies flanking them are lined with rain forest, or, where conditions are suitable, with swamp types.

Plants of the Savannahs.

The sharp line of demarcation between grassland and rain forest is striking. *Lantana camara,* which elsewhere in Queensland commonly fringes rain forests, is absent; *Acacia maidenii, Rubus moluccanus,* and *Rubus rosaefolius* may grow in intermittent narrow strips around the forest margin, but are not continuous. In general, there is little suggestion of that dynamic equilibrium that is so commonly observed. It appears as if in the course of time the rain forest has progressed to the limit of its powers, and has then stopped; its pioneers have fulfilled their function, and the climax formation occupies its potential territory to the fullest extent; or alternatively, that the grassland is so firmly established under the present conditions of grazing that encroachment of the usual ecotone types is not taking place.

The grassy areas vary in size from a few acres up to several hundred acres in extent. Their plant cover is well grazed, and forms a sward, the common grass species being *Themeda australis* (Kangaroo Grass), *Cymbopogon refractus* (barbed-wire grass), *Danthonia longifolia* (Wallaby Grass), Cynodon dactylon (Indian Couch), *Aristida vagans, Festuca bromoides,* and *Poa caespitosa* (Tussock Grass), the lastnamed being conspicuous on account of its habit. Amongst the non-grasses are *Viola betonicaefolia, Hydrocotyle vulgaris, Apium leptophyllum,* and *Tillaea verticillaris.*

It is to be noted that the bald patches are chosen as sites for farm houses and buildings and that a considerable number of weeds—native and introduced—make their appearance round them; included amongst these are *Sida rhombifolia, Acaena ovina, A. sanguisorbae, Verbena officinalis, Rumex acetosella, R. crispus, R. Brownii, Sonchus oleraceus,* and *Lepidium ruderale.*

Though the grassy areas of these mountains stand out in such sharp contrast to the surrounding rain forest, they are not entirely devoid of trees. Occasional trees, or sometimes groves, are to be found (Plate I., Fig. 2). On a large bald patch, across which climbs the road from Dalby to Mount Mowbullan and Kingaroy, may be seen *Acacia decurrens* var. *pauciglandulosa* (Black Wattle), *Rhodosphaera rhodanthema* (Deep Yellow Wood), *Grevillea robusta* (Silky Oak), *Laportea gigas* (Stinging Tree), *Ficus eugenioides* (Small-leaved Fig), *Sterculia diversifolia* (Kurrajong), and *Eucalyptus tereticornis* (Blue Gum). On a smaller area above the Big Falls is a large cedar, *Cedrela toona* var. *australis,* growing about ten yards from the rain forest margin, while in the middle of the area is a tree of *Ficus eugenioides. Sida rhombifolia* is another ligneous plant scattered through the grassland.

Of these trees, the two which tend to form communities are *Eucalyptus tereticornis* and *Acacia decurrens* var. *pauciglandulosa,* both common further down the mountain, but sporadic in the upper part within 800 feet of the top of Mount Mowbullan. On a large bald near Munroe's camp there is a fine grove of mature *Eucalyptus tereticornis* forming a pure stand on a ridge; the road passes this particular grove. Elsewhere single trees or groups may be seen occasionally.

Near the bald top of Mount Mowbullan, groves of the black wattle dot the grassy slopes; many of these are perhaps not more than ten years old, but are full grown, the plant being quick growing and short lived. Some of the trees carry large numbers of the beautiful little epiphytic orchid *Sarcochilus falcatus,* a common epiphyte of the nearby rain forest, but which is absent from the wattles at the foot of the range. A point to be specially noted is that these two tree species both provide good firewood, and are used for that purpose very commonly on the mountains, most of the rain forest trees being comparatively worthless for that purpose, besides being more difficult to get at.

The other trees that have been mentioned as occurring on the balds are isolated individuals. They are usually to be found at the foot of sudden steep dips, or on the rocky areas where the grasses are not as dominant. *Ficus eugenioides* is occasionally found perched on exposed rocks, clasping them with its roots

Ecological Conditions.

Unfortunately there are no meteorological records of these mountains. Stations on the plains below record about 26 inches rainfall per annum, but that of the mountains is obviously much higher, as is evidenced by the luxuriance of the vegetation. In the absence of data, the vegetation itself must be taken as the sole indicator of the rainfall. The 26-inch country is quite incapable of supporting rain forest. At the base of the mountains the creeks are still lined by Eucalypts, but in the foothills *Grevillea robusta* (Silky Oak), *Castanospermum australe* (Moreton Bay Chestnut), and other trees common in such situations near the better watered coast make their appearance. On the lower parts of the mountains themselves a rain forest first makes its appearance along the creeks, the flats and ridges being clothed with open Eucalyptus forest—*Eucalyptus tereticornis, Eucalyptus eugenioides, Angophora intermedia, Acacia decurrens* var. *pauciglandulosa*, and *Sterculia diversifolia* as the common trees. About 800 feet from the top of the ranges the bald patches appear. *They take the place of the open forests.* The Eucalypts disappear at about this level, and persist only as isolated individual trees or groves, infrequent enough to be overlooked by casual observers. The rain forest, however, continues in its expected habitat. At the top of the mountain it spreads out over the spurs and ridges, though not in every case. If the grasslands were replaced by Eucalyptus forest there would be nothing surprising in the distribution of the natural vegetation; the alternation of open forest on the spurs with rain forest in sheltered situations and the upper mountain ridges would be a repetition of what is commonly found in the coastal mountain ranges of Queensland. Those trees which do invade the grassland are species found in the open forest, though some of them are also common rain forest types.

It can be agreed that the grassland is characteristic of the drier situations in the upper parts of the mountain. It forms a sward which makes tree invasion difficult, especially as cattle are pastured on the balds. Further down the mountain the grass growth is much more sparse when the Eucalyptus and other open forest trees are cleared, and there is more opportunity for forest regeneration. Where on the balds a tree does become established, its competition with the grass makes conditions a little more favourable for its seedlings, and there is a tendency towards the establishment of groves.

Origin of the Grassy Areas.

The bald areas of the Bunya Mountains have existed in the present state for a very long time, and have not been tree-covered within living memory. Trees, however, have come and gone. Evidence of this is afforded by *Acacia decurrens* var. *pauciglandulosa*, a short-lived tree, which may be found at all stages as isolated individuals or in groves; and by the presence of dead roots of *Eucalyptus* and *Cedrela* in the soil in places where no trees now grow. No theories as to the origin of the grass patches have been published. One current opinion, not held locally, is that the soil is too shallow to support trees. This may be dismissed, as the soil along the road is often a foot deep, and in one place near Munroe's camp a hole was sunk for five feet before rock was encountered. Further, the isolated trees of the balds are usually in very shallow, rocky soil, and *Ficus eugenioides* may even perch on bare rocks. There is, too, the obvious evidence of sporadic trees, and of the dead roots already mentioned.

The question of the effect of winds is worthy of notice. Most of the balds are on the slopes exposed to the dry westerly winds, which from time to time sweep across the plains and up over the mountains. These are the driest slopes of the region, and their exposure and steep slope, which latter naturally has a marked effect on run-off, are reflected in the restriction of rain forest, which on the other slopes occupies most of the territory. It does not, however, explain the absence of open forest trees, which in other mountain ranges in South Queensland dominate such slopes. There is no sign of wind shearing even in isolated trees growing right out in the middle of a grassed area. Further, epiphytes such as *Sarcochilus falcatus* grow on the Acacias; their absence from the Eucalypts is due to the unsuitable nature of the bark. Along the rain forest margin, too, the trees are commonly invested with epiphytes, including *Platycerium alcicorne* and orchids. At the edge of one open stretch the luxuriant growth of *Dicksonia antarctica* following a stream, made it apparent that wind was not a factor at that particular spot. Wind has been suggested as the factor in the production of balds in the southern Appalachians; they are a conspicuous feature of the Great Smoky Mountains in North Carolina. (I am unable to trace the paper in which this claim was made; it was not, however, supported by evidence, and was advanced as a suggestion only.) Clements (2) states that these balds are seral communities of heaths or grasses initiated and maintained primarily by fire.

Sub-climax grasslands are of widespread occurrence, and in most cases fire is the important factor in their origin and persistence.

Myers (3) has described a somewhat similar occurrence of upland savannahs often on steep slopes in the Pakaraima Mountains of British Guiana. He regards the present vegetation as so eminently adapted to burning that it is justifiable to regard it as a fire climax (sub-climax in Clements' terminology). Lane Poole (4) has discussed the grasslands of the mountains of New Guinea, and advanced strong evidence of their being the result of persistent firing by natives. van Steenis (5) collected a vast array of evidence for the anthropogenous nature of grasslands in Malaysia. One very pertinent remark, made in another paper (6) is: "Climate is not the cause of, but only the condition under which deserts originate." This is equally applicable to grasslands in general, and as far as this paper is concerned, to the Bunya Mountains in particular.

My opinion is that the grasslands of these mountains were induced by fire. The aboriginal tribes formerly travelled over great distances to the Bunya Mountains for the fruiting season of the bunya pines (January to March), collecting the large starchy seeds by day and camping in the Eucalyptus forest below to roast them at night. According to some estimates, thousands of blacks gathered in the bunya season. I can trace no records of their having habitually fired the open forest area; but with great numbers camping in a limited area very susceptible to fires, it seems reasonable to assume that this would be the case. Captain Cook noted bush fires all along the Queensland coast, and great areas in coastal Queensland, formerly savannah, have, following protection from fire, become re-clothed with trees. I have been informed by Mr. Romeo Lahey that when his father came to Brisbane, One Tree Hill, which is now heavily forested, was open savannah. That the balds have had trees in the past is shown by the fact that roots can be dug up. Repeated firing of the forests would result in destruction of the trees and the establishment of a grassland sub-climax. Within about 800 feet of the top of the range the increased rainfall has produced such a grass cover that the regeneration of trees is particularly difficult, except in a few spots such as rock outcrops and the foot of small cliffs. The pasturing of cattle helps to hold the sere in the grassland stage, though in a few patches the open Eucalyptus forest climax has re-established itself (or persisted). It

Fig. 1.

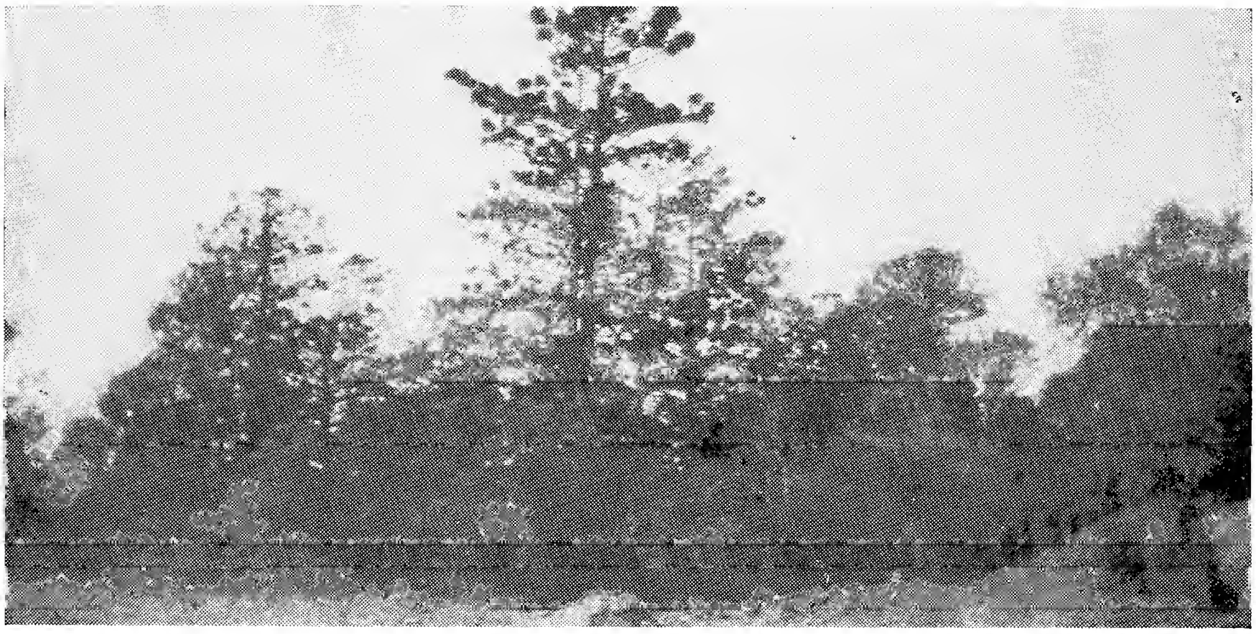

Fig. 2.

Fig. 3.

is a remarkable fact that below the rain forest the open forest has not given way to grassland, except where it has been cleared by settlers. Whether the areas away from the rain forest levels were not so persistently fired by the blacks is a point which cannot now be settled. Observation, however, indicates that regeneration of forest takes place more readily on the sparser induced grassland of the lower and drier foothills than on the mountain. Even assuming that upper and lower levels had been equally burnt over, regeneration on the lower and drier slopes would re-clothe them before the upper. On the lower slopes the Eucalypts are not aged trees; this is indicated in Plate VI., Fig. 3, which is a photograph of the eucalyptus forest just below a bald, and about 800 feet from the top of Mount Mowbullan. They would thus appear to represent a returned forest rather than a primaeval one.

Summary.

Grassy areas varying in size from a few acres to several hundred acres are interspersed with rain forest on the Bunya Mountains, about 30 miles north-east of Dalby. These replace the open eucalptus forest at an elevation of about 2,800 feet. They represent a grassland sub-climax, and only in isolated places does the *Eucalyptus tereticornis* forest climax become established. It is considered that the grassed slopes are the result of destruction of Eucalyptus forest, probably by fire by the blacks in the days when they gathered for the collection of bunya pine seeds.

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Illustrations.

Plate V.

Fig. 1.—Typical grass-covered balds in the Bunya Mountains near Munro's Camp, with rain forest in a gully.

Fig. 2.—Rain forest edge near Munroe's Camp, with a narrow ecotone of *Acacia Maidenii.*

Fig. 3.—Eucalyptus tereticornis forest abutting on rain forest (right) at about 2,800 feet altitude. Above this level, such a situation would be occupied by grassland.

Alternaria Passiflorae n.sp. the Causal Organism of Brown Spot of the Passion Vine.

By J. H. SIMMONDS, M.Sc., Department of Agriculture and Stock, Brisbane.

(*Read before the Royal Society of Queensland, 29th November,* 1937.)
(Plate VI.)

Brown spot, a serious disease of the passion vine, has been known for a number of years in the three Eastern States of Australia, and has been referred to on several occasions in the publications of the respective Departments of Agriculture.

Tryon (8) in 1917 ascribed the disease to the presence of a fungus belonging to the genus *Macrosporium,* and the results of further investigations by the author (5) supported this contention. Cultures and herbarium material were later forwarded to the Imperial Mycological Institute when the organism was examined by S. P. Wiltshire. In a letter dated 9th June, 1933 (slightly amended), Wiltshire makes some interesting comments on the systematics of the fungus, which can best be summarised by the following extracts from the communication itself.

"I believe the fungus received is new to me. It shows a tendency for the base of the beak of spores formed in culture to become zigzag. . . . Another feature is the variation exhibited by the fungus in culture, spores formed where the surface of the agar is only cut being shorter on the whole, and with thicker beaks than those formed when a portion of the agar is removed.

Comparing your fungus with other allied species, I find that *A. solani* differs from it in its longer, narrower, more robust spore body, longer beak, and especially in the stiff, straight base to the beak. *A. crassa* has a longer beak in the natural material and the spore body is much narrower, while *A. tomato* has considerably smaller spores than your fungus. An undescribed *Alternaria* belonging to the *A. solani* group from chicory recorded from Florida and Cyprus has longer, more flexuous beaks, which are sometimes branched, almost dichotomously. Both *A. macrospora* from cotton and *A. cucumerina* from water-melon have some resemblance to your species; the former has smaller spores in the natural material, with a proportionately much longer beak, the latter has spores nearly the same width, but are tapered more distinctly towards the base, the cross walls are more numerous, and the beak is longer. Both species are quite distinct from your fungus in culture.

Pathogenicity has been regarded by some as important from the systematic point of view. . . . . I am not aware of the range of hosts to which your species is pathogenic, but such information might prove interesting. No species of *Alternaria* or *Macrosporium* is recorded on *Passiflora* by Saccardo in the Sylloge, nor by Seymour in his host index of American fungi. Neither is there any such record in the host index of fungi maintained at this Institute.

There are, I think, therefore, good grounds for giving a new name, provisionally at least, to your fungus, if you consider this advisable.

[*Photo. by W. J. Sanderson, Department of Agriculture and Stock.*

Plate VI.

Alternaria passifloræ. Two collections from lesions on *Passiflora edulis*, illustrating some of the possible variations in spore characters.

As regards the choice of genera, *Macrosporium* and *Alternaria* are really identical but for various reasons, the latter is to be preferred. . . . . Your species I have observed to form chains of five spores in culture, which agrees with the popular notion of an *Alternaria*.''

The *Alternaria-Macrosporium* concept was elaborated more fully by Wiltshire (9) in a paper published in 1933, and although the organism from *Passiflora* has been known to form chains of spores in culture only, his suggestion was accepted, and the fungus was accordingly referred to the genus *Alternaria* in a recent brief review of passion vine diseases (6).

Brown spot now appears to be more widely distributed than was hitherto realised, and in view of this fact, the association of a specific name with the causal organism is desirable. As the Imperial Mycological Institute prefers that new species should be described by workers primarily concerned with them, it is here proposed that a new species *Alternaria passiflorae* be erected for the causal organism of brown spot of *Passiflora* spp. in Australia. A brief Latin diagnosis is appended. For a more detailed account of the morphology, physiology, distribution, and host range of this species, reference should be made to the literature listed. Type material will be lodged with the Kew Herbarium.

Alternaria passiflorae.

Maculis foliicolis, caulicolis, fructicolis, limitatis, brunneis vel brunneopurpureis. Hyphis hyalinis dein saepius nonnihil coloratis, cellulis 15-38 x 2-8 μ praeditis. Conidiophoris solitariis, vel caespitosis, brunneis, versus apicem hyalinis erectis, simplicibus vel raro ramosis, sparsis geniculatis. Conidiis acrogenis et pleurogenis, singulatim productis, vel in culturis observatis interdum 2·5 catenulatis, oblongis vel obclavatis, brunneis, 5-13, in medio 8·7, transverse-septatis et ad septa constrictis septis longitudinalibus nullis vel paucis, in medio 2.5, instructis; frequentissime in rostrum hyalinum 3-4 μ latum, simplex vel, in culturis observatum, 1-5 ramosum, basi flexuosum productis; 44-135 x 14-27 μ, in medio 83 x 20 μ, (erostratis); 106-253 μ longis (rostratis). *Hab.* Parasitice in foliis fructibusque vivis *Passiflorae edulis, P. albae, P. quadrangularis, P. herbertianae, P. incarnatae*, Australia.

Obs. Calore optimo 23°-28°C., maximo 33°C.

ILLUSTRATIONS.

PLATE VI.—*Alternaria passifloræ.* Two collections showing possible variations.

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Essential Oils from the Queensland Flora—Part XIII.—Backhousia Hughesii.

By T. G. H. JONES, D.Sc., A.A.C.I., and F. N. LAHEY, M.Sc.

(*Read before the Royal Society of Queensland, 29th November,* 1937.)

On account of the great diversity of composition and of the importance of some of the constituents of the oils from those species of *Backhousia* already studied (1, 2, 3, 4), it was thought desirable to investigate the other species of this genus occurring in Queensland. The present paper deals with one of these.

The tree grows abundantly in the timber forests of north-east Queensland, particularly in the Cairns district, where it is cut for its timber commonly known as Stonewood.

The oil was found to closely resemble that from Backhousia sciadophora, consisting principally of d— α and d— β pinene and sesquiterpenes, the minor constituents being sesquiterpene alcohol, a trace of an acid and a phenol and an unstable coloured body.

The cost and difficulty of collection and transport of leaves precluded the possibility of obtaining large supplies in good order, with the result that a thorough investigation of the minor constituents was not possible.

EXPERIMENTAL.

Dried leaves of *Backhousia Hughesii* weighing 130 lb. yielded on steam distillation ·78 per cent. of an oil with the following properties:—

$d_{15\cdot5}$	·8722
$[\alpha]_D$	+ 30
N^{20}_D	1·4935
Ester Value	Nil.
Acetyl Value	46·6

The oil was extracted first with sodium bicarbonate and then with sodium hydroxide solutions. These aqueous extracts on acidification and extraction with ether yielded traces only of an acid and a phenol respectively. The remaining oil after washing and drying was subjected to fractional distillation under reduced pressure (1 mm.) when the following fractions were collected:—

	Temp.	$d_{15\cdot5}$	$[\alpha]_D$	N^{20}_D
1.	Oil from liq. ammonia trap	·8617	+ 43	1·4718
2.	21–22½° C.	·8624	+ 40·6	1·4716
3.	60–78° C.	·897	+ 6·2	1·4921
4.	78–88° C.	·9035	+ 10	1·4981
5.	88–89° C.	·9119	+ 20·8	1·4994
6.	89–91½° C.	·9214	+ 30·4	1·5000
7.	91½–95° C.	·9375	+ 24·3	1·5004
8.	95–96° C.	·9565	+ 9·6	1·5003

Identification of α and β Pinene.—By repeated fractional distillation at 2 mm. pressure fractions (1) and (2) yielded samples of oil with the following constants:—

	(a) Oil from liquid ammonia trap.		(b) 25–28° C.
$d_{15\cdot5}$	·8638	$d_{15\cdot5}$	·8628
$[\alpha]_D$	+ 46·2	$[\alpha]_D$	+ 44
N^{20}_D	1·4676	N^{20}_D	1·4688

Fraction (*a*) on oxidation with neutral permanganate gave an excellent yield of pinonic acid m.p. 67°C., the semicarbazone of which melted at 204°C.

Fraction (*b*) on oxidation with alkaline permanganate yielded the insoluble sodium salt of nopinic acid on concentrating the aqueous solution. This on acidification gave nopinic acid which when recrystallised from benzene melted at 125°C.

Thus the presence of d— α and d— β pinene was established.

Sesquiterpenes.—The remainder of the oil consisted of sesquiterpenes and sesquiterpene alcohol, except for a small quantity of an unstable substance, which coloured the oil a deep yellow, and rapidly resinified during distillation. Although we suspected this substance to be of the nature of an unsaturated ketone we were unable to form any derivatives of it. Distillation over potassium purified the sesquiterpenes of this unknown but at the expense of the latter. Further fractional distillation pointed to the presence of at least two sesquiterpenes, for the following head fractions were obtained:—

	(a) 72–75° C.		(b) 84–86° C.
$d_{15\cdot5}$	·8935	$d_{15\cdot5}$	·919
$[\alpha]_D$	— 4·4	$[\alpha]_D$	+ 39·2
N^{20}_D	1·4925	N^{20}_D	1·4994

Both fractions (*a*) and (*b*) were treated with selenium at 280°C. Each gave a small quantity of azulene, the picrate of which melted at 119°C.

The recovered oil from fraction (*b*) after this treatment showed no trace of either cadalene or eudalene, although fraction (*a*) appeared to yield one of these, for the recovered oil had density ·93, compared with ·8935 for the original oil. However, we were unable to prepare a picrate of this oil, and insufficient material prevented further purification by fractionation.

Our thanks are due to Mr. C. T. White, Government Botanist, for botanical assistance, and to the Forestry Department for the collection of the leaves.

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Notes on Australian Cyperaceae II.

By S. T. Blake, M.Sc., Walter and Eliza Hall Fellow in Economic Biology, University of Queensland.

(*Read before the Royal Society of Queensland, 29th November, 1937.*)

Eleocharis Brassii S. T. Blake, sp. nov. aff. *E. nuda* C. B. Clarke, sed differt habitu robustiore glumis minus appressis, nuce multo majore, setis persistentibus.

Perennis, caespitosa, stolonifera; stolonibus ca. 1·5 mm. diam. *Culmi* erecti vel suberecti, 40-50 cm. alti, rigidi, subteretes, sub spicula vix trigoni, 3·5 mm. diam., in sicco plus minusve compressi, leviter striati, rugulosi nec septati. *Vaginae* pro more 2 laxiusculae, orifice obliquae, membranaceae, purpurascentes, superior plus minusve striata, orifice firma, brevissime mucronata. *Spicula* 3-5 cm. longa, 4-5 mm. lata, linearis, acuta, densiflora, spiraliter angulata. *Glumae* (prima latiore brevique excepta) ovatae, obtusae, concavae nec carinatae, pluristriatae, stramineae sed intus marginibus brunneozonatae et tota parte anteriore brunneo-punctatae, rigidae, marginibus extremis tenuiter hyalinae, 4.8-5 mm. longae, 2.5 mm. latae. *Stamina* 3, antherae lineares apiculatae, ca. 2·8 mm. longae. *Stylus* bifidus. *Nux* late obovata, subtruncata, 1·8-2 mm. longa, 1·6-1·7 mm. lata, aequaliter turgide biconvexa, leviter costata, nitide fulva vel brunnescens, utroque latere cellulis extimis hexagonis ca. 20-seriatis striata vel reticulata, apice $\frac{1}{4}$-$\frac{1}{3}$ parte angustiore, annulo toroso instructa; stylobasis pallida, cellulosa, complanata, triangulari-ovata, $\frac{3}{5}$-$\frac{4}{5}$ nucis aequans. ***Setae hypogynae*** 6 quarum 4 (interiores) nuce paullo breviores dentibus firmis retrorsim scabrae, 2 (interiores) tenuissimae minimae vel nullae.

Type: Queensland, Cook District—Forest Home Station, Gilbert River, in the swamps, April, 1931, *Brass* 1864. (Herb. Bris.).

Distrib.: North Australia, North Queensland.

Eleocharis pallens S. T. Blake sp. nov. aff. *E. acuta* R. Br. a qua culmis gracilioribus densissime caespitosis, rhizomate brevissimo, spicula tandem pallida, antheris breviore apiculatis, nuce breviore marginibus costata, stylobasi plerumque breviore differt.

Perennis, densissime caespitosa, rhizomate brevi haud repenti. *Culmi* pernumerosi, erecti vel suberecti, ad 5 dm. alti, graciles, subteretes, laeves sed longitudinaliter manifeste 9-10 sulcati, 0·6-1·0 mm. diam. *Vaginae* firme membranaceae, arcte appressae, leviter striatae, superior orifice truncata, incrassata et discolorata, mucrone erecta ad 2 mm. longa munita. *Spicula* linearo-cylindrica, basi obtusa, apice acuta vel subacuta, brunnea vel fulva, plerumque pallida, densiflora, plerumque 1-2 cm. longa, 2 mm. lata. *Glumae* numerosae, arcte appressae, vel raro aliquantum patentes, facillime deciduae, ovatae vel oblongo-ovatae, acutae apice triangulares, scariosae, dorso leviter carinatae, plus minusve brunneo-tinctae, ceterum hyalinae, 2·9-3·3 mm. longae. *Stamina* 3, antherae lineares, apiculato-cristatae, cum crista 0.15 mm. longa 1.6-2.0 mm. longae. *Stylus* trifidus (rarissime de casu bifidus). *Nux* late obovata vel suborbicularis vel basin versus nonnunquam aliquantulum attenuata, plus minusve inaequaliter biconvexa vel subplanoconvexa, saepe turgida, marginibus costata, fulva vel brunnea vel nonnunquam fusca, nitida, lateribus laevis vel rugulosa, plerumque leviter reticulata (cellulis extimis parvis verticaliter breviter oblongis, saepe prominulis) 1·1-1·4 mm. longa, 0·9 mm. lata. *Stylobasis* multo variabilis in eadem spicula, plerumque plus minusve deltoidea vel ovato-triangularis, saepissime compressa, pallida vel fulva, in parte inferiore plus minusve spongiosa et fimbriolata, ad $\frac{1}{3}$ nucis aequans; saepe tamen valde depressa ovata, vel substipitata. *Setae hypogynae* 7-10, plerumque validae, retrorsim scabrae, pallidae vel brunnescentes, plerumque subaequales nuce breviores longioresve, nonnunquam breves vel longissimae.

Type: Queensland, Warrego District, Offham ca. 25 miles south of Wyandra, in depressions in grassland, 700 ft., April 13, 1936, *Blake* 11235 (Herb. Bris.).

Distrib.: Widely spread in the drier parts of the mainland of Australia.

Eleocharis plana S. T. Blake sp. nov. aff. *E. acuta* R. Br. sed praecipue culmo valde complanato latiusculo differt.

Rhizoma longe repens ca. 2 mm. diam., culmorum caespites distantes ferens. *Culmi* rigidi, erecti vel obliqui, ad 80 cm. alti, plani vel leviter plano- vel concavo-convexi, 2-4 (pro more 3) mm. lati, longitudinaliter striati, transversim irregulariter rugulosi. *Vaginae* rigide membranaceae vel subherbaceae, striatae, superior apice discolorata incrassata truncata vel fere truncata mucrone rigida 1·5-3 mm. longa munita. *Spicula* pallida vel brunnescens, lineari-cylindrica, subacuta, plerumque 10-15 mm. longa, 2-2·5 mm. diam. *Glumae* 2 infimae bracteiformes, ceterae fertiles ovatae, acutae, leviter carinatae, tenuiter membranaceae, stramineae, marginibus apice triangulari inclusa late hyalinae, 3.4-3.7 mm. longae. *Stamina* 3, antherae lineares, 1.4 mm. longae, crista lineari 0.2 mm. longa inclusa. *Stylus* trifidus. *Nux* tandem nitide brunnea, obovata, turgida, biconvexa, vix costata, minute punctulata vel rugulosa, 1·2-1·8 (plerumque 1·4) mm. longa, 1·0-1·1 mm. lata, cellulis extimis minutis breviter verticaliter oblongis; stylobasis triangularis vel ovata, compressa, pallida, cellulosa, basi tumida, aliquantum hispidula, 0·6-0·8 mm. longa (ca. $\frac{1}{2}$ nucis aequans), 0.5 mm. lata; *setae hypogynae* 6-8, tenues, retrorsim scabrae, nucem cum stylobasi subaequantes.

Type: Queensland, Darling Downs District; Palardo, west of Miles, in swamps, 1,100 ft., February 16, 1935, *Blake* 7615 (Herb. Bris). "Rhizome creeping, stems erect ca. 2 ft., dull green, rigid, nearly flat, faintly longitudinally striate, and more faintly transversely so."

Distrib.: Queensland (Port Curtis District, Moreton District, Darling Downs District), New South Wales.

The species described above will be fully discussed in a revision of the Australian members of the genus, which is almost complete.

The Plant Communities of Western Queensland and their Relationships, with Special Reference to the Grazing Industry.

By S. T. BLAKE, M.Sc., Walter and Eliza Hall Fellow in Economic Biology, University of Queensland.

(*Read before the Royal Society of Queensland, 29th November,* 1937.)

(Plates VII—XXVI., two maps and two text figures.)

In a State such as Queensland, where the national wealth is dependent to such an enormous extent upon the success of the grazing industry, an accurate survey of the pasture lands, and indeed of all vegetation, would seem to be a prime necessity. Such a survey has yet to be made. It is true that three previous maps, featuring the vegetation of Queensland, have been published. The first was "The Forest Conditions of Queensland," prepared for the British Empire Forestry Conference of 1928 by E. H. F. Swain.[37] As this deals purely and simply with commercial timbers and their occurrence, its application is very limited, and is quite misleading to the student of general vegetation. Two maps were published by the Council for Scientific and Industrial Research. The first of these is "The Soils of Australia in Relation to Vegetation and Climate," by J. A. Prescott, published in 1931.[31] Then in 1936 appeared "A Survey of the Pastures of Australia. . . .," by A. McTaggart.[25] Both dealt with Australia as a whole, and as a result Queensland was very inadequately treated. Serious errors occur, and while some are the natural result of the method of preparation and the practical impossibility of obtaining reliable data about many districts, others are less easy to explain, particularly the inconsistency in nomenclature. Some of the most serious of these will be pointed out when discussing the communities. A most useful purpose was served by these maps in that they stressed the necessity for detailed work in this direction. The best general accounts of Queensland vegetation have been given by Domin[14] and White,[39] while its general relationships have been discussed by Herbert.[21]

In the present paper an attempt has been made to describe all the important plant communities that occur in the area usually referred to as Western Queensland. The paper is based entirely on field work carried out in connection with general botanical investigations on pasture problems. A large part of the area was hitherto practically unexplored botanically, and the floristics of a large part of the remainder imperfectly known. As the result of intensive field work, carried out over the period of three years as a Walter and Eliza Hall Fellow, material has now been accumulated for a fairly thorough knowledge of the area. Considerable time will be required before all the botanical material can be worked up, but in view of the increased interest and activity which is being manifested in pastoral problems, it has seemed advisable to present the general results of this work, leaving the details to be filled in later. As the work progresses material will be available for a more comprehensive account of the vegetation of Queensland than has yet been possible.

The limits of the occurrence of some communities have been in part plotted from surveys and other data made available to me through the courtesy of officers of the Department of Public Lands. However, I take full responsibility for the discrimination of the communities as such, and for their arrangement.

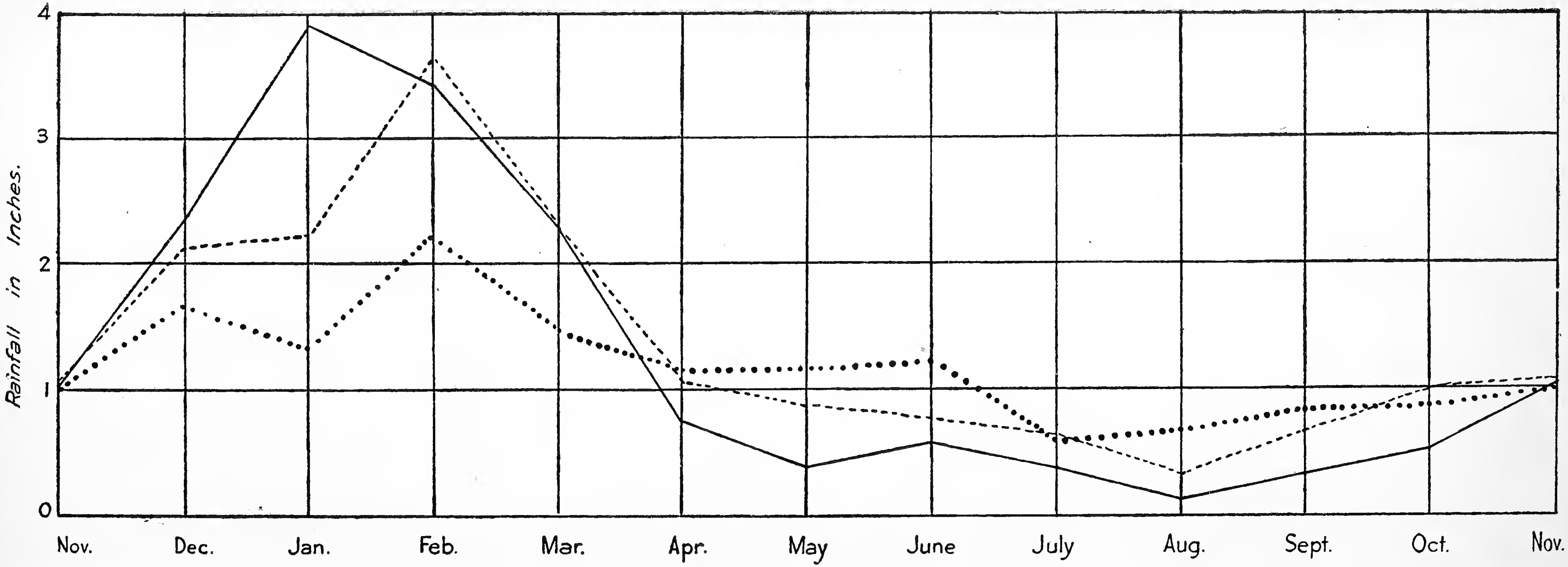
It is with deep pleasure that I offer my sincere thanks to the many persons who have assisted me in diverse ways. First and foremost I wish to express my deep gratitude to the members of the Walter and Eliza Hall Trust. This Trust made the work possible, and has continued to finance it, and it is through the courtesy of the members that it has been possible to bring the work to its present extent. Throughout the prosecution of field work in all parts of the State, transport facilities have been afforded me by many people. To the officers of the Department of Agriculture and of the Department of Public Lands I am indebted in this and other ways. Through the courtesy of many graziers, I have been enabled to study the composition of pastures in relation to stocking and other aspects. The section on soils has been prepared with the assistance of members of the Department of Geology in this University. To others who have assisted in any way whatsoever, I tender thanks.

The area here discussed covers nearly 330,000 square miles, and embraces the greater part of purely pastoral Queensland with the exception of the very large area surrounding the Gulf of Carpentaria, which constitutes a definite botanical province to be defined later. The southern boundary of this province is approximately the northern limit of the area described in the present paper. The climate, topography, soils, river systems, and available water are discussed. The plant communities, of which about forty-five are recognised, are arranged in fourteen groups, and described as to habitat, dominant species, floristic detail, reaction to stocking, their relationships, and their history. To account for certain features, including the instability of some of the large communities, the idea of a fluctuating climax is introduced. Maps showing the distribution of the chief soil-types and plant associations are included.

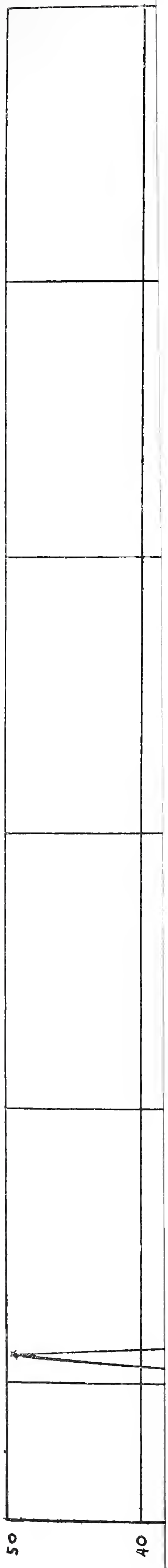
Climate.

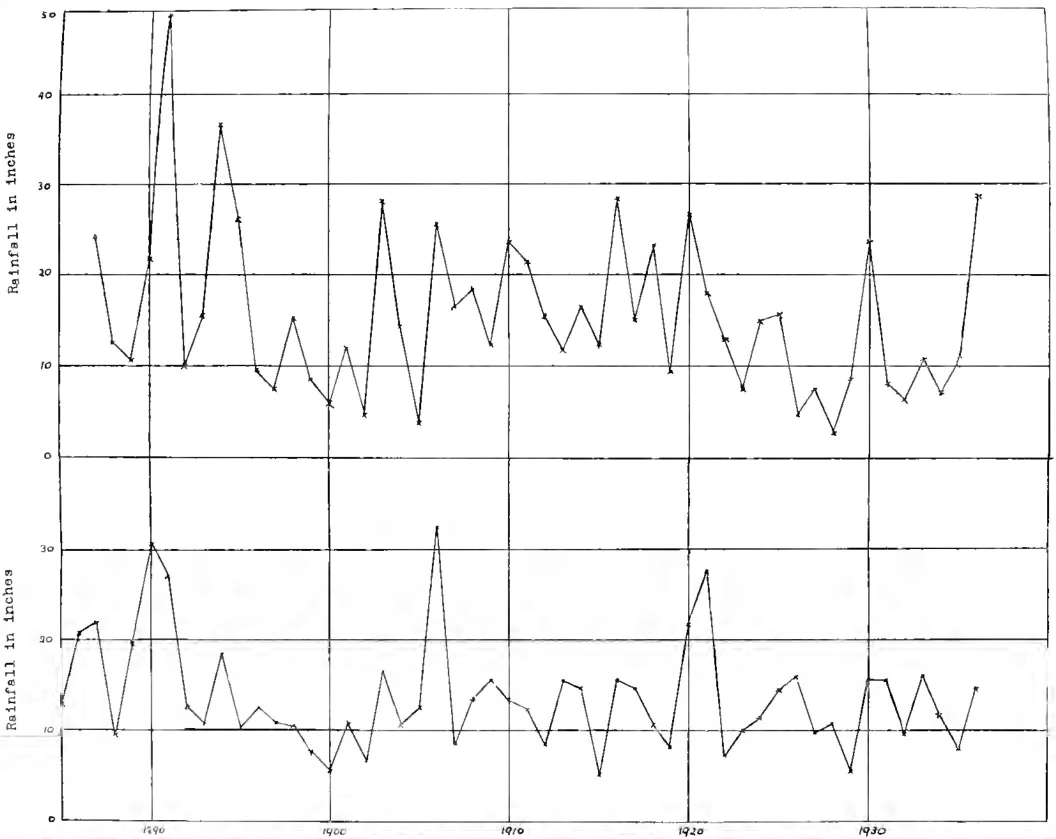
The whole of the area lies within the 30-inch isohyet and the greater part within the 20-inch isohyet, while in the far south-west the average annual rainfall falls below 6 inches. Extremes of temperature are usual. By far the greater part lies within Davidson's Desert Zone and the greater part of the remainder is within his arid zone[13] (see, however, discussion under Simpson Desert on p. 199). The rainfall is rather erratic throughout and in the south-west is sporadic. There are occasional years of heavy rainfall and frequent periods of prolonged drought.

To the north rain falls almost exclusively in summer, while to the south-east winter rains become increasingly important. No reliable data are available as to the minimum effective fall, but on the "downs" it is commonly considered that isolated falls of less than half an inch are of no value. On light soils smaller falls produce a definite response in the vegetation. It has been proved that in the very low rainfall areas of South Australia[29, 42] and elsewhere that dew is of considerable importance to plant growth, and this is probably true for parts of Queensland.



Text Fig. 1.—Graph showing average monthly rainfall throughout the year for three stations each with an average annual rainfall of about 15 inches. The full line is the graph for Mackinlay, the broken line is that of Longreach, and the dotted line that of Cunnamulla. Note the increasing importance of winter rains towards the south and the very pronounced summer rainy season towards the north.


50
40



Text Fig. 2.—Graphs showing variation yearly in rain fall for Mackinlay (above) and Cunnamulla (below).

In Western Queensland the term "season" is almost invariably used in relation to rainfall. A "good season" is a period in which rain has been sufficient in quantity and distribution to produce a good permanent growth of grass, &c., and a relative sufficiency of surface water; while a "bad season" is one in which these effects have not been attained.

Some idea of the nature of the rainfall is shown by the graphs in text figs. 1 and 2. These and also the isohyets on map 1 have been prepared from official records from earliest times to 1936.

Topography and Geology.

The greater part of the area does not exceed 1,000 feet above sea-level, and near the border of South Australia descends almost to sea-level. Much of the country consists of plains and undulating country. Many of the plain areas are alluvial in origin. The Barkly Tableland in the north-west, on which Camooweal is situated, is an extensive, nearly flat, area with a gentle southern slope. Its greatest height is about 800 feet. It is composed largely of the sometimes siliceous Georgina limestones of Cambrian age. On the eastern margin are the rocks of the Templeton Series, also of Cambrian age, consisting of sandstones, siltstones, cherts, and siliceous shales (Whitehouse[41]). Apart from a few basalt tablelands, of which the most striking is one which extends for about 100 miles in a general east-west direction from the Great Dividing Range to the north-east of Hughenden, the remainder of the non-hilly country consists of rolling downs gradually flattening out to plains in some places. These downs and plains are within the Great Artesian Basin, and rest upon calcareous shales of Cretaceous age belonging to the Winton, Tambo, and Roma Series.

There are three groups of mountainous or hilly areas. In the Cloncurry-Mount Isa district is an extensive development of rugged, frequently knife-edged ranges and hills exceeding 1,500 feet above sea-level in places, composed of a wide variety of gneisses, schists, and other rocks of Pre-Cambrian age. In the east is the Great Dividing Range running in a general north-south direction, with its offshoots—the Drummond, Warrego, and Chesterton Ranges. The rocks are of varied nature and age, but sandstones are common and gneisses occur. The eastern scarp of the Great Dividing Range is well marked, but on the westward side the country flattens out with no definite scarp. Much of the Warrego Range, with its extensions and branches, the Gowan, Cheviot, and Grey Ranges, are merely elevated regions of the rolling downs, though Tertiary sandstone hills are often associated.

Over a large part of the rolling downs and to the south-east is a great development of flat-topped ironstone capped sandstone hills and tablelands of chiefly Tertiary age in all grades of weathering (figs. 29, 11, 13.) Towards the South Australian border, the tablelands which are here scarcely 50 feet above the valleys, form with the downs a characteristic topography intermediate between the two. The whole system is frequently called the "Desert Sandstone."

Everywhere associated with the sandstone area, and particularly in the far south-west, are the gibbers (cf. figs. 5, 6, 11). These gibbers are boulders or pebbles varying in size from that of a man's head downwards. They are the fragmentary remains of the ironstone capping (duricrust) of the hills broken down by weathering, and by a continuation of the same process reduced to polished, irregularly-rounded fragments stained brown, reddish-brown, or purplish-brown by iron oxides. On the gibber plains of Sturt's Stony Desert the gibbers attain their greatest size and often form a thick layer, but elsewhere they are more usually represented by a surface layer or thin scattering of small pebbles rarely exceeding an inch in diameter and often quite small. In this state the pebbles are frequently referred to as "gidgea gravel." On the sides of the hills every stage in the weathering of the duricrust can be seen. The uppermost edge frequently assumes fantastic forms.

Superimposed on the gibber plains and elsewhere in the south-west is a big development of sand-dunes. They are in some way related to the sandstones and the gibbers, and it seems likely that they were derived from them. They have been discussed previously by Madigan[24] and Ratcliffe.[34 35] Their greatest development is in the Simpson Desert, where they form a series of long parallel ridges, usually pale-yellowish in colour, mostly 30-50 feet high, rarely if ever exceeding 60 feet, and spaced from one-sixth to one-quarter of a mile apart. The direction of their length varies from N 20° W at Birdsville to N 40° W where they cross the Central Australian border in about latitude 23° S. Between the dunes are nearly perfectly flat claypans. Crystals of gypsum, commonly known as "copi" (also spelt "copai," "kopi," and "kopai"), are frequently associated.

The direction of the dunes is governed by the direction of the prevailing wind. On their naked crests are superimposed small crescentic dunes caused by secondary winds. The latter are accordingly frequently undergoing change, and sand being shifted and blown about by the wind (fig. 21). This sand is not always blown off the the dune. In the few instances where personal observation was possible the sand was first blown off the crest and was then caught in an eddy on the leeward side and carried *up* the dune and deposited a few yards behind the point of departure. The net result is merely an alteration of the conformation of the crest.

On one occasion efforts at throwing light objects from the top of a sandhill were consistently defeated, such objects being regularly caught by these eddies and returned to the crest of the dune.

But under certain conditions sand is removed from the mass. On the edge of the desert, and sometimes at a considerable distance from any dune, small pockets of fine sand occur among the gibbers. They *may* be formed *in situ,* but it seems more likely that they are the result of sandstorms, the sand being transported in the manner described by Bagnold[1] for the Libyan Desert.

There is, however, as pointed out by Madigan,[24] a definite movement of the dunes in the direction of their length. This is well shown where the northern end of a dune is close to a watercourse where there is a tendency for trees to be buried. It is likely that this movement, comparatively slow as it is, is stopped by large streams. It is also stopped in places by low, stony ridges.

Near large streams and swampy areas the dunes tend to lose their regular arrangement.

To the north and east of the Simpson Desert proper is an area where sandhills occur different in many respects from the true desert dunes, but, nevertheless, closely related thereto. This is the "marginal country" of Ratcliffe. They are usually of a bright brick-red colour, though neighbouring hills may differ in this respect. They are scattered over the gravelly downs and alluvial flats and occasionally occur between river channels (fig. 38). Sometimes they form small clusters, very frequently small isolated dunes occur, and only rarely are they of any length. There appears to be no well-marked prevailing wind, but meteorological data on this point are lacking.

Very many of the dunes have hollows on the crest, and occasionally in such hollows masses of dune rock are exposed. From the large number of stone chips and occasional nardoo-stones and other implements found in these hollows, it is evident that the dunes were often occupied by aborigines. It is very likely that this occupation was the cause of the hollows being produced by wind eddies.

There is generally a limited area surrounding the dune or dune complex covered by sand. Beyond this area no sand is to be found (fig. 25). Within the dune mass small claypans may occur, and they may retain water for a considerable time (fig. 26).

Still further away from the desert the sandhills gradually lose their individuality, finally being represented merely by small sandy patches. These will be discussed below in dealing with the vegetation.

Drainage and Surface Water.

Several long rivers belonging to the four great drainage systems of the State traverse this part of the country. Though of noble proportions in times of flood, yet for a large part of the year they are little better than a string of waterholes. Those rivers with sandy beds are frequently quite dry for long distances, though water can be obtained without much trouble by digging. Such streams are the Flinders and the Maranoa.

The comparative paucity of surface water has exerted a powerful effect on the history of pastoral settlement, and accordingly the effect of the latter on the vegetation. But important changes followed on the discovery and wide utilisation of artesian water. Both artesian (flowing) and sub-artesian (non-flowing) bores are numerous. With flowing bores it is the general practice to lead narrow drains (bore-drains) from the bore-head over the country, sometimes for many miles, making use of the undulations of the ground to traverse as large an area as possible before they are finally led into a stream bed. The presence and lay-out of the drains are, of course, of inestimable value to the grazier, as they assure him of a permanent water supply for his stock. At the same time they indirectly control the nature of the pasturage by controlling the movements of grazing animals, and even produce a few distinctive communities of their own.

The construction of earthen tanks in many places has likewise been a factor in vegetation control by controlling the movements of stock, and perhaps also by the divergence of rain water.

The average fall of the rivers is about 12 inches per mile, and in the lower courses may be considerably less. The stream is not restricted to a single channel as a rule, but is divided among several. In times of flood these channels overflow and their united waters may spread for many miles, thoroughly saturating the soil and depositing silt. The rate of flow of such water is very slow. Fig. 39 shows a portion of the Diamantina River after the flood waters had receded a considerable distance.

The country between the channels is referred to as "channel country," and that affected by flood waters as "flooded country." Some of the large lakes of the south-west, such as Lake Yamma Yamma and Lake Machattie, are large areas of flooded country.

A few centres of inland drainage occur, giving rise to lakes of a different nature. Nearly all are more or less brackish, Lake Buchanan particularly so, producing a heavy thickness of salt in drying up. The other important lakes of this type are Galilee, to the north-east of Aramac and south of the previous, and the Dynevor Lakes, between Eulo and Thargomindah.

Soils.

So far there has been little detailed work done on the soils of the area. Profiles have been studied in very few places indeed. Most of the present discussion is based on my samples of surface soils now in the Department of Geology of the University of Queensland, supplemented by field notes. This is indeed the only source for a great part of the area. For the area between St. George and Cunnamulla I have had the assistance of Dr. F. W. Whitehouse, who has kindly placed his unpublished field notes at my disposal. For some localities I have relied entirely upon his work. Dr. W. H. Bryan has assisted me in classifying the soil samples.

There is a fairly sharp distinction between sandy and non-sandy (heavy) soils, and these are closely correlated with rock type. The line of demarcation between the two is often remarkably sharp, as is shown in fig. 1. This line of division between the so-called "desert" and the "downs" is one of the most remarkable and most important features in the State.

Prescott[31] recognises ten major soil types as occurring in Australia, and in a later publication[32] figures profiles. Five of these types are indicated as occurring in our area. These are the desert soils, the soils of the semi-desert and desert steppe, the black earths, grey and brown soils, and podsolised soils. To these must now be added his lateritic sand plain. True alluviums are also widespread.

The first type embraces the desert sands which have been discussed above. The soils of the semi-desert appear to be represented by a development of deep, excessively fine-grained, bright-reddish sandy loam extending from east of Cunnamulla to Thargomindah. Whitehouse considers this to be a fossil alluvium. It is readily affected by the wind when the plant cover has been removed. For reasons detailed below I do not consider the gibber and gravel plains to belong to this type, but to the brown soils.

The black earths and the grey and brown soils are collectively known in Queensland as "black soils," a term also used to designate such alluvial soils as are very sticky when wet. True black earths occur widely in the Clermont-Springsure belt, extending east, south, and somewhat to the west. In some places they occur patchily. They are derived both from basalt and from shales. In the extreme north, similar soils occur on the basalt tableland to the north and north-west of Hughenden, and near Prairie. (Slightly to the north-east of Hughenden and to the north of Springsure soils of a much lighter texture are derived from vesicular basalt. In the latter case a thin sandy soil is produced. Both must be regarded as very exceptional cases.)

Grey and brown soils are of wide occurrence. They are the typical soils of the rolling downs and the Barkly Tableland, and extend to the Stony Desert. They are chiefly clay loams, clay silts, and silt loams, rarely becoming somewhat sandy, and then chiefly on the crests of undulations. There are two well-defined types within the group. What appears to be the typical grey soil is friable, contracts greatly on drying, and distinctly grey in colour. The other, which is invariably associated with gidgea gravel, is much less friable and distinctly yellowish-brown in colour. This type characterises the "gravelly downs" and underlies the gibbers of the gibber plains. In an area to the west of Betoota the soil is remarkably fine and incohesive, and is known locally as "bull-dust."

Large tracts of sand, apparently comparable in nature with the lateritic sand plains of Western Australia, occur between the Balonne and the Warrego Rivers, and to the north-east, south-east, and west of Windorah.

Part of the large sandy area associated with the Great Dividing Range also appears to be comparable, while modifications occur in the neighbourhood of Quilpie and Adavale.

Podsolised soils occur in the north and central-east, in the former case alternating with lateritic soils.

Over a considerable part of our area occur the formations known as claypans. These are flat expanses with a hard, more or less polished surface, and usually devoid of permanent vegetation. They are of regular occurrence between the sandhills of the Simpson Desert and are frequently found beside stream channels. Another development is found in the Cunnamulla district on old alluvium. Claypans may also be found under other conditions.

Both impregnation by salts and scouring by wind and water seem to be important factors in the production of claypans. Before wind can play a part a bare surface has to be produced by drought or other means. Some are merely the dry beds of large shallow lakes.

The soil of claypans varies, but is usually silty in nature and nearly impervious to water. Frequently there appears to be little, if any, difference between the soil of a claypan and the soil of an adjacent well-vegetated patch, but no detailed work has been done in this direction. In many claypans there occur small patches of a slightly different nature, frequently sandy, and these often support vegetation. The appearance is produced of small islands scattered about the claypan, an effect which is enhanced when water is lying on the claypan (fig. 14).

While soil-erosion has no doubt played a part in the formation of some of these claypans, erosion on a large scale appears possible only on two types of soil. In each case it is dependent on the destruction of the plant cover. Soil drift is very noticeable on the reddish sandy loam west of Cunnamulla under such conditions, and can occur on the sandy tracts near Windorah. It is likely to occur also in the timbered sandy country in the south-east if wholesale clearing is allowed to continue.

Erosion due to water is important in places on the rolling downs, chiefly as gully erosion. Water erosion in these places is a natural and inevitable phenomenon, and through long periods of time has produced the marvellously rich "channel country." In some places, however, such erosion has become serious, due to the combined effects of trampling by stock and drought. These cases are discussed below when dealing with the effects of stock on vegetation.

There is no evidence whatsoever for the contention that an encroachment of the desert is in active progress as alleged by Hirschfeld.[22]

Vegetation.

The major factors influencing the vegetation appear to be soil type, incidence of rainfall, and drainage. As periodic droughts are experienced, it is perhaps natural to find that many species, apparently the more highly drought-tolerant or drought-escaping, enjoy a wide geographical range. Towards the south, as the winter rains increase in importance, a marked change in the floristic detail takes place. Other important factors influencing distinctive community formation are the remarkably sharp western boundary of the sandy soil associated with the Great Dividing Range, the distribution of the desert sandstone, the increasing aridity towards the south-west, the trend of the rivers in this direction, and the effect of settlement. The effects of the white man and his introduced grazing animals are not capable of exact estimation, but in many cases they are very pronounced and distinctive communities have resulted. It is convenient to classify these as induced communities as does Cockayne.[11]

The terminology here employed calls for some explanation. It has been usual for non-Queenslanders to describe the *Eucalyptus*-dominant communities of Queensland as "savannah" (savanna), or more frequently "savannah woodland," as for example Prescott,[31] and Domin[15] ("savannenwälder").

In Queensland they are commonly referred to as eucalyptus forest, or, particularly if other tree species are important, as "open forest," or simply "forest." The first has been employed by Warming.[38] The grasslands have been variously described as "savannah," "grass steppe," "open grassland," "downs," and "plains."

Owing to the loose application of the term "savannah," both in Australia and elsewhere, it has seemed advisable to employ the terms "eucalyptus forest" to those communities dominated by species of that genus and in which the trees are fairly close together, and "eucalyptus parkland" to those in which the trees are more scattered. Although in such eucalyptus forests grasses are always prominent, they rarely bear any relationship to neighbouring grassland species.

The use of the term savannah is here restricted to a type of grass-dominant community with scattered shrubby trees usually of a stunted appearance. There appears sufficient precedent for such usage, though it includes part of Prescott's "sclerophyll scrub."

Scrub is here used in its generally accepted sense of a closed association of small trees or tall shrubs, and frequently consists of pure stands of individual species. In many cases, however, some of these scrubs should be described rather as forests if tree height be any criterion. However, for the present at any rate, the local usage will be followed in this respect.

The descriptive names of the individual communities have been selected, so far as freedom from ambiguity permitted, from terms in common use. Where practicable also, vernacular names of plants have been introduced, but it must be stressed that many of these are used very loosely, and variations in spelling may be found. Apparently many of the incongruities present in McTaggart[25] are the result of an attempt to identify plants by means of local names alone.

The chief community types recognised as occurring in our area can be arbitrarily arranged as follows:—

A. Primitive Communities.
- I. Grasslands.
- II. *Triodia* communities ("Spinifex country").
- III. Regional Forests.
- IV. Scrubs.
- V. Fringing Forests and Scrubs.
- VI. Channel Country.
- VII. Communities dominated by Chenopodiaceae (Saltbush, &c.).
- VIII. Communities of the Sandhills.
- IX. Miscellaneous communities of the more arid regions.
- X. Miscellaneous communities of the Great Dividing Range.

B. Induced Communities.
- XI. Artificial grassland.
- XII. Communities of the Bore-drains.
- XIII. Communities of the Stock Routes and Reserves.
- XIV. Introduced species.

A. PRIMITIVE COMMUNITIES.

Strictly speaking, primitive communities are communities which have not been affected by and are not the result of man's action. All, or nearly all, primitive communities have been modified in some way or other, and owing to the practical impossibility of determining exactly how much modification has taken place, it has been found convenient to group together here those communities which have not been profoundly affected by man's activity.

The importance of railway enclosures and cemetery reserves in arriving at a concept of truly primitive vegetation is discussed below.

I. Grasslands.

In grasslands tall woody plants are nearly or quite absent. Trees, when present, are mostly stunted, usually very scattered, but sometimes numerous enough to produce parkland.

According to the dominant genus the grasslands fall into three well-marked groups:—

1. Blue grass country with *Dichanthium sericeum* (blue grass) dominant.
2. Mitchell grass country with *Astrebla* spp. (Mitchell grasses) dominant.
3. *Triodia* grasslands, which are more conveniently described below.

The Blue-grass Grasslands (fig. 2).

These are characteristic of the better rainfall areas and the soil is usually a black earth. The grasses are tufted species, the tufts being very leafy, fairly close together, and not very large. The more prominent species are less fibrous and shorter lived than the dominant species of the other grasslands. They are numerous and frequently two or more are co-dominant. The most characteristic are the blue grass (*Dichanthium sericeum* and certain closely allied forms), *Bothriochloa erianthoides* (satin top, silver top), *Paspalidium globoideum* (shot grass, sago grass, tapioca grass), *Panicum decompositum, P. queenslandicum, Digitaria divaricatissima* (all known as star grass, a term also applied to *Chloris* spp.), and *Thellungia advena* (water grass). Other characteristic plants are *Ixiolaena brevicompta,* generally known as "chamomile" and highly esteemed as a fodder plant, *Caspedia uniflora, Sida pleiantha* and other species, various legumes such as species of *Indigofera* and *Neptunia,* and others.

Two climatic subtypes occur. The southern zone lies chiefly in the Darling Downs district and lies beyond the scope of the present paper. With a pronounced winter rainfall, the genera *Danthonia* and *Stipa* with *Aristida leptopoda* are important. *Themeda avenacea* is also important in places. This species, though widespread, elsewhere rarely occurs in grassland.

In the northern zone *Stipa* and *Danthonia* are absent, and *Astrebla* and *Iseilema* occur, usually sparsely and frequently as the result of invasion. *Aristida leptopoda* is common in places and is alleged to have been introduced by stock from further south, whence its usual vernacular name of "Darling Downs spear grass."

On small bare places are to be found such species as *Brachyachne convergens* and *B. tenella, Enneapogon nigricans* ("fluffy top" is one name in common use), *Tragus biflorus,* and a few other grasses, together with *Portulaca intraterranea* (pigweed), *Trianthema crystallina, Tribulus terrestris, Atriplex semibaccata, Euphorbia Drummondii* (caustic or caustic weed), and *Boerhaavia diffusa* (tahvine). *Chenopodium album** (fat hen) is seasonally prominent, sometimes attaining considerable height.

Degradation of the pasture gradually results in the progressive dominance of the comparatively worthless *Panicum decompositum,* often with *Aristida leptopoda* common.

For the most part blue grass country is treeless (except along watercourses), but its continuity is broken by patches of forest on differing soils, and occasional trees stray into the grassland. These are principally *Eucalyptus populifolia* (box), *E. melanophloia* (ironbark), and *E. terminalis.* The weeping myall (*Acacia pendula*) sometimes occurs chiefly on the forest edge, usually as copses (scrubs). Isolated brigalow (*Acacia harpophylla*) scrubs are not uncommon.

The Mitchell grass Grasslands (figs. 3, 4, 6-9).

Mitchell grass dominates very large areas of plains and rolling downs on soils belonging to the group of grey and brown soils. Considerable areas also occupy old alluviums, which are usually strongly silty. Over a very large part of these plains and downs trees are completely absent except along the deeper watercourses. *Acacia farnesiana* (mimosa or prickly acacia) occurs as scattered compact shrubs of 6-8 feet or so along shallow gullies in the north and north-east.

Over much of the country, however, trees are more or less prominent. They are confined almost entirely to the following species:—*Atalaya hemiglauca* (whitewood), *Ventilago viminalis* (vine tree or supple jack), *Flindersia maculosa* (leopard-wood), *Owenia acidula* (emu-apple or gruie), *Apophyllum anomalum* (mustard bush), *Acacia Cambagei* (gidgea, gidgee, gidyea, gidya, giddia, or gidiya), *A. homalophylla* (boree), and *A. pendula* (myall or weeping myall).

Of these whitewood, vine-tree, gidgea, and boree are widely spread, while emu-apple, leopard-wood, and mustard bush occur chiefly in such

* Introduced.

places as the crests of those undulations as have a shallow slightly sandy soil. Myall occurs only towards the south-east, and usually on the edge of grassland as described above. All with the exception of gidgea are useful fodder plants, and even this is eaten.

Whitewood is usually a small tree with grey scarcely fissured bark, and an open somewhat irregular crown of pinnate glaucous leaves. In its very young stages the leaves are very coarse and frequently simple. Under certain conditions, particularly when in flower or young fruit, it may be poisonous, but nowhere in our area is walkabout produced as in the far north-west of the State or in the Kimberley district of West Australia. (Murnane and Ewart.[27])

Vine-tree commences life as a cluster of two or more slender stems which later on intertwine to produce the characteristic trunk-system. The crown is usually dense and weeping, of a dark dull green, but small stunted shrubs are common. It is one of the best forage trees.

Boree is mostly a straight tree with a rather light grey somewhat fissured bark, and a rather sparse somewhat obovate crown composed of numerous crownlets of glaucous narrow pendulous phyllodia.

Gidgea is usually a dull glaucous bushy-headed tree with dark grey fissured bark, but occasionally approaches boree in appearance. The flowers always, and the phyllodia when moist, have a powerful somewhat foetid odour.

Leopard-wood commences life as a divaricate prickly shrub, from the centre of which arises the characteristic slender trunk with its smooth mottled grey and cream-coloured bark and rather dense oblong crown of small simple scented leaves.

Mustard-bush, when mature, has a comparatively short, sometimes irregular, trunk with dark grey hard furrowed bark, and a dense rounded leafless crown of long, rather rigid, but more or less pendulous, somewhat flexuose dull green branchlets. The spiny stipules prominent in the younger plants are usually small or rudimentary.

The emu-apple is a small shapely tree with a very dense rich-green crown of pinnate leaves and a strong tendency to sucker.

The characteristic grasses are the four species of *Astrebla* (Mitchell grasses), *Eulalia fulva* (brown top, sugar grass), and *Eragrostis setifolia* (never-fail). *Dichanthium sericeum* (blue grass) occurs over the areas of better rainfall, and is fairly common at times.

These species of *Astrebla, Eulalia,* and *Eragrostis* are all long-lived species with short thick branching rhizomes closely covered by shining horny scales. They form dense tussocks, withstand heavy grazing, have the ability to sprout from the lower nodes, and respond very rapidly to rain. The *Eragrostis* is the least palatable.

In normal grassland these tussocks are spaced from 1½ to 3 feet apart, rarely closer.

In *Astrebla,* the older leaves are flat and more or less recurved when dry, and of a characteristic whitish colour. When in full vigour they are usually of a rich green, though a tendency to glaucousness is shown in *A. pectinata* and *A. elymoides.* They flower freely, but seed sometimes fails to mature, partly due to insect attack, and perhaps due partly to local climatic variations. A smut, *Tilletia* sp. aff. *T. fulva,* has been found near Dirranbandi. The awned spikelets are readily transported by stock. Contrary to general opinion the grain germinates freely and under a variety of conditions. The young seedlings are, however, readily torn up by stock. As a rule the old plants are not grazed until the other plants of the pasture are eaten.

The species vary somewhat in habit. *A. squarrosa* (bull mitchell) and *A. pectinata* (barley mitchell) produce erect-growing tufts with comparatively short, dense, bristly inflorescences, the former attaining 4-6 feet, and green, the latter mostly about 2 feet, and somewhat glaucous. Distinct races are included in the other species, but both are more spreading in habit. The leaves of *A. elymoides* (weeping mitchell or hoop mitchell) are frequently slightly glaucous and dry off before those of any other species. The flowering culms are long, very slender, and weakly spreading or strongly flexuose. *A. lappacea* (common mitchell or curly mitchell, sometimes also downs mitchell) is rather intermediate in habit with a stouter inflorescence.* The leaves show a more pronounced tendency to curl when dry than in the other species.

Eulalia fulva forms erect, leafy tufts of varying height with a tawny or bright-brown inflorescence of two or more erect or slightly oblique closely appressed densely but shortly hairy racemes. The old leaves are flat and reddish-brown in colour.

Eragrostis setifolia forms rather compact tufts rarely attaining 2 feet, with rigid inrolled sometimes slightly pungent leaves.

Ungrazed vigorous areas of the more spreading species may show an almost complete though undulating cover when viewed from a short distance, but otherwise the tufts are very distinct. Under suitable conditions the spaces between the tufts are closely occupied by a rich variety of short-lived perennials or facultative perennials and ephemerals belonging to a variety of families, chiefly grasses, *Chenopodiaceae, Malvaceae, Leguminoseae,* and *Compositae.*

The chief grasses are *Iseilema* spp. (Flinders grasses),† *Panicum Whitei* (pepper grass or pigeon grass), *P. decompositum* (variously but inconstantly known as star grass, windmill grass, and sometimes as neverfail), *Eriochloa* spp. (sometimes known as summer grass), *Chloris divaricata, C. truncata* (both known as star grass), *Aristida latifolia* (feather top), with *A. leptopoda* and other spp. in the south, *Enneapogon avenaceus, E. Lindleyanus, E. nigricans* (white top, fluffy top), *Dactyloctenium radulans* (button grass), *Sporobolus australasicus, S. Caroli* (both known as fairy grass), and *S. actinocladus.*

Of the chenopods the most important are *Salsola australis* (roly poly), *Atriplex* spp. (salt bushes and salt weeds), *Bassia* spp. (goathead, prickly bush or roly poly, red and other burrs, &c.), *Kochia coronata, Threlkeldia proceriflora,* and the shrubby *Chenopodium auricomum* (blue bush), and *Rhagodia parabolica.*

Among the legumes the following are important:—*Sesbania Benthamiana* (sesbania or sesbania pea), *Rhynchosia minima, Crotolaria dissitiflora, Glycine falcata, Psoralea graveolens, P. cinerea, Indigofera* spp., *Aeschynomene indica, Neptunia* spp., and *Cassia* spp. (including some shrubby spp.).

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* One race approaches *C. elymoides* rather closely.

† These have been discussed in a previous paper (6).

The *Malvaceae* are numerous in individuals belonging to the genera *Abutilon* (chiefly *A. malvifolium*), *Sida* (*S. virgata, S. corrugata,* and others*), *Hibiscus* (*H. trionum, H. brachysiphonius, H. ficulneus,* this last being known as wild rosella), and *Malvastrum spicatum*.

Some of the composites are *Calotis hispidula* (martagai, bogan flea, or bindey-i), *C. scapigera, C. lappulacea,* and other spp. (bindey-i, daisy burr), *Brachycome* spp., *Helipterum* spp., *Rutidosis helichrysoides, Gnaphalium indicum,* &c.

Among other families the following spp. are important:—*Trianthema crystallina* (bastard pigweed), *T. decandra, Portulaca* spp. (pigweed), *Amaranthus Mitchellii* (bogabri, smooth roly poly), *Corchorus trilocularis* and spp., *Euphorbia Drummondii* (caustic or caustic creeper) and spp., *Daucus brachiatus* (carrot), *Plantago varia* (lamb's tongue), *Solanum esuriale* (wild tomato), *Ipomoea Brassii* (cow-vine) and spp., *Boerhaavia diffusa* (tahvine), and *Eremophila maculata* (native fuschia—a low shrub).

The annual and sub-perennial vegetation is of the greatest importance, for upon its nature depends the value of the pasture. The great value of Mitchell grass lies not so much upon any high nutritional qualities it possesses, but upon the fact that the plants do not break up when dry, and while in that state are still acceptable to stock, and retain sufficient nutriment to carry stock long after the other plants have been eaten off or in times when drought has hindered the development of other plants. Such a pasture is in reality a paddock of standing hay. In mixed pasture it is usual for Mitchell grass not to be grazed until the other members of the pasture have been eaten, and indeed, there is sufficient evidence to show that in some localities, at least, pure Mitchell grass has little value for fattening.

The plants other than grasses are popularly referred to under the collective term "herbage," and the broad distinction is useful.

The shorter-lived vegetation varies tremendously in composition, and several minor communities are distinguishable. The nature of these is a reflection, not only of minor variations of surface and drainage, but very largely of "season" and of stocking in previous years. These communities can thus be designated "indicator communities." Incidence of rainfall also plays a very big part in determining the communities, summer and early autumn rains tending to produce grass growth, while winter rains usually produce a preponderance of herbage. But there is no absolute rule, and in the more arid parts the actual amount of rain that falls seems to be the most important factor. Light rain in winter frequently results in the so-called "blackening" of grass, rendering it brittle and unpalatable. (Blake[5, 6]).

The *Astrebla* grasslands are by no means homogeneous, even when certain local variations are neglected. There are several well-marked types which may be arranged in three groups characterised by differences in soil type, dominant species of *Astrebla,* nature of the chenopods if present, reaction to stocking, and other features. Probably when the floristic detail has been adequately studied, it will be found that these types can be defined in other terms as well, and perhaps further subdivided.

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* Some are undescribed.

1. The Ashy Downs Group.—On the typical "ashy downs" which occupy the north and east portions of the Mitchell grass communities (fig. 3), the soil is grey to dark-grey in colour, very fine-grained, friable, and nearly free of gravel. When dry it opens out in large deep cracks, and swells considerably when wet. Trees are usually absent; when present they are restricted to sparsely scattered, more or less stunted whitewood or vine tree, or occasional shrubs of *Acacia sentis* (gundabluie). *Astrebla pectinata* is rare or absent, chenopods are restricted to *Salsola*, though *Atriplex Muelleri* occurs as a product of degradation, and *Iseilema* is well represented, both in species and individuals. In most years herbage is comparatively scanty.

On badly-drained areas *A. squarrosa* is the dominant species. This is the "bull mitchell country" so characteristic of large areas in the neighbourhood of Nelia, Nonda, and Julia Creek. *A. elymoides* (weeping mitchell), *Eulalia fulva* (brown top), *Chenopodium auricomum* (blue bush), and other plants of damp places such as *Iseilema convexum, I. calvum* (Flinders grasses), *Eragrostis leptocarpa, Cyperus Gilesii, Sesbania Benthamiana* (sesbania), *Neptunia* spp., and *Minuria integerrima* are associated.

On better drained country the characteristic species are *Astrebla lappacea* (common mitchell) and *A. elymoides* (weeping mitchell) often as alternes. On the rolling downs this is the characteristic community, frequently with small bull mitchell communities in the depressions.

Related to the true ashy downs are areas to the north and north-west of our area, but represented in part by the country near Camooweal. Bull mitchell is the characteristic grass, but the other species may all be present in some proportion. A large glaucous species of *Eriachne* occupies the smaller channels. To the north, towards the Gulf of Carpentaria, other communities dominated by bull mitchell grass occur, but they lie without the scope of the present paper. All these communities have one character in common; the dry grass does not support stock in the same way as it does further south.

2. A south-eastern development, which may be regarded as the extension of the ashy downs to the regions of higher or more evenly distributed rainfall. In places a gradation to blue grass is shown, a feature which will be dealt with in more detail when discussing the relationships of the grasslands.

The soil is frequently a black earth, and the characteristic species are *Astrebla lappacea, A. elymoides, Aristida leptopoda,* an undescribed species allied to *A. muricata, Thellungia advena, Panicum queenslandicum, Paspalidium globoideum,* and other grasses, while *Calotis scapigera, Brachycome* spp., and *Sida pleiantha* are among the herbage plants. *Iseilema* is represented chiefly by *I. membranaceum,* though *I. vaginiflorum* occurs in places. In depressions *Panicum prolutum, Eragrostis parviflora, E. leptocarpa, Cyperus bifax,* and an undescribed species allied to *C. Gilesii* and *C. fulvus* are prominent.

Myall, either as scattered trees or "scrubs," occurs in places, but in many instances has been destroyed.

On the basalt tableland to the north and north-west of Hughenden a community of a very similar grass composition occurs, though *Iseilema* is represented also by the northern *I. Windersii.*

There is a type of community botanically related to both ashy downs and gravelly downs which is to be found on areas of old alluvium near Cunnamulla and elsewhere (fig. 4). The soils are sometimes somewhat yellowish in colour, claypans are frequent, but though chenopods are frequent at times the plant composition is rather of the ashy downs. It has been described by Francis.[19]

3. The Gravelly Downs group (figs. 6-9).—The gravelly downs (also called stony downs and pebbly downs) takes its name from the fact that the soil, a yellowish brown to light chestnut clay silt or clay loam (rarely somewhat sandy), is invariably associated with gidgea gravel, and is more compact than that of typical ashy downs. Towards the South Australian border, the gravelly downs grade imperceptibly into Sturt's Stony Desert.

A characteristic feature, particularly of the more arid parts, is the occurrence of small, shallow depressions, comparatively free from gravel, which are known as "crab-holes" or "gilgais."

The dominant grass is *Astrebla pectinata* (barley mitchell). In the less arid parts the other species are usually associated to some extent, and *A. lappacea* is often locally dominant, while it is to be found occasionally in the drier parts. Annual species of *Bassia* and *Atriplex* are very characteristic of the gravelly downs, sometimes mixing freely with the grasses and other herbage, sometimes forming definite communities as described below and then alternating with portions of the grass community (fig. 7). Within the gravelly downs as thus defined, three broad trends may be recognised. In two of these there is a fairly close and regular ground cover, and the bull mitchell community above described occurs in some form or other in depressions (fig. 8). In one trend *Acacia Cambagei* (gidgea) is prominent, either as the scattered scrubs described below, or as more scattered trees (gidgea downs). In the other trend boree (*Acacia homalophylla*) appears as scattered trees tending to form a parkland (boree downs). Very frequently there is an intermediate state (gidgea-boree downs) (fig. 9). Except for an isolated area near Hughenden, where chenopods (except *Salsola*) are rare, the characteristic species of *Bassia* are *B. lanicuspis* on the gidgea downs, and *B. anisacanthoides* and *B. echinopsila* on the boree downs.

The third trend is found in the area within the 10-inch isohyet. The vegetation tends to restrict itself to the margins of the crab-holes and along gullies, while large areas are at times quite devoid of plant life. The characteristic *Bassia* is a form closely allied to *B. divaricata* and *Atriplex Muelleri,* so common elsewhere, is rare or absent. A typical crab-hole near Haddon's Corner (fig. 6) carries at its margin *Astrebla pectinata, Sporobolus actinocladus, Panicum decompositum, Bassia* sp. aff. *B. divaricata, Atriplex spongiosa,* and *A. conduplicata.* Except for a comparatively small area to the north of Birdsville (fig. 12), where occur scattered plants of the very peculiar almost pine-like "waddy" *Acacia Peuce,* with its exceptionally hard and heavy wood, trees are absent or represented by occasional shrubs of *Acacia tetragonophylla* (dead finish) or *Cassia* spp. At the head of gullies in the low ridges an occasional shrub of the handsome *Eremophila Latrobei* occurs, to be replaced lower down by *Acacia cyperophylla* (minaritchie) and still lower down by gidgea. *Acacia cyperophylla* appears to be restricted to the east and south of the Diamantina River, so that between Birdsville and Boulia much of the upper part of the gully is bare of shrubs.

On the little pockets of drift sand among the gibbers in areas adjacent to the Simpson Desert, a varied and interesting plant population frequently occurs. Mitchell grass (the usual *A. pectinata*) may itself occur here, though more frequently the plants are shorter-lived species, such as *Iseilema eremaeum* (restricted apparently to this area), *I. vaginiflorum, Stenopetalum lineare, Goodenia* sp., *Bassia* spp.

II. Triodia Communities (figs. 28-33).

Triodia is a genus of grasses restricted to Australia, and widely known as "spinifex"* or "porcupine grass." From many points of view it is a very interesting group, closely allied to both *Astrebla* and *Danthonia,* but differing widely in habit from nearly all other grasses. The culms are freely branched below, and the plants form dense tussocks, or large somewhat hemispherical hummocks, spiny by reason of spreading, hard, rigid, often rather long, more or less strongly pungent leaves, which are for the most part convolute and apparently terete. The hummocks may attain six feet or more in diameter and four feet in height, though usually they are smaller than this. The flowering culms, borne one to three feet higher, are usually exceedingly numerous, but the flowering period is brief, and appears to be dependent on rainfall. The seedlings commence to branch when very young; old plants frequently die in the centre, the hummocks then assuming an annular or crescentic or even an S-shaped form. The production of stolons is common, but this feature appears to depend to some extent on habitat, and is not constantly specific in nature.

Some species are very viscid, with a strong resinous odour. These produce mostly compact green tufts with less pungent, less rigid, but often longer leaves than is usual in other species, and are rarely stoloniferous. This type is sometimes referred to as "turpentine grass" or "turpentine spinifex."

All species are readily inflammable when green. The less pungent species have a distinct fodder value dependent largely on their extreme resistance to drought and the readiness with which they put forth fresh growth after rain or burning. The grain is an excellent stock food, particularly for cattle and horses. The resin was used by the aborigines in preparing cements. The upturned plants have been used as bed-mattresses. The sand-dwelling species are most important agents in preventing soil-drift.

The genus is widely spread in Queensland, and is to be found occupying a great variety of habitats. The species enter into the formation of several distinct communities, usually referred to collectively as "spinifex country." These communities are usually exceedingly xerophytic in appearance, but curious anomalies occur, chiefly outside our present limits. True trees are nearly always absent, but crooked or gnarled, single- or several-stemmed shrubs or tree-shrubs are not uncommon, particularly species of *Acacia, Hakea,* and *Eucalyptus,* the latter thus partaking of the mallee-form. As pointed out below, gradations to true *Eucalyptus* forest occur, in which *Triodia* is present merely as a member of the ordinary grass-flora of the latter. Occasionally a type of grassland or steppe is produced, in which the species of *Trioda* are the tallest members of the community.

* Not to be confused with the genus *Spinifex.*

In the typical *Triodia* communities, the hummocks of *Triodia* completely dominate the landscape. A complete cover is never attained, though occasionally the edges of the plants are sufficiently close to prevent a person from walking between them with any degree of comfort. Usually, however, the plant masses are much further apart. Between the masses various perennial and numerous annual plants, often small, find a footing. An undescribed creeping species of *Neurachne* is widespread, and is noteworthy from the fact that it is one of the two distinctly creeping grasses indigenous in Western Queensland.

The species of *Triodia* do not as a rule mix, but alternating stands are common. It seems probable that some species are very sensitive to variations in the substratum, but owing to the present chaotic state of the genus it is not possible to discuss these in detail.

The habitats are frequently highly siliceous in nature, either sand or sandstone or acid volcanic rocks, but siliceous limestone and silt beds are also supporters of such communities.

Several well-marked major communities are known, and there occur numerous small or scattered ones in special habitats. The more important are as follows:—

1. The grassland community of the north-west. This is found on undulating siliceous Cambrian limestone east of Camooweal and north-east of Duchess. The surface is stony, and there is scarcely any soil, though in the hollows small patches accumulate which support Mitchell grass, chiefly, if not entirely, bull mitchell. The community is very poorly known. In the Duchess development, *T. pungens* appears to be an important species. The species of the other area are unknown, but at least two are important. Annual plants, such as species of *Enneapogon*, *Eriachne*, *Polycarpaea*, &c., are common after rain. *Trichinium* is well represented. The mallee-like *Eucalyptus leucophylla* occurs in places, sometimes as a prominent member of the association. There appears to be a definite gradation to the following.

2. The *Eucalyptus pallidifolia* - *E. leucophylla* - *Triodia* community (mountain gum—spinifex country) (fig. 32). This is well developed on the rugged mountainous country of the Cloncurry—Mount Isa district. Except in the valleys where there is a varying depth of fine sandy or loamy soils, reddish in colour, soil is practically absent. The characteristic "trees" are *Eucalyptus pallidifolia* (mountain gum or snapping gum) and *E. leucophylla* (generally, though incorrectly, known as coolibah). The mountain gum usually produces a cluster of two or more rather crooked or spreading rather slender trunks with a pure white smooth bark, and a sparse crown of rather small glaucous leaves. It is specially characteristic of the hills, and is invariably associated with *Triodia*. Its timber is very brittle. *E. leucophylla* is of somewhat similar growth-form, but the bark is a brown or grey shortly fibrous "box" bark, the leaves are longer and the young growth is very glaucous. The species occurs on the low ridges, but is particularly characteristic of the valleys and flats.

Another eucalypt, *E. pruinosa* (silver box, silver-leaved box, silver leaf), occurs near the north and north-eastern edge, but is more characteristic of a very different community to be described in a later paper. It is usually stouter than the preceding species, with a dark grey, rugged, somewhat coarsely-flaky bark, and large rounded opposite sessile silvery leaves. In the present case it occurs chiefly on lower ground often where *Triodia* tends to be partly replaced by *Aristida*.

Frequently on the more rugged peaks and scarps are to be found isolated trees of *Sterculia australis* (bottle-tree), where it makes a striking spectacle with its very stout, swollen trunk and dense green crown of deciduous leaves.

Other characteristic shrubs and small trees of the community are *Terminalia aridicola, Ficus opposita, Eucalyptus pyrophora* (bloodwood), *Eremophila* sp. nov. (?), *Cassia* spp., and several species of *Acacia,* including the ubiquitous gidgea. *A. costinervis* is the most striking of these. It is a handsome fastigiate shrub with curly, flaky, reddish and grey bark, rich green viscid phyllodia, and when in flower, with a profusion of brilliant yellow spikes.

Several species of *Triodia* occur. Of these *T. pungens* is very abundant over large areas, but on the more precipitous slopes is at least partly replaced by two much more pungent non-stoloniferous species. *Eriachne* is a characteristic genus, and particularly the series of forms described under the names *E. mucronata* and *E. scleranthoides.* In its extreme form the latter is a peculiar grass, forming small dense patches among rocks in the more rugged places. The culms are only a few inches long, but are closely covered by several short slightly recurved rigid pungent, convolute leaves, and a very short inflorescence of one or very few spikelets.

Several plants are viscid, some strongly so. Among the most striking are the abovementioned *Triodia pungens* (some forms only) and *Acacia costinervis,* two smaller species of the same genus, the annual *Polanisia viscosa,* and the following grasses and sedges:—*Eragrostis desertorum, Enneapogon asperatus, Cyperus ixiocarpus, C. Cunninghamii,* and *C. xerophilus.* The latter is associated with *Eriachne scleranthoides.*

Other important species are the glaucous, leafless, bushy or climbing *Sarcostemma australe* (caustic bush or caustic climber), with its cylindrical, somewhat fleshy stems, various species of *Abutilon,* with their handsome lemon-yellow or deeper yellow flowers, which open only at dusk or when well shaded, and close in bright sunlight, an occasional variously coloured *Hibiscus,* numerous species of *Trichinium,* with their dense spikes of hairy flowers of green, pink, crimson, or mauve, the woolly *Scaevola densivestita,* spiny, thick-leaved, and more or less velvety species of *Solanum, Indigofera* spp., *Tephrosia* spp., small species of *Polycarpaea, Euphorbia,* and *Heliotropium,* the widespread annual *Bulbostylis barbata,* and many grasses. The chief of these are (perennials): the lemon-scented *Cymbopogon bombycinus,* a characteristic form of *Themeda australis, Sehima nervosum, Aristida* spp., particularly *A. arenaria, A. longicollis, A. inaequiglumis,* and *A. pruinosa,* the creeping *Neurachne* mentioned above, and the annuals: *Iseilema dolichotrichum, Rottboellia formosa, Schizachyrium* sp., *Paspalidium rarum, Digitaria ctenantha, Enneapogon* spp., *Chloris scariosa, Sporobolus australasicus, Eriachne ciliata, E. pulchella,* and *E. tuberculata.*

3. Extensive *Triodia*—dominant communities are to be found on the hills of Desert Sandstone except in the south and south-east. They occur on the tops of the larger hills, but more particularly over considerable areas on the broken tablelands (figs. 29-31). Small trees are

usually associated, but they may be very scattered. These are usually an *Acacia,* of which gidgea (*A. Cambagei*), lancewood (*Acacia* sp.), and mulga (*A. aneura*) are the most important, though other species also occur. On the lower ground the mallee, *Eucalyptus normantonensis,* is found in some places (fig. 31). Several species of *Triodia* occur, but most, if not all, are undescribed. Usually they form rather large and comparatively widely spaced masses. Between these *Bassia eriacantha, B. lanicuspis, B. tricuspis, B. longicuspis,* and *Kochia Georgei* occur chiefly on the hills. Otherwise there is little difference between the details of the flora of the hills and the shallow valleys between. *Sida* spp., *Abutilon* spp. the woody crucifer *Lepidium strongylophyllum, Trichinium* spp., *Polycarpaea* spp., *Frankenia serpyllifolia,* and a few grasses, including two undescribed species of *Neurachne,* an undescribed *Sporobolus, Aristida arenaria, Brachyachne ciliaris, Brachiaria Gilesii, Paspalidium rarum* and an undescribed species, *Eriachne scleranthoides, E. pulchella,* and *E. tuberculata.*

On Mount Walker, near Hughenden, and probably also on the neighbouring hills, a rather different community occurs more nearly related to parts of the forest country to the east. The *Triodia* is *T. pungens,* and scattered trees of *Eucalyptus Whitei* and *E. pyrophora* occur, together with lancewood, dead finish (*Albizzia basaltica*), and other shrubby plants.

4. The Spinifex Sand-plain of the south-west (fig. 28). On the lateritic sand-plain between Windorah and the South Australian border and to the east of Jundah, a *Triodia*-community covers large areas of country. Over considerable areas shrubs of any kind are absent, but elsewhere more or less scattered small shrubby trees or shrubs are found. Chief among these are a very stunted form of *Eucalyptus papuana,* with its pure white smooth bark and sparse crown of narrow drooping leaves, and *Hakea Ivoryi,* a narrow irregular shrub up to 15 ft., with terete pungent lobes to the pinnate leaves. A bloodwood, *Eucalyptus pyrophora,* and mulga (*Acacia aneura*) are also important, while to the north-east, where the eucalypts assume tree dimensions, the peculiar "desert oak" (*Acacia juncifolia*), with its long terete phyllodia, and an occasional beefwood (*Grevillea striata*) are noticeable. Occasionally, also, almost a parkland effect is produced.

The dominant species of *Triodia* is *T. Basedowii,* and over the greater part at least is the only species. It is a large stoloniferous species, and occurs also on the sandhills of the Simpson Desert. Indeed, the present community may be considered to occur in a modified and disconnected way along the bases of many of these sandhills. So far as is at present known, the associated plants are chiefly grasses of which *Eragrostis eriopoda, Aristida Muelleri, A. arenaria, Neurachne* sp. are most important. Other plants known to occur are *Calandrinia* spp. (parakeelya), *Bassia Cornishiana, Brunonia australis,* and a few composites. The parakeelya is a famous fodder plant with thick fleshy leaves, and stock can live on it for a considerable time without water.

5. There is an ill-defined community developed to the east of Barcaldine, in which *Triodia pungens* and *Eucalyptus papuana* are associated on sand. In many respects it is intermediate between the north-eastern development of the previous community and Eucalyptus forest. Desert oak is generally present. It might be considered as a

very extreme case of the south-western community in which *Triodia pungens* replaces *T. Basedowii,* but it is desirable to draw attention to it by reason of its connection with Eucalyptus forest.

6. Communities of silt-beds. These communities are found in a few places on a fine silt, which is nearly impervious to water. So far as known the area of greatest development, which lies some miles to the east of Barcaldine, appears to be a centre of inland drainage, and water may lie on the surface for a considerable time. The species is allied to *T. irritans,* and forms large masses with stout, excessively rigid and pungent leaves. It is locally known as "porcupine grass," and the community as "porcupine plain." Apart from a few scattered irregular shrubs of *Hakea acacioides* (needlewood), with its pungent terete leaves, and the peculiar diminutive composite *Eriochlamys Behrii,* very little else grows, and the country is almost worthless.

7. The communities of *Triodia Mitchellii* and allied species. Under this heading are arranged those communities in which very viscid species predominate. They appear to be developed no further west than long. 145° 15′ E., roughly a line passing through Burra on the crest of the Dividing Range west of Pentland, and Cunnamulla. *T. Mitchellii* is the most important species.

There are two major trends in the communities. In one of these the characteristic habitat is the rocky crests of the hills in the neighbourhood of Springsure, and of those associated with the Great Dividing Range. In the nature of the numerous eucalypts and ericoid shrubs which are usually present, as well as in a few other features, these communities should be regarded rather as slightly modified forms of the range communities described below.

In the other case a true *Triodia* savannah is formed. Scattered individuals or groups of dwarfed eucalypts are always present, but discontinuously. The habitat is a slightly elevated tract of loose, usually reddish sand. The eucalypts are the irregular white to grey-barked *E. dealbata* to the west of St. George, and stunted *E. melanophloia* to the south of Charleville, in both places accompanied by the characteristic *Angophora melanoxylon,* while in communities lying between Jericho and Barcaldine (fig. 33) these are replaced by the bushy-crowned *E. setosa* (nut-wood), a mallee-form of *E. exserta,* and the widely tolerant *E. erythrophloia.* Several shrubs occur throughout, including the root-parasite *Leptomeria* sp., *Grevillea juncifolia, Acacia* spp. (*A. argentea* is a handsome plant of the more northern area), *Olearia* spp., &c. Many of the smaller herbaceous plants occur throughout, and indeed many of these are characteristic of loose sandy places in many parts of the State. The chief species or genera are *Calandrinia* spp., *Stackhousia viminea, Goodenia* spp., *Brunonia australis,* several composites belonging to the genera *Calotis, Rutidosis,* and *Craspedia,* and numerous grasses, such as *Panicum effusum,* or a closely allied species, *Digitaria Brownei, D. ammophila, Cymbopogon* spp., *Schizachyrium* sp. nov., *Themeda australis,* numerous spp. of *Aristida, Eragrostis eriopoda, Eriachne mucronata, E. aristidea, Neurachne* sp., and a few sedges such as *Fimbristylis Neilsonii* and *Bulbostylis barbata.*

To the west of Pentland, near the upper part of the Great Dividing Range, on shallow sand overlying sandstone, is a community mentioned and figured by Prescott as a "desert scrub." It is in many respects intermediate between a *Triodia* savannah and a range community.

Triodia sp. aff. *T. Mitchellii* is everywhere prominent, usually forming large masses. *Eucalyptus setosa, E. erythrophloia,* shrubby *E. exserta,* stunted *E. melanophloia,* and the peculiar *Melaleuca tamariscina* with its whitish somewhat papery bark and long slender pendulous branchlets with minute almost scale-like, closely set leaves are in more or less prominence, but the characteristic feature is the frequency of numerous species of brilliant-flowered ericoid myrtaceous and leguminous shrubs belonging to such genera as *Calythrix, Thryptomene, Baeckia, Burtonia,* and *Jacksonia.*

III. Regional Forests.

Under this heading are included those forests and related communities which occupy fairly extensive and continuous areas. There are three well-marked types: (1) Eucalyptus forests and parklands; (2) Cypress pine (*Callitris glauca*) forest; and (3) Ooline (*Cadellia pentastylis*) forest.

1. Eucalyptus Forest. The communities dominated by species of *Eucalyptus* have been variously described as pointed out above. Owing to the frequently rather sparsely foliaged crown with its vertical leaves, the forest floor receives a considerable amount of light, and a rich ground vegetation is usually present. In parkland, as here understood, the trees are more widely spaced, without as a rule any other alteration in the community. The genus is represented in Queensland by about 120 species. Of these, about 45 are actually known from our area, though only about 30 are of any real importance, and some of these are restricted to special habitats and have a small range. The discrimination of the species is a difficult task. Species, which may be very similar as herbarium specimens, are often very distinct in the field, while others are almost indistinguishable in the field in the absence of fruit. Besides, some species vary considerably in habit under different conditions. Shrubby states of *E. papuana* and *E. exserta* have already been mentioned. Both may occur as large trees, the former particularly being often very shapely.

Popular classification is based largely on the nature of the bark, and as this is an obvious character which is often correlated with others, it is most useful. Sometimes it affords the readiest means of distinguishing species otherwise closely related.

The chief groups based on this character are:—

(*a*) The Gums, possessing a smooth bark which is shed yearly in thin scales or strips, leaving a very clean, smooth trunk and branches. Usually there is some grey, persistent flaky or scaly bark at the butt. *E. papuana* and *E. pallidifolia* are previously mentioned species belonging to this group.

(*b*) The Boxes, with grey or mealy, fibrous, much interlocked, persistent bark. In this, as in all groups, the small branchlets are almost invariably smooth, the characteristic bark not developing until a later date. *E. populifolia* is the widest spread species of this group.

(*c*) The Ironbarks, with a hard, rough, deeply furrowed, dark grey or black bark more or less impregnated with a dark red kino ("gum"). *E. melanophloia* is a previously mentioned species of this group.

(*d*) The Stringy-barks, possessing a very fibrous, persistent bark. True stringy-barks are scarcely represented in this area.

(*e*) The Bloodwoods. Typical bloodwoods possess a persistent bark, which is somewhat spongy, friable, and more or less distinctly tessellated. They are not common in the interior, where the term is used for closely related species with a distinctly scaly but friable bark on the trunk, but with a gum bark on the branches. An allied type is the "Yellow Jack," with a yellowish, very spongy but more or less friable and tesselated bark.

Sometimes the bark of the upper part of the tree may be different from that on the greater part of the trunk. Such a tree is said to be "half-barked," and is described in such terms as "gum-topped box," and "gum-topped ironbark." The line of demarcation may be very sharp. Sometimes the shed bark of the upper part may remain as long strips hanging from the line of junction.

A few cases of intermediate type are met with, as in the case of *E. pruinosa* and *E. exserta*, where the bark is intermediate in nature between the ironbark and the box.

The seedling leaves of many species are very different in shape, venation, and disposition from the mature leaves. Sometimes there is a pronounced intermediate stage, usually with very large leaves. When damaged by fire or ring-barking, trees sucker freely, and the leaves of such suckers are very similar to those of seedlings. The intermediate stages are, however, passed through more rapidly.

Eucalyptus forest in some form or other occupies extensive areas in Queensland, and definite *Eucalyptus*-prominent communities are to be found almost throughout the State on a variety of soil types. Many of the communities grade into one another, and sharp distinctions are not possible. The extreme forms are, however, so well marked that it is equally impossible to regard the whole development as a single community. It is not feasible in the present paper to deal with the forest areas in detail, and trends only will be indicated. As an initial generalisation it may be stated that ironbarks tend to occupy hilly or stony ground with shallow soil. On the crests of ranges and similar places yellow jacks replace the ironbarks. Boxes are characteristic of flattish or low-lying ground, while gums are commonly to be found on river banks, though a few are restricted to barren rocky hills.

In describing the communities it is convenient to select a central type as it were, point out its prominent features, and then indicate how the other communities differ. This is the box-ironbark (*E. populifolia—E. melanophloia*) community so common in the so-called "desert country" to the east of Barcaldine and elsewhere (fig. 34). The soil is chiefly sandy, mostly lateritic in nature, but podsolised soils occur in places.

E. populifolia (poplar box, or box), usually a straight tree attaining 40 ft. or more, is a typical box with a grey or mealy bark, a rather dense crown obovate in shape, and shining green broadly ovate to broadly lanceolate leaves on long very slender petioles. Near the border of New South Wales some of the smaller branches are gum-barked.

E. melanophloia (silver-leaved ironbark, or called simply ironbark, where no other tree of this group is present) has the characteristic bark of the group. In this community it is usually a straight or slightly crooked tree with a rather broadly oblong somewhat dense crown; the leaves are opposite, sessile, rigid, glaucous, and more or less orbicular-ovate, and not very different from the juvenile leaves. The young growth is strongly pruinose.

The two species grow either mixed or in separate alternes, and both enter into other communities. When alternes occur, the ironbark occupies areas of shallower soil. Another species of extensive range frequently enters the community. This is *E. papuana*, variously known as cabbage gum, sugar gum, and pudding gum. When associated with box and ironbark, it forms straight, shapely trees with a fairly compact crown with more or less pendulous branchlets and narrow undulate varnished sap-green or rarely glaucous-green leaves. The species has a typical pure white gum bark, sometimes with a little persistent grey scaly bark at the base, but this is of very irregular development. The leaves are relished by cattle. Other smaller trees and shrubs frequently enter the community, but a definite undergrowth is not formed. Among the important species are *Eremophila Mitchellii* (buddah or sandalwood), *Petalostigma quadriloculare* (quinine) with its short, dark grey, rough-barked trunk and a broad very dense crown; *Bursaria incana* (prickly pine), usually a narrow small tree more or less spiny; *Albizzia basaltica* (dead finish), usually shrubby, though sometimes assuming tree size; *Capparis Mitchellii* (bumbil), a small tree with a rather large bushy crown; *Pittosporum phillyraeoides* (cattle bush), a slender pale-green tree or tall shrub with a smooth light grey bark and an excellent stock food; *Sterculia diversifolia* (kurrajong), a shapely deciduous tree and another excellent fodder plant; and several species of *Acacia*. *Carissa lanceolata* (currant bush) forms large prickly bushes; *Parsonsia lanceolata, Pandorea pandorana,* and the prickly *Capparis lasiantha* are characteristic lianas. *Loranthus* spp. parasitises some of the trees, and in places the leafless and rootless parasitic *Cassytha filiformis* covers some of the larger plants with a maze of yellowish filiform stems. The orchid *Cymbidium canaliculatum* is an epiphyte in parts.

The forest floor is dominated by grasses. Chief among these are: *Chrysopogon pallidus, Bothriochloa Ewartiana* (desert mitchell, forest mitchell, desert blue grass), *B. decipiens* (chiefly the luxuriant var. *cloncurrensis*), *Themeda australis* (kangaroo grass), *Sorghum plumosum, Cymbopogon* spp., *Panicum* spp., *Digitaria* spp., *Aristida* spp. (very common), *Enneapogon* spp., *Eragrostis* spp., and *Triodia pungens*. Other plants which are widely spread are: *Erodium cygnorum* (crow foot), *Waltheria americana, Abutilon otocarpum, Ipomoea* spp., *Evolvulus alsinoides, Trichinium alopecuroideum, Bassia convexula* (a slender form), *B. Birchii* (galvanised burr), *Trichodesma zeylanicum, Goodenia* spp., various legumes such as species of *Zornia, Glycine, Crotolaria, Tephrosia, Swainsona,* and *Indigofera,* such composites as *Calotis* spp., *Brachycome* spp., *Helichrysum* spp., *Ixiolaena tomentosa, Craspedia uniflora,* and *Senecio* sp., and a few sedges, of which *Cyperus fulvus, C. conicus, Fimbristylis Neilsonii, F. dichotoma* and allied forms on the drier ground, and *Cyperus concinnus,* and *C. iria* on the damper ground are most important.

To the south the ironbark tends to drop out of the community, tending to form separate communities on stony ground with *Eriachne* prominent. Two small trees, not common in the centre, become important. *Geijera parviflora* (wilga) usually forms a handsome plant with a dense broad somewhat weeping crown of narrow pendulous pale somewhat olive-green leaves. There are two races, one of which is freely eaten by stock, and the other ignored. They are apparently inseparable morphologically. *Eremophila Mitchellii* (buddah, sandalwood, false sandalwood) is a smaller single-stemmed shrub with a rounded dense dark dull green crown. It also is eaten by stock, at least in some places. *Heterodendron oleifolium* (boonery or rosewood), myall (*Acacia pendula*), and whitewood (*Atalaya hemiglauca*) occur in places where the soil becomes somewhat clayey. *Triodia* is absent, or is represented in places by *T. Mitchellii*. *Angophora melanoxylon* (apple) is common in places. The genera *Stipa* and *Danthonia* become prominent, and *Neurachne Mitchelliana* (mulga mitchell) and *Amphibromus* sp. nov. are often important, particularly where mulga (*Acacia aneura*) enters the community. *Paspalidium* spp. are also important, and the distinctive *Sida pedunculata** may be prominent.

To the north *E. populifolia* is replaced by the closely similar *E. Brownii,* which differs chiefly in the narrower adult leaves and differently shaped juvenile leaves. *E. melanophloia* frequently tends to be restricted to the rather stony hillsides, its place in the community being taken by a narrow-leaved species, of which *E. racemosa* is most widely spread. In the neighbourhood of Prairie the smaller, more glaucous *E. Whitei* is important. These ironbarks often occur pure, and *E. racemosa* frequently attains considerable size. Usually it is a well-formed tree with a fairly large crown of narrow pendulous leaves. Other plants are the trees *Grevillea glauca* (nut-wood), *G. parallela* (silky oak), *Melaleuca* spp., an occasional *Terminalia,* the shrub *Astrotricha pterocarpa,* the peculiar fern *Gleichenia microphylla,* the sedge *Fimbristylis cymosa,* and such grasses (chiefly annuals) as *Rottboellia formosa, Schizachyrium* spp., *Elyonurus citreus, Thaumastochloa pubescens, Ectrosia leporina, Brachiaria holosericea,* and *Arundinella setosa*. *Bothriochloa pertusa* is known from the far north-east corner, and *Aristida hygrometrica* occurs along the northern edge. Both these species are very characteristic of the communities further north.

Two other eucalypts are prominent in the central and northern areas. These are the bloodwood *E. erythrophloia* and the yellow jack *E. similis.* They tend to form separate communities on areas of loose reddish sand. The bloodwood tends to form an open parkland, and its association with *Triodia Mitchellii* has already been described. Sometimes, however, the ground vegetation is that characteristic of the yellow-jack community. The yellow jack usually forms fairly large spreading trees, fairly close together, and between them is a dense growth of typical loose-sand grasses—*Aristida* spp. *Perotis rara, Triraphis mollis, Enneapogon* sp., and others. Particularly in the central parts *Aristida sciuroides* is very prominent. Sometimes exceeding 6 feet and rarely shorter than 5 feet, the species forms close tufts of slightly branched, erect slender culms with long, narrow, gracefully inclined or weeping inflorescences.

* *Sida pedunculata.* A. Cunn., not of Domin.

Associated with the steeply undulating country of the Drummond Range, and also further north and south, is a parkland of a narrow-leaved ironbark (*Eucalyptus racemosa*, at least in part) with *E. erythrophloia* and *E. melanophloia* in varying proportions. The grasses appear to be chiefly kangaroo grass (*Themeda australis*) and black spear (*Heteropogon contortus*).

In the hilly country near Springsure and the Carnarvon Range the handsome but poisonous *Macrozamia Moorei* (zamia) is frequent.

2. Cypress Pine Forest.—The chief species is *Callitris glauca*, which ideally is a handsome, conical, more or less glaucous tree, sometimes of considerable size, sometimes small. Frequently it is more or less broken. The community varies from forest to parkland, and almost invariably is developed on loose, pale-coloured sand. Transitions to Eucalyptus forest (box-ironbark) are common. *Triraphis mollis, Perotis rara, Nicotiana* spp. (wild tobacco), *Abutilon* spp., *Sida* spp., are common plants, but sometimes the vegetation is much richer with *Aristida* spp., *Digitaria* spp., *Panicum effusum*, or an allied sp., *Sorghum plumosum, Fimbristylis Neilsonii, Bulbostylis barbata, Clematis microphylla*, and others.

3. Ooline Forest.—Ooline (*Cadellia pentastylis*) sometimes at least forms a close forest of fairly tall trees, which in appearance is not unlike rainforest. Lianas and epiphytes, except algae, lichens, and mosses, are, however, absent. The dominant and sometimes the only tall tree is the ooline itself, with a dense crown of deep-green leaves. A tall acacia (*A. aneura*) is sometimes present as isolated trees, sometimes forming alternes; *Eucalyptus pillagaensis*, a slender gum-topped box, is occasional, as also are other species. There is a distinct second story, in which *Acalypha nemorum* is most prominent as a dense shrub of 4-5 feet, with small leaves, dark green above paler below. With it is associated a large, massively shrubby, strongly glaucous species of *Rhagodia*, the shrubby *Notelaea punctata*, the shrubby grasses *Stipa ramossissima* (up to 5 feet), *Eragrostis megalosperma*, and "*Panicum*" *uncinulatum** (2-3 feet). Other plants include species of *Olearia, Sida, Abutilon, Nyssanthes*, and *Dodonaea*, the fern *Cheilanthes, Paspalidium, Stipa, Eragrostis leptostachya*, and other spp., the peculiar diffuse *Calyptochloa gracillima* with cleistogamous spikelets hidden in the base of the leaf-sheaths, *Chloris unispicea, Cyperus gracilis*, and *Carex inversa* (a form or very closely allied species).

This is a most interesting community with a curious assemblage of species. In many ways, both in aspect and composition, it recalls certain coastal communities. The community is known to me only from the development on a low ridge (altitude, 1,600 feet approximately) about 20 miles west of Mitchell on a greyish, gravelly silt loam. On removal of the forest large tussocks of *Aristida ramosa* var. and small ones of *A. caput-medusae*, together with a rather small, densely tufted *Paspalidium* and other plants, take possession.

Other communities are said to occur in similar circumstances to the south of Morven.

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* This is not a true *Panicum*, but its true genus is still uncertain.

According to Jensen[23] ooline occurs associated with other species in brigalow scrub to the east of our area.

IV. Scrubs.

Scrubs are widespread in Western Queensland, and while in many parts they possess a varied composition, over most of our area they consist of nearly pure stands of some species of *Acacia*, with or without a definite ground vegetation. The scrubs may be of large extent or they may occur scattered through forest and grassland, sometimes along watercourses. In such cases their boundaries are often sharply marked. Frequently a nearly complete canopy is produced; at other times the individuals are more scattered. To the eastward some of the scrubs attain forest size.

The genus *Acacia* is represented in Queensland by well over 120 species, the great majority of which possess no true leaves except in the seedling stage. The functions of the leaves are carried out by phyllodes—the enlarged, usually flattened, often broad petiole—which vary considerably in size, shape, and nervature in different species, but is by no means constant on the same plant. The flowers are small, usually yellow or cream, and borne in variously arranged heads or spikes.

As in the case of *Eucalyptus*, classification is most difficult, but presents greater problems than in that genus. The chief characters relied upon are the presence or absence of leaves, the capitate or spicate nature of the inflorescence, the shape and nervature of the phyllodes, and the characters of pod, seed, and funicle. Owing to the very erratic nature of the flowering period of most species, flowers and particularly pods of many forms are rarely met with, and even yet the taxonomic status of some widely spread forms is quite uncertain.

The differences in habit are enormous, some species being low undershrubs, others being tall trees, while many types of branching occur. Some species are viscid. The bark varies considerably, but in a few species only is it sufficiently characteristic to be of practical importance.

Several forms have received popular names frequently of aboriginal origin, and while some are of local importance only, in many cases these names are most useful in community-description.

The most important scrub-forming species are Gidgea, Lancewood, Mulga and Bendee, Minaritchie, and Brigalow.

Gidgea (*A. Cambagei*) has been described previously. Indeed, it is difficult to treat of most communities without mentioning it, for of all trees and shrubs in Western Queensland the gidgea enjoys the widest range of habitats. Though generally distinctive enough in the field, it occasionally approaches boree (*A. homalophylla*) in appearance, while in the herbarium the two species are scarcely separable, and for a very long time were treated as one in scientific literature.

In the basin of the Georgina River, in its middle part, gidgea is the name of the somewhat similar but usually more gnarled *A. Georginae*.

Lancewood is the name applied to a group of species of similar growth form and habitat requirements, and of which *A. Shirleyi* appears to be the most common. Others have not yet been identified. The dull-coloured crown of numerous rather pendulous long narrow phyllodes is borne on a fairly straight trunk, sometimes tall, with a grey fissured but somewhat flaky bark and numerous inclined rather straight branches.

Mulga and Bendee at present appear to represent different states of the very variable species, *A. aneura.* Typical mulga possesses a trunk, sometimes very short, with a compact slightly fissured or nearly smooth bark. The main branches are fairly numerous, are oblique, and the secondary and other branches tend to be horizontal, so that the glaucous phyllodes appear to be arranged in tiers. The phyllodes are very variable in size and shape. Several types are recognised depending on size of plant (''dwarf mulga'' and ''tree mulga''), shape of phyllode (''narrow-leaved mulga,'' ''broad-leaved mulga,'' &c.), and palatability to stock. Some forms are readily and even greedily eaten, others are avoided when possible. ''Red mulga'' is *A. cyperophylla* below.

Bendee is used in two senses. It is mostly used to designate a tall form usually with an irregularly furrowed trunk, and less strongly glaucous crown. This form is frequent in the south-east in the Eucalyptus forest on stony ground, either as scrubs or perhaps more frequently as scattered trees. In many places the names mulga and bendee appear to be used indiscriminately.

In the more arid districts, however, ''bendee'' appears to designate a stunted trunkless form, also growing on barren ridges, often with no other vegetation whatsoever. This, however, appears to be a distinct though undetermined species.

A. brachystachya is also called mulga.

Minaritchie is the name applied to at least two species with a characteristic curly-flaky bark, grey on the outside, pinkish within. One of these is *A. cyperophylla* with characteristic long sub-terete phyllodes arranged in a graceful bushy crown. More particularly in South Australia it is also known as ''red mulga,'' and is considered an excellent stock feed. The other is an undetermined and possibly undescribed species with entirely different botanical characters.

Brigalow (*A. harpophylla*) is a small or large tree with a hard dark-grey or black furrowed bark, and a very dense rounded glaucous crown of rather large strongly falcate phyllodes. It suckers freely from the roots, and almost invariably occurs in scrubs. Like other species of *Acacia* it is parasitised by *Loranthus Quandang,* often very freely.

Gidgea Scrubs (figs. 10, 11, 17).—These occasionally occur in Eucalyptus forest, and on claypans, and are frequently scattered over the less arid parts of the gravelly downs. In the more arid regions they are to be found in places as fringing scrubs along the channels (fig. 11). Big developments of scrub, sometimes rather open, occur on and between the Desert Sandstone hills and tablelands. Gradations between scrub and grassland are common. The characteristic associated plants of typical scrub are *Chenopodiaceae* (*Bassia longicuspis, B. tricuspis, B. divaricata, B. echinopsila, B. lanicuspis,* the peculiar foetid *Chenopodium rhadinostachyum,* and other species of that genus, the shrubby *Kochia Georgei* and occasionally other spp., *Atriplex* spp.), *Tetragonia expansa* (wild spinach), large-flowered spp. of *Abutilon* such as *A.*

Mitchellii and *A. calliphyllum*, *Trichinium nobile* with its large mauve-grey inflorescence, and a few other spp., and other plants. Near the Wilson River the *Bassia* population is very varied, and though *B. longicuspis* and *B. tricuspis* are absent, *B. intricata*, *B. patenticuspis*, and *B. decurrens* are common. In some places *Sarcostomma australe*, occurring as a climber is prominent.

On destroying gidgea a rich herbaceous vegetation usually results, with an abundance of grasses, but according to some reports this is not permanent. In Mitchell grass country, however, the mitchell grass may take possession.

The details of the communities of *Acacia Georginae* are scarcely known. The soil in the area studied is a light brown silt loam. *Eremophila maculata* (fuchsia), *Cassia* spp., *Atriplex* spp., *Ehretia salicina*, and certain widespread annuals are known, but at the time of my only visit the country was badly drought-stricken and very little ground vegetation was recognisable. Possibly several of the plants recorded by Bailey[2] for the Georgina River find their home with the gidgea. For a very long time this community has had a bad reputation of being very deadly to cud-chewing animals at certain times of the year. A hypothetical explanation of this long-known mysterious poison was put forward by Finnemore[17] in which it is claimed that the pods contain a substance which in association with fuchsia liberates prussic acid from the latter. As a matter of fact, a saponin or closely related substance is present in the young leaves and pods of the gidgea but is absent from the old leaves, and this may be the actual cause of the deaths. Field observations seem to support this view, but the subject cannot be discussed here.

The Lancewood Scrubs.—These are found chiefly on the more rugged slopes or tablelands of sandstone connected with the Great Divide and in similar situations elsewhere, such as Mount Walker near Hughenden, to the south-west of Winton, west of Eromanga, and to the east of Eulo. The forest-floor is often littered with fallen branches, and there is very little ground vegetation. In the more western areas the lancewood seems to be a local replacement of gidgea, and what vegetation there is consists of scattered individuals of species characteristic of gidgea scrub. *Eremophila* sp. aff. *E. Latrobei* is frequently present as a handsome shrub of 4-5 feet. In the eastern development scattered plants of the suffrutescent grass *Cleistochloa subjuncea* may occur as plants of 1-1½ feet.

Mulga Scrubs (figs. 18-20).—Mulga scrub in some form or other is found over extensive areas in Western Queensland. It forms a most valuable reserve fodder in times of drought. If the plant is not cut down entirely, but pruned so that a leading branch is left, it readily recovers, and an almost constant supply is assured. Complete lopping, however, destroys the plant, and in areas where this has been done a large part of the vegetation has been destroyed, and soil drift has become locally serious. Figs. 19 and 20 illustrate the differences. Generally speaking the plants decrease in size westward. In the east mulga scrub grades almost imperceptibly into Eucalyptus forest. In the south-west open or partly open patches often occur. Whether these are natural or have been induced is difficult to say. It seems likely that some at least are induced. Clapyans also occur.

Apart from the communities of the spinifex sand-plains and the sand-hills in which mulga is important and which are discussed elsewhere, there are three distinct habitats for mulga scrubs. The first is the reddish fine sandy soil mentioned above, with extensions further east. The second is reddish "iron-shot loam" (silty clay with fine gravel) of apparently lateritic origin, as for example between Quilpie and Windorah. The third is the desert sandstone hills and the more or less broken country between which often is intermediate in character between the hills and the second type. With the exception of the actual hills these three types are frequently referred to as "red country."

In the neighbourhood of Charleville, for instance, box (*Eucalyptus populifolia*), ironbark (*E. melanophloia*), and ironwood (*Acacia excelsa*) occur in the community as scattered plants, but further west they are replaced by various *Myoporaceae* belonging to the genera *Myoporum* (*M. deserti,* the ellangowan, a powerful poison) and *Eremophila,* of which *E. Latrobei, E. Dalyana, E. Freelingii,* and *E. Gilesii* are the chief. The bloodwood (*E. pyrophora*), beefwood (*Grevillea striata*), and kurrajong (*Sterculia diversifolia*) are scattered through the communities. Alternes with gidgea are common in places, while on some of the low stony ridges the mulga is replaced by the low bendee. *Eucalyptus Thozetiana* (mountain yapunyah) occurs on many of the ridges. Other rather similar low ridges carry only a few shrubs of the rigid *Acacia tetragonophylla* (dead finish).

The ground vegetation is varied and sometimes, chiefly in the more open places, rather dense. Characteristic species are the various so-called "mulga grasses" (*Aristida arenaria, A. anthoxanthoides, A. latifolia*), mulga mitchell (*Neurachne Mitchellii*), *Amphipogon* sp. nov., *Chloris pectinata, Eragrostis eriopoda, E. Kennedyae, Tripogon loliiformis, Fimbristylis* sp. aff. *F. dichotoma* (the two latter known as "eight-day grass" or "five-minute grass" on account of their rapid response to rain), *Sida platycalyx* ("noodle" or "lifesaver," another excellent fodder which responds very rapidly to rain), *S. pedunculata, Atriplex* spp., numerous spp. of *Bassia,* of which *B. paradoxa, B. uniflora, B. Cornishiana, B. parallelicuspis,* and *B. convexula* are specially characteristic, occasional plants of *Kochia Georgei, K. triptera,* and *Calotis* sp., *Evolvulus alsinoides,* and *Velleia connata.*

In the more open parts of the community, crab-holes sometimes occur lined by *Aristida anthoxanthoides, Eragrostis xerophila, Enneapogon* spp., and a *Bassia* or so.

[Note.—According to McTaggart[25] *Centotheca lappacea* is a prominent member of the Queensland mulga scrubs. It is, however, restricted to the rain forests of the north-east coast.]

Minaritchie Scrubs.—These occur almost entirely fringing the gullies in the more arid parts. *A. cyperophylla* appears to be almost restricted to the area between Cooper's Creek and the Diamantina River. It occurs in the upper part of the gullies, and on the flatter ground tends to be replaced by gidgea. Ground vegetation, if any, is scanty.

Another minaritchie occurs either as scrubs or associated with gidgea and mulga on sandstone hills in the arid parts.

Brigalow Scrubs.—Brigalow scrubs cover or used to cover very large areas in Queensland. Their greatest development lies outside our present limits, so that a full treatment must be reserved until later. For the present they will be discussed rather in their relation to the other communities than as to their detailed composition.

A well-developed scrub is very dense and occupies a very heavy, very dark grey or black soil. They may occur scattered in grassland or in Eucalyptus forest, or may be very extensive. According to Jensen[23] the soil occupied contains a high percentage of sodium carbonate. *Casuarina lepidophloia* (belar or belah), *Geijera parviflora* (wilga), *Eremophila Mitchellii* (budda), and other shrubs and small trees are frequent in places. Until comparatively recently these scrubs were heavily infested with prickly-pear (*Opuntia inermis*).

V. Fringing Forests.

Along all the larger watercourses in the grasslands are to be seen communities dominated by trees with which are associated a few smaller plants which are rarely, if ever, found elsewhere. These fringing forests may be very narrow, or may extend some little distance into the grassland, and more or less gradually merging into it. In forest, the rivers are lined with a few species which do not enter into the general make-up of the community, thus forming a type of fringing forest. And, thirdly, there is another kind which is developed along some of the larger northern rivers with a wide sandy fossil flood plain. In the far south-west fringing forest is intimately associated with and forms part of the channel country.

In forest, the characteristic trees lining the rivers are *Eucalyptus camaldulensis* (more generally known as *E. rostrata,* and in Queensland popularly called "river gum," though other names are used) and *Melaleuca saligna* (tea-tree or paper-bark). The latter occurs chiefly in the north, and is a tall tree with a thick whitish many-layered papery bark, and a dense, rather glaucous crown with long slender branchlets and narrow, pendulous leaves hanging in graceful festoons. The gum is a large tree of varied habit, sometimes straight, sometimes irregular, with a whitish or pale grey bark and rather green lanceolate leaves. The forests of the fossil alluvial plains usually have, in addition to the above, several other trees. In the neighbourhood of Hughenden, for example, there occur also *E. coolabah, E. pyrophora, E. papuana* (as a very handsome tree), *Bauhinia Carronii* (bauhinia), *Acacia salicina, A. Sentis, Owenia acidula, Atalaya hemiglauca, Eremophila Mitchellii, Eremophila bignoniiflora,* the two rounded spiny spreading shrubs *Carissa lanceolata* and *Capparis nummularia* (Flinders rose, elsewhere called split-heart), the climbing cucurbitaceous *Melothria argentea,* the handsome parasitic *Loranthus Miquelii, L. Exocarpi,* a few "herbage" plants such as *Portulaca* spp. (pigweed), *Abutilon* spp., *Sida* spp., *Malvastrum spicatum, Bassia anisacanthoides, Psoralea patens, Calotis* spp., and numerous grasses, including *Chrysopogon pallidus, Bothriochloa Ewartiana, B. decipiens* var. *cloncurrensis, Dichanthium annulatum, Themeda avenacea, Brachiaria Gilesii, B. Windersii, Digitaria ctenantha, Chloris pectinata, C. acicularis* var. *queenslandiae,* and more or less frequent spp. of *Aristida* and *Enneapogon.*

Minor variations occur elsewhere, but they rarely alter the general character of the type.

The typical fringing forest of the "downs" is of very different character (figs. 14, 37, 39). The characteristic tree is *Eucalyptus coolabah* (coolibah, coolibar, coolabah), a "gum-topped box" of irregular habit with the lower bark dark grey and somewhat rugged, and the light grey upper bark varying in the extent of its development. Small trees which are frequently associated are the green bushy-crowned

Eremophila bignoniiflora (river angee or emu-bush) and the somewhat glaucous willowy *Acacia salacina* (the "bellalie" of the Cooper country), and *Bauhinia* occurs in places.

A fairly definite herbaceous vegetation is associated. At the edge of pools a zone of *Cyperus dactylotes,* the rather shrubby cane-grass *Leptochloa digitata,* and sometimes also *C. exaltatus* is usual. On the bank a dense growth of *Cyperus victoriensis* and *Paspalidium jubiflorum* is most characteristic, and *C. bifax* and *Panicum Whitei* are often associated. In damp places generally, but chiefly where the *Cyperus* is absent, or less dense, *Eragrostis japonica, Dichanthium annulatum, Eleocharis pallens, Alternanthera nodiflora, Morgania glabra, Mentha australis,* and *Minuria integerrima* occur.

Towards the southern border in the fringing forests of the Warrego, Paroo, Bulloo, and Wilson Rivers a characteristic tree accompanies the coolibah. This is the yapunyah (*Eucalyptus ochrophloia*), a much narrower and greener tree than the coolibah and usually more regular. The upper bark is somewhat reddish in colour.

The yapunyah extends further away from the channels than does the coolibah, so that there is often a broad intermediate zone in which Mitchell grass and chenopods may be frequent.

Near Dirranbandi there is a modification of the fringing forest in that a broad belt of coolibah parkland is formed in which Mitchell grass is prominent and is sometimes dominant. In other places a salt-bush community is associated.

VI. Communities of the Channel Country.

Channel country is most strongly developed along the lower courses of the Bulloo, Wilson, Cooper, Diamantina, and Mulligan (including Eyre's Creek). A fringing forest is present along the deeper channels, but it is in the more or less open country between that the characteristic communities are developed. These communities are almost entirely herbaceous, and often entirely annual. Their existence depends, not to any marked degree on local rainfall, but on the extent of the periodical floods. After big floods the vegetation is most luxuriant, and forms a fine fattening pasture. The floristic detail is imperfectly known. The tall, handsome-flowered *Lavatera plebeia* (hollyhock) is frequent near the coolibahs in some places. Two grasses are characteristic and are highly esteemed. These are the so-called "soghum," *Echinochloa Turneriana,* an erect, succulent annual of several feet and a heavy producer of grain, and the "pepper grass," *Panicum Whitei.* This is not so tall. The herbage is particularly rich, the more outstanding plants being *Trigonella suavissima* (clover), *Blennodia canescens* (heliotrope), *B. nasturtioides* and other spp., *Lepidium rotundum* and spp., *Craspedia chrysantha* (yellow top), *Helipterum* spp., *Senecio Gregorii, Calocephalus* sp., *Gnephosis eriocarpa, Goodenia* spp., various *Scrophulariaceae, Marsilea Drummondii* (nardoo), and occasional plants of *Bassia* spp. and *Atriplex* spp. (fig. 38).

In many places communities of *Cyperus victoriensis* occur, and in the wetter places lignum swamps (fig. 39) and cane-grass swamps are developed. (*See* below under "Miscellaneous Communities"). Claypans are well developed in places, and rarely chenopod communities occur.

VII. Communities Dominated by *Chenopodiaceae*.

The family *Chenopodiaceae* is strongly represented in Queensland in species and individuals. A few species are widely spread, including some on the sea-coast, but the majority are characteristic of the drier parts of the interior. Some species have already been mentioned when describing other communities. Here it is proposed to deal with the several communities in which chenopods are not only dominant, but in which other plants are relatively rare or even absent.

Several species are long-lived, compact shrubs, many are annual or short-lived plants, usually bushy in habit. Several of the latter enter into the formation of communities which are the degradation products of heavily over-grazed country. As such they are actually induced communities, but for the sake of continuity and clarity it is better to describe them here and then refer back to them later. Others are definitely of a seral or quasi-climax nature, and they also will be discussed in this connection elsewhere.

Communities of Shrubby Species (Shrub Steppe).—Within this group come the salt-bush steppe and blue-bush steppe of South Australia. These communities appear to be of minor importance in Queensland. Two areas of *Kochia* steppe occur some distance to the north of Birdsville on a heavy grey soil derived from a Tertiary limestone. The sole perennial vegetation consists of the dense dull greyish shrub *Kochia planifolia*. When examined the only other vegetation consisted of a fairly close covering of *Enneapogon* sp. on small patches of fine drift sand.

Small communities of a somewhat similar nature (*K. Georgei* and other spp.) have been observed on stony ground comparable with gravelly downs near Thargomindah, and another on red soil near Eromanga, so that it is possible that small patches of like nature may be scattered about in the drier regions.

Two types of *Atriplex* communities (saltbush) are to be found. Old Man Saltbush (*A. nummularia*) dominates communities chiefly of limited extent which occur along the Georgina River and Eyre's Creek, some of the tributaries of the lower Diamantina and of Cooper's Creek, and also the lower Bulloo (Bailey [2]). There is an apparently isolated development associated partly with coolibah (*Eucalyptus coolabah*) and partly with box (*E. populifolia*) to the south-east of Dirranbandi. Probably, however, similar communities occur elsewhere near the New South Wales border. Old man saltbush forms large, dense, silvery-glaucous shrubs which can attain 8 feet or more in height, but they are usually kept very much smaller by grazing, as the leaves and young shoots are very palatable to stock.

In all cases so far observed this type of community is developed either near or on flooded ground. Herbaceous plants are usually those of such areas, in the far west often those of claypans.

The communities of *Atriplex vesicaria* of South Australia have been described in great detail by Osborne, Wood, and Paltridge ([28, 29, 42, 43]). Such communities are rare in Queensland. The best development so far seen is on Narine Station, to the south-east of Dirranbandi, where the complete dominance of the saltbush is due at least in part to the removal (by horses) of Mitchell grass which had at one time been associated. Saltbush, at least in this locality, appears not to be relished by horses. The soil is a grey clay silt common in the district. A few trees of box (*Eucalyptus populifolia*), leopardwood (*Flindersia maculosa*), and sandalwood (*Eremophila Mitchellii*) occur, while herbaceous plants are those common in degraded Mitchell grass pasture, of which *Sida virgata, Malvastrum spicatum,* and annual species of *Atriplex* and *Bassia* are prominent.

On Narine and Noondoo both species of *Atriplex* mix in places, and *Rhagodia spinescens* is frequently associated. This mixed community is developed in association with either box or coolibah. In the far south-west of the State *A. vesicaria* occurs within the limits of the gravelly downs. A fairly well-marked development occurs on the eastern slope of the Grey Range west of Thargomindah on reddish brown to yellowish brown gravelly fine sandy loam (fig. 35). Various species of *Bassia,* with occasional trees or patches of gidgea and *Eremophila Dalyana,* are associated.

In several places traces of similar communities occur, as for instance to the west of Eromanga. Scattered plants sometimes form a kind of fringing community beside some of the gullies in the Stony Desert, usually in association with a few shrubs of *Eremophila* or *Cassia.*

Chenopodium auricomum (blue bush) and *C. nitrariaceum* are rather tall shrubs which sometimes form definite communities under somewhat swampy conditions. The former species is usually associated with bull mitchell grass, but not always. It is widespread. The latter species has so far only been observed in the very arid regions.

Communities of Annual Species (Herb Steppe).—Although the individuals of these short-lived communities have no permanence in themselves, yet the actual communities are, on the whole, well defined, and may persist for many years. Many are, however, quite unstable. The numerous species which go to form these communities belong particularly to the genera *Salsola, Atriplex, Bassia, Kochia,* and *Threlkeldia.* Many species regularly form the ground communities of gidgea scrub, and several enter the composition of grasslands. These have been mentioned above. The communities here described are, with one exception, developed on treeless country.

Salsola Communities.—*Salsola Kali* is a very widespread polymorphic species, of which the Australian forms have sometimes been considered as distinct under the name of *S. australis.* In Queensland the species extends from the east coast to the Simpson Desert. Two varieties have been noted from the interior, of which var. *strobilifera* is most characteristic. The species is fairly generally known as roly-poly, and the var. *strobilifera* is frequently called buck-bush. The latter is a characteristic coloniser of the sand-hills, and will be considered later in this respect, though it also occurs in other places.

The species in all its forms is a more or less rounded bush, more or less prickly except when young, which at maturity breaks off at the ground-level and is bowled over the ground by the wind, scattering seeds as it does so, until it is finally brought to rest by a fence or bore drain. In this stage it is a great pest, but when young it is readily eaten by stock.

Roly-poly is present in grassland almost everywhere, and at times assumes physiognomic dominance. Sometimes it forms pure or nearly pure communities on stock-routes, and possibly because of this the dominance or apparent dominance on grassland has been interpreted as due to over-grazing. While this may be true in some cases, it is quite certain that in many, possibly the majority, of instances this dominance is an example of "seasonal dominance." Gregory[20] notes that on the Peak Downs (near Capella) *Salsola* was very abundant long before the country was stocked.

Species of *Atriplex* and *Bassia* may form pure stands or they may mix with one another and with *Threlkeldia proceriflora* to form certain distinctive communities. The species of *Atriplex* concerned form low rounded or spreading bushes of whitish aspect with flat, more or less mealy leaves. *Bassia* is by far the largest genus, and is represented by about thirty species in our area. A few are true perennials and distinctly shrubby. The majority are facultative perennials. Usually annuals, they can perennate under favourable conditions, though they probably are only relatively short-lived. They are nearly all dense, low bushes, branching freely close to the ground. In many the branches are rather short or intricate; in others they are often longer and divaricate. In the former case more or less rounded bushes are usually produced; in the latter the plants are usually less compact. The leaves are fleshy and in most species very narrow or terete, green to sub-glaucous, but very frequently the whole plant is more or less covered with a hoary or white tomentum. The fruits are sessile and axillary, and usually solitary, furnished with two or more usually rigid spines, which may be quite short or, in *B. longicuspis,* may attain 1½ inches. In some the fruits fall at maturity; in others they remain firmly attached, and distribution depends on the breaking up of the plant. In most cases the species furnish good forage at least when young. Some become somewhat woody when old, and long-spined forms are avoided as much as possible.

Threlkeldia proceriflora resembles in general habit some of the smaller species of *Bassia.*

The Communities.—A widespread community consists of a mixture of *Atriplex Muelleri* (annual salt-bush), *Bassia anisacanthoides, B. echinopsila* (red burr), and *Threlkeldia proceriflora.* The community is invariably developed on a heavy soil, and appears in some places to be a climax community. In such cases it is usually associated to some extent with gidgea. In other cases it is certainly an induced community, resulting from the degradation of Mitchell grass grass-land by over-grazing. These cases have been discussed by Francis,[19] and will be further considered below.

The proportion of the species in the community varies considerably, and one or more may be missing. Owing to the relative unpalatability of the saltbush there is a tendency for it to dominate the situation, and in places it occurs as a pure stand. Towards Dirranbandi there is a marked tendency for it to be replaced by *A. leptocarpa.*

To the far south-west this community is represented by others (fig. 11), of which the characteristic species are *Bassia* sp. aff. *B. divaricata, Atriplex spongiosa,* and *A. conduplicata.* This type of community is widely distributed over the gravelly downs with many variations. Several species of *Bassia* are usually present, including those of the former community. Near the Cooper *B. brachyptera* is prominent, and in the north of the gravelly downs area *B. lanicuspis* frequently dominates.

Bassia Birchii, commonly known as galvanised burr, though also as camel burr and Woolerina burr, has a strong tendency to form communities on sandy soil. In most cases these are the result of heavy overgrazing. The burr acts as a coloniser soil-binder and seed bed, and its character has been briefly discussed in a previous paper.[5]

Other species assume physiognomic dominance at times. *Bassia quinquecuspis* (roly-poly or prickly bush), *B. bicornis* (goat-head), and others form communities in grassland, usually induced.

Samphire and Cottonbush Communities (fig. 36).—On the saline sandy shores of the Dynevor Lakes, and on the extensive silt beds of the middle and lower course of the Wilson, near Haddon's Corner, and still further to the north-west, is developed a type of community not closely connected with the foregoing. Annual and perennial chenopods are prominent, but other plants are very important. Those most widely spread are *Pachycornia* spp. and *Arthrocnemum* spp. (samphire), *Kochia aphylla* (cotton-bush), *Bassia tricuspis, Gunniopsis quadrifida,* and *Glyceria ramigera* (cane grass). Near the Wilson the peculiar *Kochia*-like shrub *Hemichroa* is common. *Cyperus victoriensis* is common in places in depressions, but on the edge of the Dynevor Lakes it appears to be replaced by *C. gymnocaulos.* Several annual plants occur, notably *Bassia* spp., *Babbagia dipterocarpa, Malacocera tricornis, Eragrostis Dielsii, E. leptocarpa,* a distinctive undescribed species of the same genus, and others.

VIII. The Communities of the Sandhills (figs. 22-27).

The communities of the sandhills are numerous and varied, their composition being influenced by their position on the dune and the nature of the latter. Weather conditions are, of course, very important. The present discussion will be confined to the dunes of the Simpson Desert and those of the "marginal country" surrounding it. Perennial plants—at least long-lived ones—are relatively few. For a large part of the time a great part of the dune and, perhaps, the crest always is at the mercy of the wind, and is frequently undergoing minor changes. Thus a very special kind of habitat is produced. On the lower part, which may be relatively stable, a more or less permanent vegetation may exist, closely related to the *Triodia* community of the lateritic sand-plain as pointed out above.

A few small trees and large shrubs are occasionally to be found on sandhills. The commonest are *Acacia aneura* (mulga), *A. ligulata, A. dictyophlebia,* and *Hakea leucoptera* (needlewood), while in the marginal country *Clerodendron floribundum, Owenia acidula* (emu-apple), *Atalaya hemiglauca* (whitewood), and *Eremophila* spp. are occasionally to be seen. The common shrubs to be found throughout, or nearly throughout, the sandhill area are the large bushy dull-greyish *Crotolaria Cunninghamii* (parrot bush or bird flower), with its peculiar large green-veined greenish yellow flowers and the smaller very glaucous *C. eremaea* with its bright yellow flowers while two grasses are widely spread. *Triodia Basedowii* (spinifex or porcupine grass) has already been described. On the sandhills it tends to form irregular masses, particularly if on the upper slopes. *Spinifex paradoxus* (sandhill cane grass or simply "cane grass") (fig. 22) is a dioecious rhizomatous dense intricately-branched green shrub up to 5 feet high, with rather few short rigid leaves. Both these species are excellent sand-binders. Other more or less distinctly perennial plants of wide distribution are *Scaevola depauperata, Leschenaultia divaricata, Ptilotus latifolia, Newcastlia cephalantha, Psoralea eriantha, Echinospermum concavum, Solanum ellipticum,* and the slender more or less herbaceous *Sida argentea* and *Andrachne Decaisnei.*

A host of short-lived plants appears after rain. Of these some are commonly and, perhaps, restrictedly colonisers. Among these are the grasses *Plagiosetum refractum* and *Paractaenum novae-hollandiae*. The former is common on the marginal hills (fig. 24), but in the true desert it seems to be replaced by the latter. Both species form large masses on the sides of the dunes, tending to stabilise the sand. The other coloniser is the ubiquitous buckbush (*Salsola australis* var. *strobilifera*). Another plant which colonises the hills, in some localities at least, is the brilliant yellow-flowered *Tribulus hystrix* with its large grotesque spiny fruits. It is often to be seen partially buried, the long trailing and flattish pinnate leaves holding the sand. *Calandrinia* spp. (parakeelya) are common at times. In the Simpson Desert, and at least in parts of the marginal country, occur the brilliantly yellow-flowered *Goodenia cycloptera ?*, the lilac or white-flowered, sweet scented *Blennodia pterosperma*, the yellow and white flowered *Myriocephalus Stuartii* (poached eggs), the brilliant yellow *Senecio Gregorii*, and others.

Apparently under some conditions *Crotolaria* can act as a coloniser, though probably only in the marginal country.

On the spread of the sandhills in the marginal country there is very frequently a fairly dense community of varied composition. Sometimes a patch of mulga scrub is present, while fig. 25 shows a community on Mount Howitt in which a close growth of *Eriachne ovata* with *Eragrostis eriopoda*, *Aristida Muelleri*, *Neurachne* sp., *Eriachne aristidea*, *Amphipogon* sp. nov., and *Sida argentea*. In another case occurred an interesting and unusual community of Mitchell grass (*Astrebla pectinata*), the sand having apparently acted as a mulch. At the edge of the spread an occasional tree is often to be found, such as *Bauhinia* or the bloodwood *Eucalyptus pyrophora*.

Moving north and east from the centre of the desert shrubs and trees become prominent. Firstly, mulga and needlewood come into greater prominence. In the east these tend to be replaced, firstly, by hop-bush (*Dodonaea* sp.), and still further east by cypress pine (*Callitris glauca*), Towards the north the mulga and needlewood are gradually replaced by two eucalypts, *E. papuana* and *E. pyrophora*. The extreme case of this is shown in fig. 27, illustrating a community some miles to the south of Boulia. The sandhill is reduced to a broad slightly elevated patch of sand supporting *Eucalyptus papuana*, *Eragrostis eriopoda*, *Aristida Muelleri*, and *Atriplex elachophylla*.

The further away from the desert the greater the tendency for the occurrence of sandhills to be restricted to the neighbourhood of watercourses.

IX. Miscellaneous Communities of the More Arid Regions.

There still remain several communities of local importance to be considered. These are often small in extent, and occur scattered through the area, frequently restricted to special habitats. Some of these are dominated by or consist entirely of a single species. One group is treated separately below, the others may be grouped as follows. Some of these have already received incidental mention:—

1. Communities dominated by a single species, which is more or less shrubby—
   - (*a*) Lignum swamps.
   - (*b*) Cane-grass swamps.
   - (*c*) *Cassia phyllodinea* communities.
   - (*d*) *Eremophila* communities (except *E. Mitchellii*).

2. Communities of ephemeral species—
   (*e*) Communities of claypans.
   (*f*) Communities of sandy river beds, &c.
   (*g*) Communities of muddy or silty river beds, &c.

Lignum (*Muehlenbeckia Cunninghamii*) forms large more or less hemispherical masses of nearly leafless cylindrical stems (fig. 39). Individual plants may be several feet in diameter. They form distinctive communities either lining channels or occupying depressions chiefly in grassland or channel country. The plants may be contiguous or some distance apart. The intervening space may be bare or populated by various plants, the species being those of damp places. Lignum communities are always subject to flooding in such a way that water lies on the ground for a considerable time.

Cane grass is the name given to two stout rigid, branched, shrubby grasses up to 8 feet high, with comparatively short, rigid, more or less inrolled leaves. They are characteristic of areas where water lies for a considerable time. One of these grasses is *Leptochloa digitata* of fairly wide range, except in the driest areas, where it is replaced by the other. It frequently forms a zone around waterholes. Associated plants, if any, are those typical of damp places. The other species is *Glyceria ramigera*, which is nearly restricted to the more arid regions except for an apparently isolated development to the east of Cunnamulla. Large communities sometimes occur on claypans, and other plants seem to be rare or absent. It is eaten by stock. It is almost certain that the cane grass referred to by Bailey[3] belongs to this species, and not to the previous.

Cassia phyllodinea is a compact glaucous leafless shrub mostly 2-3 feet high, with flat narrowly obovate vertical phyllodia and yellow violet-scented flowers. Communities, sometimes dense, sometimes open, are formed on flats of a claypanny nature or in open places in mulga scrub. In the former case other plants are often absent. In the latter, where the community is often more open, plants of the crab-hole development previously described are often present.

Eremophila spp. occasionally form small communities chiefly in mulga scrub or occasionally on the tops of the desert sandstone hills.

Communities of the Claypans (figs. 14, 40).—It has already been pointed out that several communities may be associated with claypans. In the extreme development of claypans, however, vegetation is restricted to scattered plants of ephemeral species, particularly grasses. The characteristic species are *Aristida anthoxanthoides, Tragus biflorus, Enneapogon* spp., sometimes *Uranthoecium truncatum, Brachyachne ciliaris, Eragrostis Dielsii;* besides *Trianthema decandra, Portulaca* sp., and an occasional *Bassia*. All these are pioneer species, and many are characteristic of bare places generally. *Cyperus bulbosus* (mungeroo), a species perennating by tunicated bulbils, is present in many places.

The Communities of River Beds.—After a stream has dried up quite a variety of plants spring up to form a very open but short-lived community. Many of these are found in damp situations generally; others appear to be more or less restricted to the rivers. Species of wide occurrence are *Cyperus pygmaeus, C. iria, Brachiaria Windersii, Echinochloa colona, Diplachne Muelleri, Eragrostis japonica, E. parviflora, E. leptocarpa, Glinus lotoides, Ammannia* spp., *Alternanthera nodiflora, Centipeda* spp., &c. On the sandy beds, particularly in the north, *Fimbristylis miliacea, F. microcarya, Bulbostylis barbata, Brachiaria piligera, B. miliiformis, Setaria surgens, Chloris virgata, Polanisia viscosa* occur in addition, while on muddy beds *Pterigeron adscendens, P. odorus, Pterocaulon glandulosum, Minuria integerrima, Morgania glabra, Neptunia* spp. *Marsilea Drummondii* (nardoo) and *Sporobolus Benthamii,* a rather wiry stoloniferous grass, are characteristic. The three species last named are perennial, but can be included here.

X. Miscellaneous Communities of the Dividing Range.

On the uppermost rocky slopes of the Great Dividing Range and some of the adjacent ranges and hills is developed a peculiar and most interesting type of community. Eucalypts and *Acacia* spp. are present, sometimes stunted, either mixed or certain species of *Acacia* tending to form scrubs. The characteristic feature is the development of an often dense undergrowth of shrubs of ericoid habit belonging to the families *Epacridaceae* (*Acrotriche, Leucopogon, Melichrus*), *Myrtaceae* (*Calythrix, Thryptomene, Baeckia*), *Rutaceae* (*Boronia, Phebalium*), *Leguminosae* (*Burtonia, Jacksonia, Daviesia, Aotus, Bossiaea,* also *Hovea*), and prickly, thick-leaved spp. of *Solanum.* A characteristic grass is the wiry suffruticose *Cleistochloa subjuncea,* with its cleistogamous spikelets in the leaf-axils. The dioecious, rigid *Scleria sphacelata* occurs in places. Its presence is interesting, as it also occurs in the coastal rain-forests.

In the steep gorges of the Carnarvon Range the tropical fern *Angiopteris evecta* has been found, while on the cliff faces *Platycerium Veitchii* occurs. The eucalypts of this district are varied, and include the ironbark *E. nubilis,* the gum-topped ironbark *E. decorticans, E. maculata* (spotted gum), *E. citriodora* (scented gum), *E. trachyphloia* (yellow bloodwood), *E. tesselaris* (Moreton Bay ash or carbeen), *Angophora intermedia,* and other trees. Further north *E. peltata,* a yellow jack, is abundant.

This type of community appears to occur throughout the length of the Great Divide, and a full account cannot be given in the present paper. A most interesting feature is the similarity of the shrubs to the shrubs of the Wallum of the east coast.

B. INDUCED COMMUNITIES.

XI. Artificial Grassland.

In many timbered localities attempts have been made to improve the natural pasture by killing, usually by ringbarking, and frequently by the ultimate removal of the trees. This has been freely practised to the south-east, chiefly beyond our present limits. The result is usually the production of an artificial grassland, in which the original herbaceous members of the forest community dominate, at least at first. A close ground cover is produced, usually with one or more species dominant. On the more usual sandy soils there is always a tendency for certain species of *Aristida* to dominate, of which *A. echinata* is most prominent in the south-east. With continued stocking *Bassia Birchii* tends to replace the grass. Careful stock management is necessary to maintain a satisfactory pasture.

On the heavier soils in the south-east there is not such a pronounced tendency for the dominance of *Aristida. Chloris divaricata* (star grass) is usually prominent, though *Sporobolus Caroli* dominates at times.

There seems to be no definite rule. Further change takes place in one of two ways. Sometimes, particularly when coolibah was present in the original vegetation, Mitchell grass, particularly weeping Mitchell (*Astrebla elymoides*), gradually assumes dominance with *Eriochloa* sp. prominent. On the other hand, many chenopods may enter the pasture, the most characteristic species being *Atriplex neurivalvis, Bassia stelligera,* and *B. quinquecuspis* and its var. *villosa*. Heavy over-grazing results in the dominance of the *Atriplex leptocarpa-Bassia-Threlkeldia* community described above.

Eremocitrus glauca (lime-bush) frequently enters the pasture, and tends to form scrubs of erect, glaucous shrubs or small trees.

Gidgea scrub has been rung or felled in places, but full details of the induced communities are not available. In some places the final result is grassland (Mitchell grass) with a percentage of chenopods, and possibly some of the chenopod communities are also of similar origin. In one locality studied to the west of Quilpie *Eragrostis* spp. dominated. The commonest species were *E. Kennedyae* and an undescribed species with small spikelets widely spread in Western Queensland. It has been reported that in freshly rung gidgea scrub a wealth of herbage appears, but does not persist for any length of time.

XII. Communities of the Bore-drains.

Along all bore-drains, and particularly at the end where they spread out, sometimes to form swampy areas, species are to be found which rarely, if ever, occur elsewhere in our area. Along the banks of most drains is to be found a close mat of couch (*Cynodon dactylon*), and sometimes on the lower ground *Sporobolus Benthamii*. With these may be associated a tall, stout species of *Eriochloa*. Near the bore-head a few chenopods, notably *Atriplex Muelleri* and *Bassia* spp., are often to be found.

Lower down the drain, where the stream is slower, or in the channel into which drains are usually led, there sometimes occurs a dense stand of the bullrush *Typha angustifolia* var. *Brownii*.

In a swampy area near Barcaldine at the end of a bore-drain in Eucalyptus forest several coastal sedges occur, including *Kyllinga brevifolia, Fimbristylis depauperata, F. dichotoma* var., *Fuirena ciliaris,* and *Cyperus difformis*.

XIII. Communities of Stock-routes and Reserves.

Effects of Grazing.

Artificial stocking by cattle, sheep, and horses, together with the introduction of the rabbit, must have produced a profound effect on the original vegetation. Not only have the plants been subjected to more intensive grazing than previously, but this has been of a much more destructive nature. Rabbits are practically restricted to the southern parts, but it is difficult, if not impossible, to assess the extent of change wrought by them alone. All that can be attempted, in the present paper at least, is to describe some of the results brought about by stocking, and to indicate the trends of the changes taking place.

For purposes of comparison it has been usual to study the vegetation in railway enclosures and cemetery reserves, but difficulties are numerous. In the first place, railway enclosures are of value in open country only. Then many stray species are distributed by passing trains. Frequently in severe drought stock has been turned into the enclosures; and, finally, in many places there are no enclosures.

Cemetery reserves are often located on atypical areas, particularly on the downs, where they are regularly located on a slightly sandy rise, if such is available in the district. And it is always likely that the vegetation may have been interfered with in some way.

Although, from the grazier's point of view, the effects of continued heavy stocking are very deleterious, yet there is no doubt that over large areas, particularly on the ashy downs, the pasture has been considerably improved by stocking. A striking example of this came under observation to the north of Barcaldine on typical ashy downs, and is illustrated in fig. 15. The paddock on the right had been consistently heavily stocked with sheep for several years. On the right is a piece of land which has lain idle for many years. The photograph was taken in December, 1935, following good rains, which were preceded by a long, severe drought. The stocked paddock carries a very fine stand of mixed Mitchell grass and herbage, while the idle ground carries a very sparse vegetation, consisting chiefly of young *Salsola* and the bottle caustic, *Euphorbia Stevenii.*

This is certainly an extreme case, but comparable examples are not wanting. Frequently, when a paddock is spelled or but lightly stocked for a period, differences are noticeable between it and neighbouring paddocks, sometimes in favour of one, sometimes of the other.

These different reactions to stocking seem to be connected with the nature of the soil. The loose, "cracky" nature of the ashy downs has been alluded to above. The continual trampling tends to pack the soil, making it more compact, when it holds moisture better. A better and more permanent plant growth is induced. Heavy stocking on the gravelly downs, at least for short periods, may also result in an improvement in the pasture.

The tendency for sheep to graze up-wind also produces its effects on the pasture. Thus the dominantly leeward side of a paddock is more continuously and closely grazed than is the windward side, which, indeed may be comparatively little grazed (fig. 16). The position of water in a paddock modifies the effect of this tendency, so that where fences are judiciously arranged with respect to watering facilities a more even grazing of paddocks is secured.

There is, however, a limit to the permanent carrying capacity of any particular area, and when this is regularly exceeded a very different state of affairs results. Sooner or later the more palatable species are gradually eaten out. Young plants are not allowed to reach maturity, so that seed becomes scarcer and scarcer, and as the older plants die there are no young ones to replace them. There is thus a tendency for the palatable species to be replaced by others less palatable, and these again by species still less palatable.

The extreme case of such replacement is well shown near towns on the reserves and commons. This is due largely to the communal herds of goats, sometimes assisted by cattle and travelling stock.

The plant communities of such places are often most striking. The perennial plants are the least palatable species, and associated are various short-lived annuals. On sandy soil *Bassia Birchii* (galvanised burr) finds its greatest development, associated with such plants as *Aristida* spp., *Tragus biflorus,* and *Perotis rara.* On the heavy soils the communities are often remarkably different in neighbouring localities. At Hughenden the very conspicuous *Pimelea haematostachya* (wild poppy or bottle brush) with its tufted, erect, nearly simple stems, very glaucous leaves and dense scarlet to crimson flowering spikes becoming white in fruit, dominates the situation in places. It is absolutely ignored by all classes of stock, including goats. In more open situations are found *Flaveria australasica, Brachyachne convergens* (spider or fern grass), *Enneapogon avenaceus, Malvastrum spicatum, Sida virgata, Atriplex Muelleri, Cassia planitiicola,* and frequently *Iseilema* spp. These are common species of these reserves. Towards the south chenopods become numerous and varied, chiefly *Bassia* spp. and *Atriplex* spp.

On stock routes—those great arterial highways along which many thousands of stock pass annually from pasture to pasture, or from pasture to market—the original vegetation has undergone many pronounced changes. Here, possibly more than anywhere else, do extremes of environmental conditions operate upon plant life. The trampling effect of the passage of many thousands of animals must in itself be a severe test on the plant. Added to this is the grazing of these same animals. And perhaps equally important is the effect of the continual manuring and urination on the plants and on the soil. On the downs the position of even comparatively old sheep camps can be recognised by the presence of a community of *Atriplex Muelleri.* And this is one of the commonest plants of stock routes on heavy soils, frequently forming large communities. In the central and southern parts the chief vegetation consists of the *Atriplex Muelleri-Bassia-Threlkeldia* community described above. (See also Francis,[19] where the history of the community on the Ward Plain is discussed.) Other plants commonly found on stock routes are *Wedelia asperrima* (sunflower weed), *Pennisetum Basedowii* (these two chiefly in the north, and the latter probably introduced by stock either from still further north or from North Australia), *Bassia bicornis* (goat head; chiefly found in the central parts), *Salsola* (ubiquitous), *Bassia quinquecuspis* (chiefly towards the south), and some annual grasses, chiefly *Enneapogon* and *Tragus. Iseilema* spp. (Flinders grasses) are common at times, chiefly in the north.

[NOTE.—In this connection it is interesting to note the results of an irrigation experiment carried out near Ilfracombe in 1935-6. An area of ashy downs was flooded with bore water. A crop of chenopods at first appeared, but after rain there was practically no plant growth.]

Bare places are not uncommon (fig. 13), and true claypans are frequent in places, particularly as the result of concentrated trampling followed by scouring near watering places. These carry the annual vegetation described above for these places.

It must not be thought that stock routes carry only this degraded vegetation. Actually every gradation from grassland to claypan occurs, and on the larger stock routes Mitchell grass may be abundant in places. Much depends on the season and the amount of stock that passes.

On sandy soil *Aristida* spp., *Triraphis mollis, Perotis rara,* and *Bassia Birchii* are the characteristic species, the lastnamed tending to assume dominance.

At the present time recuperation of stock routes is a serious problem, and drastic measures in their control will be necessary. Regeneration on the routes and on over-grazed areas generally is possible, but the time factor is important. Many instances of some degree of regeneration have come under my notice, usually as the result of spelling or partial spelling. A great deal depends, of course, on the season.

XIV. Communities of Introduced Species.

The most important species are *Parkinsonia aculeata* (parkinsonia), *Xanthium pungens* (Noogoora burr), *X. spinosum* (Bathurst burr), and *Argemone mexicana* (Mexican poppy).

Parkinsonia aculeata was introduced from the West Indies as a shade and fodder tree, and has been freely planted about homesteads and towns. It has a tendency to form copses, and occasional small patches are to be seen in some localities. In a few places a string of trees may be seen along shallow channels on the downs.

The species of *Xanthium* are among the worst pests of the grazing districts. Both are poisonous when young, and the spiny burr-like fruits are a terrible nuisance in wool and hair. Bathurst burr is of comparatively little importance in our region, and rarely persists for any length of time. It can be controlled by judicious pasture management. Noogoora burr presents a very different and much more serious problem. It is almost invariably restricted to watercourses and edge of channels, and is being continually distributed further down stream. Not infrequently it forms an impenetrable barrier to sheep, so that they are unable to reach water.

It is most unfortunate that the burr was first introduced to the upper courses of the streams.

Argemone mexicana is gradually extending its range westward, sometimes forming more or less definite communities on dry stream beds. It is avoided by stock.

Prickly pear (*Opuntia inermis* and other spp.) once formed dense communities over large areas, but it is being rapidly exterminated by *Cactoblastis cactorum.*

THE STATUS OF THE COMMUNITIES AND THEIR RELATIONSHIPS.

On examining the field-interrelationships of the communities described above the following features stand out very clearly:—

1. Brigalow scrub is slowly but surely extending its range, many changes having taken place within the memory of living men. Both grassland and Eucalyptus forest have been invaded and replaced. All stages in the invasion can be seen, and in some older scrubs box stumps are to be found. With the invasion of forest the nature of the soil gradually changes until the very heavy nearly black soil of old-established scrubs is obtained.

2. There is a tendency for gidgea to invade the grassland of the gravelly downs.

3. The reverse process is also in operation. Gregory[20] records large areas of dead *Acacia,* presumably gidgea, along the Barcoo. And in 1935-6 large areas of dead gidgea were to be seen to the south-west of Winton and elsewhere (figs. 10, 11), with grass coming in.

4. Mitchell grass has replaced blue grass over large areas. At the beginning of the present century blue grass dominated a far larger area

than it does to-day. The exceptionally severe drought of 1902 appears to have been one of the factors concerned in the change, but the lower palatability and the longevity of Mitchell grass appear to have decided the issue. For in recent years blue grass has been fairly common in railway enclosures though absent or nearly absent elsewhere. This change has occurred in the pastoral districts of Warrego and Maranoa, and appears to be still in progress in the Leichhardt district. It is not of a continually progressive nature, however, for in parts of the Maranoa and Mitchell districts at least, Mitchell grass was very common, if not dominant, many years previous to 1902,* and, indeed, prior to settlement (Mitchell[26]).

5. The relationship between the chenopod communities and the grasslands is a very unstable one. Some of the communities of the former group are plainly of a seral nature, such as those induced by overgrazing. Sometimes an apparently stable system is to be found where alternes (fig. 7) occur but in which the actual area occupied by each alterne varies from time to time. A similar system occurs on a very large scale on the fringe of the Stony Desert. The usual state of affairs is a mixed grass-chenopod vegetation confined to the crabholes (fig. 6). In some years perennials may be lacking or chenopods alone may occur (fig. 11), or even these may be absent (fig. 5, see also Sturt[36]). At other times this country is said to be continuously though lightly covered with Mitchell grass.

6. The Simpson Desert is a distinctly stable formation as a whole, and its northern and eastern boundaries are clearly limited by the direction of the prevailing wind and the river channels. The sandhills of the marginal country appear to be quite stable except for minor variations in conformation. Some occur among river channels and are obviously older than the latter (fig. 38). (It may be pointed out that the northern and eastern limits of the marginal country approximate to, but lie within, the limits calculated by Prescott[33] as the theoretical limit of the Australian Desert. However, it must be stressed that meteorological data for Western Queensland generally, and for the more arid areas particularly, are so very meagre that very little importance, if any, can be attached to theoretical considerations based upon them. Furthermore, complications are introduced by the presence of gibbers and gravel and by the little pockets of drift sand, both of which check evaporation, and by the presence of ridges and hills. It is only in times of severe drought that true desert conditions prevail.)

Beyond the marginal country there is another series of sandhills which gradually disappear to the north and east. It has already been pointed out that there is a complete gradation in character and vegetation from the dunes of the Simpson Desert to these low, scarcely discernable, far-outlying ridges. It would seem that at one time the desert occupied a greater area than it does to-day, and as it regressed the dunes gradually became more stable, were weathered lower and lower, and began to support an increasingly stable vegetation.

7. Lake Eyre and some associated lakes in South Australia used to be fed by Cooper's Creek, the Diamantina, and Mulligan Rivers. These streams very rarely reach Lake Eyre now. It has been generally considered that this, together with the occurrence of dead and dying coolibahs along the banks, was evidence of an increasing aridity of climate. But the failure of these streams to reach the lake appears to be due to a very different cause. It has been pointed out that the country

* According to records in the Department of Public Lands.

in these regions is often excessively flat, and that very extensive alluvial plains occur. These plains are being continually built up, slowly it is true, but sufficient maybe to hinder the very slow flow of the stream and each year making it more difficult for the rivers to reach the lake. It is now only in years of exceptionally heavy flood that the streams have sufficient power to scour out the silted channels to reach the lake.

8. It may be not out of place here to mention that changes in vegetation are in progress elsewhere in Queensland. In many instances rainforest is spreading at the expense of open forest. Young plants of open forest species are never found within the rainforest, though young plants from the latter invade open forest. As in the case of invasion by brigalow the character of the soil changes with the appearance of rainforest, becoming richer in humus. Many instances of pockets of Eucalyptus forest entirely surrounded by rainforest occur. The only feasable explanation seems to be that the Eucalyptus forest was formerly of far greater extent and that these pockets were isolated by advancing rainforest. The sere in parts of South Queensland has been described by Swain.[37]

Similar instability exists between the Wallum country of the east coast and Eucalyptus forest on the one hand and rainforest on the other.

The point which is desired to be stressed is that almost throughout Queensland the vegetation is of an unstable nature, so that it is frequently difficult to state what are seral and what are true climax communities. For Western Queensland it has been shown that these changes are oscillating, not progressive. It is convenient to use the term "fluctuating climax" to denote that condition which appears relatively stable, but which in reality is in a state of unstable equilibrium. A true static climax may never exist. The communities of blue grass and of Mitchell grass in the districts abovementioned are an example of an fluctuating climax. So also are the chenopod communities and the Mitchell grass communities at the edge of the stony desert, and elsewhere. The major communities concerned in the fluctuating climax may be termed "complementary communities," "complementary associations," &c., as the case may be. Each complementary community is a climax under the existing set of conditions. What these conditions are is at present doubtful. Rainfall and, since settlement, stocking appear to be two of the factors concerned, but only indirectly, and it is possible that cyclic variations in the salt content of the soil may be an important factor. It has been well proven that there is a pronounced tendency for salts to accumulate in the upper layers of soils in dry climates, while the opportunities for lessening the concentration are few. Whatever the actual cause it is scarcely necessary to stress the importance of the changes in relation to the carrying capacity of the country.

With this concept in mind it is possible to recognise the following formations and associations in Western Queensland*:—

I. The Open Forest Formation, in which the chief associations are—

1. Eucalyptus Forest. In addition to the *Eucalyptus*-dominant communities, the following communities occur often as definite sub-associations or consociations:—

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* In the sense of Clements ([10]).

(*a*) Cypress pine (*Callitris glauca*) forest.

(*b*) Fringing forest in part, principally such communities as described above as occurring near Hughenden.

(*c*) *Eucalyptus papuana—Triodia pungens* community.

(*d*) *Eucalyptus—Triodia Mitchellii* communities.

2. The mixed *Eucalyptus—Acacia*—ericoid shrub association of the Great Dividing Range.

Other associations occur elsewhere in Queensland.

II. A Closed Forest Formation, represented by the two associations, ooline forest and (mature) brigalow scrub. The formation is richly developed further east, and includes true rainforest and other associations.

III. The Acacia Scrub Formation, including the following associations:—

1. Gidgea scrub (fig. 17).
2. Mulga scrub and its variations, including most of the communities of *Cassia phyllodinea* and some claypans (figs. 18-20).
3. Lancewood scrub.

IV. The *Triodia* Formation, with four well-defined associations—

1. The *Eucalyptus pallidifolia—E. leucophylla—Triodia* Association, comprising the first and second *Triodia* communities described above (fig. 32).
2. The Desert Sandstone Association, consisting of the *Triodia* communities associated with *Eucalyptus normantonensis*, gidgea, lancewood, and mulga. (The third community figs. 29-31.)
3. The Spinifex Sand Plain. (The fourth community—fig. 28.)
4. The sixth community (*T. irritans* or an allied species) is best regarded as a distinct association belonging to this formation.

V. The Grassland Formation with the following associations:—

1. The Blue Grass Association. (Fig. 2.)
2. The Ashy Downs Mitchell Grass Association. (Figs. 3-4.)
3. The Gravelly Downs Mitchell Grass Association. (Figs. 6-9.)
4. A Herb Steppe Association. (Fig. 11.)

Each of the first three associations consist almost entirely of the communities described above under these names. The various types described may be regarded as sub-associations. The fourth association consists of a small part of the annual chenopod communities, particularly those in which *Atriplex Muelleri*, *A. spongiosa*, *A. conduplicata*, *Bassia lanicuspis*, *B.* aff. *divaricata*, and *B. anisacanthoides* play an important part. The first association is complementary with both the second and third, and the third and fourth with one another. The second and third intergrade or alternate and may be in part complementary, but there is insufficient evidence on this point.

VI. The Channel Country Formation, included in which are:—

1. A Fringing Forest Association, including the *Eucalyptus coolabah* and *E. coolabah—E. ochrophloia* communities, and the minor communities described under these. (Fig. 37.)

2. The Herbaceous communities of the alluvial plains. (Figs. 37, 38.)
3. Most of the communities of *Atriplex nummularia* (old man saltbush).
4. Some of the cottonbush and samphire communities.
5. Some claypans.

The formation is a heterogeneous and discontinuous one, but the communities cannot be satisfactorily arranged elsewhere. They are all dependent more or less for their existence on the actual flooding of the country. Where water lies for any length of time, swamp conditions prevail, and as similar conditions occur beyond the limits of the true channel country, these communties have been considered to form a separate but likewise discontinuous formation.

VII. The Swamp Formation.—There is possibly but one association with, however, three well-marked consociations.

1. Lignum swamp. (Fig. 39.)
2. *Glyceria ramigera* (cane grass) swamp.
3. *Chenopodium* (including Blue bush, *C. auricomum*) swamps.

VIII. The Shrub Steppe Formation.—The best developed associations are—

1. The *Kochia planifolia* Association and other *Kochia* communities.
2. The *Atriplex vesicaria* Association, consisting of scattered communities of this species. (Fig. 35.)
3. The cotton-bush communities (in part).

The first of these associations is small in area and consists of scattered communities, the others are closely connected with, and grade into, associations of other formations.

IX. Desert.—The true desert in Queensland embraces the Simpson Desert (figs. 21-23) and Sturt's Stony Desert. The Simpson Desert consists of the true desert sandhills alternating with claypans, the latter of which sometimes carry gidgea, mulga, coolibah, or cotton-bush steppe. Near Poeppel Corner mulga occurs on the sandhills themselves.

The Stony Desert grades into the gravelly downs, and in places is complementary thereto. In its extreme form it carries a few plants of *Eremophila*, &c., and scattered plants of annual species of *Chenopodiaceae*, particularly *Bassia* spp. (fig. 5).

Ecotones.—Some of the above formations and associations are remarkably well defined, as for example, Mitchell grass grassland and Eucalyptus forest, grassland and the various *Triodia* associations, &c., but in others broad ecotones occur. This is particularly noticeable between Eucalyptus forest and mulga scrub. Sometimes gidgea scrub acts almost as an ecotone between the Mitchell grass associations and the other associations.

Explanatory Notes to the Map.—It has been found advisable to omit the swamp formation and not to distinguish the different associations of the forest, shrub steppe, and channel country formations. Broad ecotones are indicated by diamonds, alternes by narrow horizontal bands, and scattered small areas by triangles. These diamonds, bands, and triangles refer merely to areas in which these features occur, not to definite areas occupied. Likewise areas in which fluctuating climaxes occur are indicated by vertical bands.

The height of the geological hammer to be seen in some of the plates is 13 inches.

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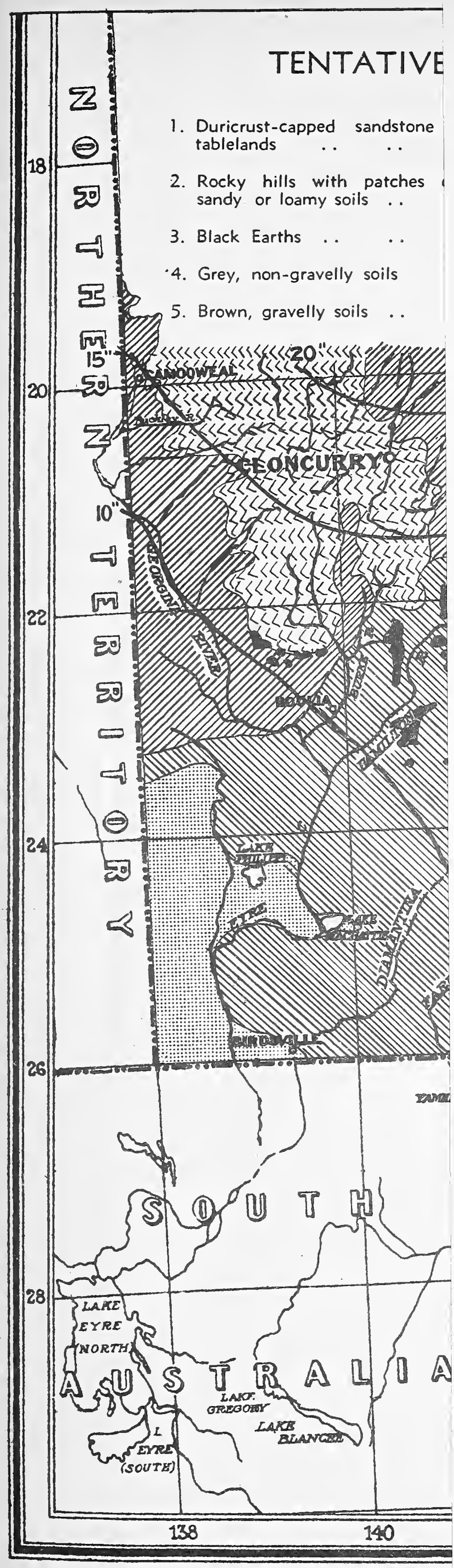
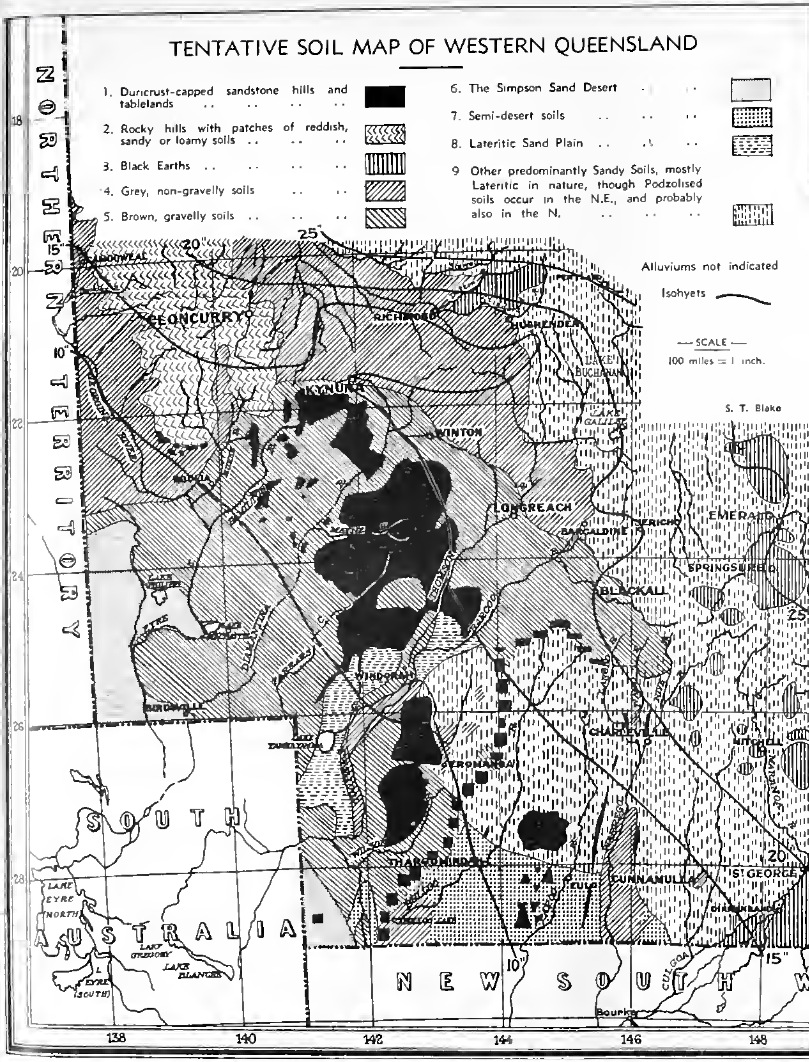

TENTATIVE
1. Duricrust-capped sandstone tablelands . . . .
2. Rocky hills with patches sandy or loamy soils . .
3. Black Earths . . . .
4. Grey, non-gravelly soils
5. Brown, gravelly soils . .
NORTHERN TERRITORY
SOUTH AUSTRALIA
CAMOOWEAL
CLONCURRY
GEORGINA
RIVER
BOULIA
HAMILTON
LAKE PHILLIPI
EYRE
LAKE MACHATTIE
DIAMANTINA
BIRDSVILLE
LAKE EYRE NORTH
LAKE GREGORY
LAKE BLANCHE
L EYRE (SOUTH)
20"
15"
10"
18
20
22
24
26
28
138
140


TENTATIVE SOIL MAP OF WESTERN QUEENSLAND
1. Duricrust-capped sandstone hills and tablelands
2. Rocky hills with patches of reddish, sandy or loamy soils
3. Black Earths
4. Grey, non-gravelly soils
5. Brown, gravelly soils
6. The Simpson Sand Desert
7. Semi-desert soils
8. Lateritic Sand Plain
9 Other predominantly Sandy Soils, mostly Lateritic in nature, though Podzolised soils occur in the N.E., and probably also in the N.
Alluviums not indicated
Isohyets
SCALE
100 miles = 1 inch.
S. T. Blake
NORTHERN TERRITORY
SOUTH AUSTRALIA
NEW SOUTH W
CLONCURRY
RICHMOND
HUGHENDEN
KYNUNA
WINTON
LONGREACH
BARCALDINE
JERICHO
EMERALD
SPRINGSURE
BLACKALL
WINDORAH
CHARLEVILLE
MITCHELL
THARGOMINDAH
CUNNAMULLA
ST GEORGE
DIRRANBANDI
EULO
BOULIA
Bourke
LAKE BUCHANAN
LAKE GALILEE
LAKE EYRE NORTH
LAKE EYRE (SOUTH)
LAKE GREGORY
LAKE BLANCHE
CULGOA
DIAMANTINA
THOMSON
BARCOO
18
20
22
24
26
28
138
140
142
144
146
148
25"
20"
15"
10"

2

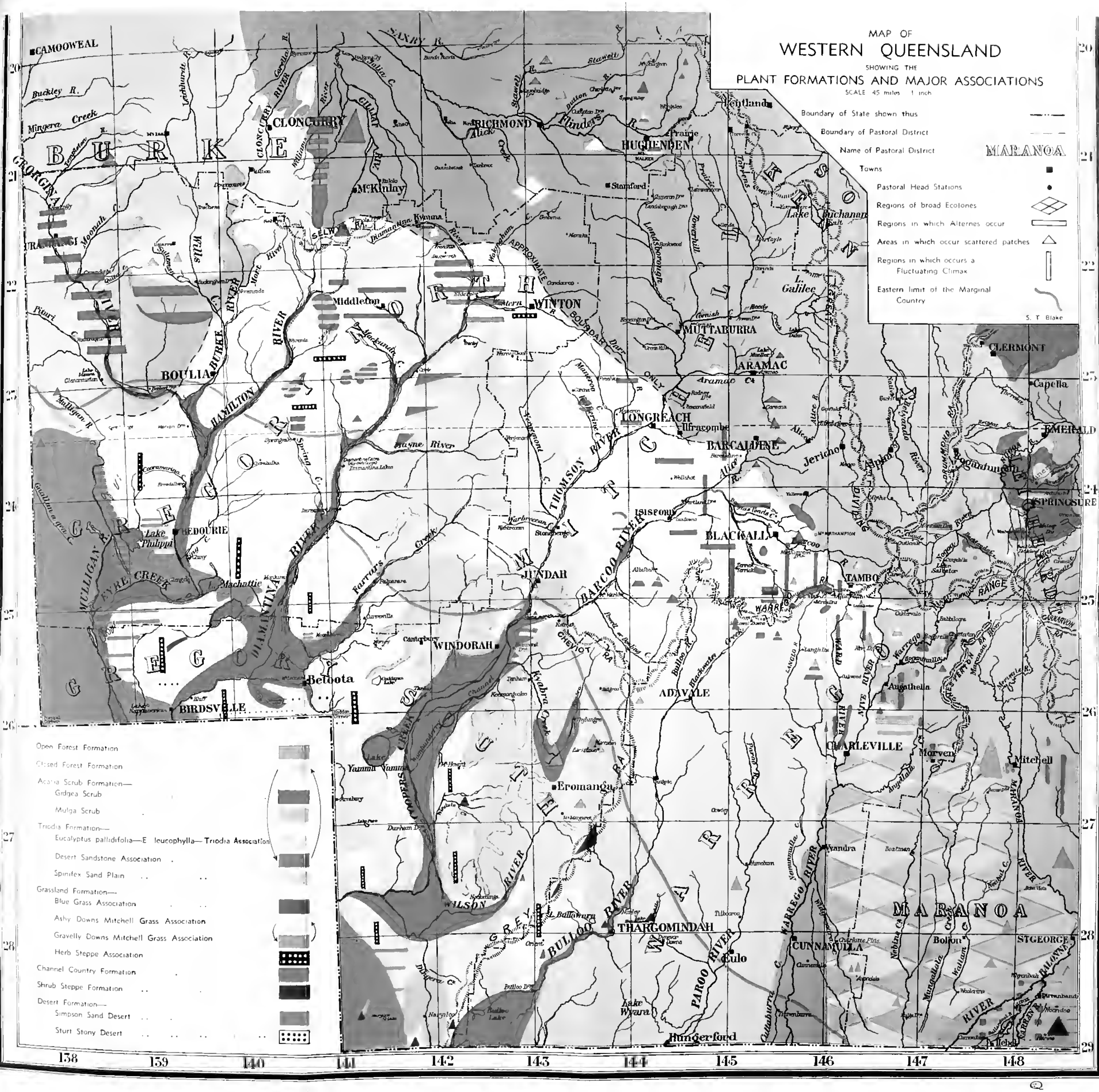

MAP OF
WESTERN QUEENSLAND
SHOWING THE
PLANT FORMATIONS AND MAJOR ASSOCIATIONS
SCALE 45 miles 1 inch
Boundary of State shown thus
Boundary of Pastoral District
Name of Pastoral District
MARANOA
Towns
Pastoral Head Stations
Regions of broad Ecotones
Regions in which Alternes occur
Areas in which occur scattered patches
Regions in which occurs a Fluctuating Climax
Eastern limit of the Marginal Country
S. T. Blake
Open Forest Formation
Closed Forest Formation
Acacia Scrub Formation—
Gidgea Scrub
Mulga Scrub
Triodia Formation—
Eucalyptus pallidifolia—E. leucophylla—Triodia Association
Desert Sandstone Association
Spinifex Sand Plain
Grassland Formation—
Blue Grass Association
Ashy Downs Mitchell Grass Association
Gravelly Downs Mitchell Grass Association
Herb Steppe Association
Channel Country Formation
Shrub Steppe Formation
Desert Formation—
Simpson Sand Desert
Sturt Stony Desert
BURKE
NORTH GREGORY
SOUTH GREGORY
MITCHELL
KENNEDY
LEICHHARDT
WARREGO
MARANOA
CAMOOWEAL
CLONCURRY
RICHMOND
HUGHENDEN
McKinlay
Stamford
Pentland
WINTON
Middleton
BOULIA
MUTTABURRA
ARAMAC
CLERMONT
Capella
LONGREACH
Ilfracombe
BARCALDINE
Jericho
Alpha
EMERALD
SPRINGSURE
ISISFORD
BLACKALL
TAMBO
JUNDAH
BEDOURIE
WINDORAH
Betoota
BIRDSVILLE
ADAVALE
CHARLEVILLE
Augathella
Morven
Mitchell
Eromanga
THARGOMINDAH
Eulo
CUNNAMULLA
Wyandra
Hungerford
Bollon
ST GEORGE
DIAMANTINA RIVER
THOMSON RIVER
BARCOO RIVER
COOPERS CREEK
WARREGO RIVER
PAROO RIVER
BULLOO RIVER
WILSON RIVER
GEORGINA
MULLIGAN R.
EYRE CREEK
HAMILTON RIVER
BURKE RIVER
FLINDERS R.
APPROXIMATE BOUNDARY ONLY
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Fig. 1.—Near Barcaldine. Junction of the "desert" (the sandy forest country on the left) and the "downs" (the grassland on heavy soil to the right. A gidgea scrub is visible in the extreme distance).

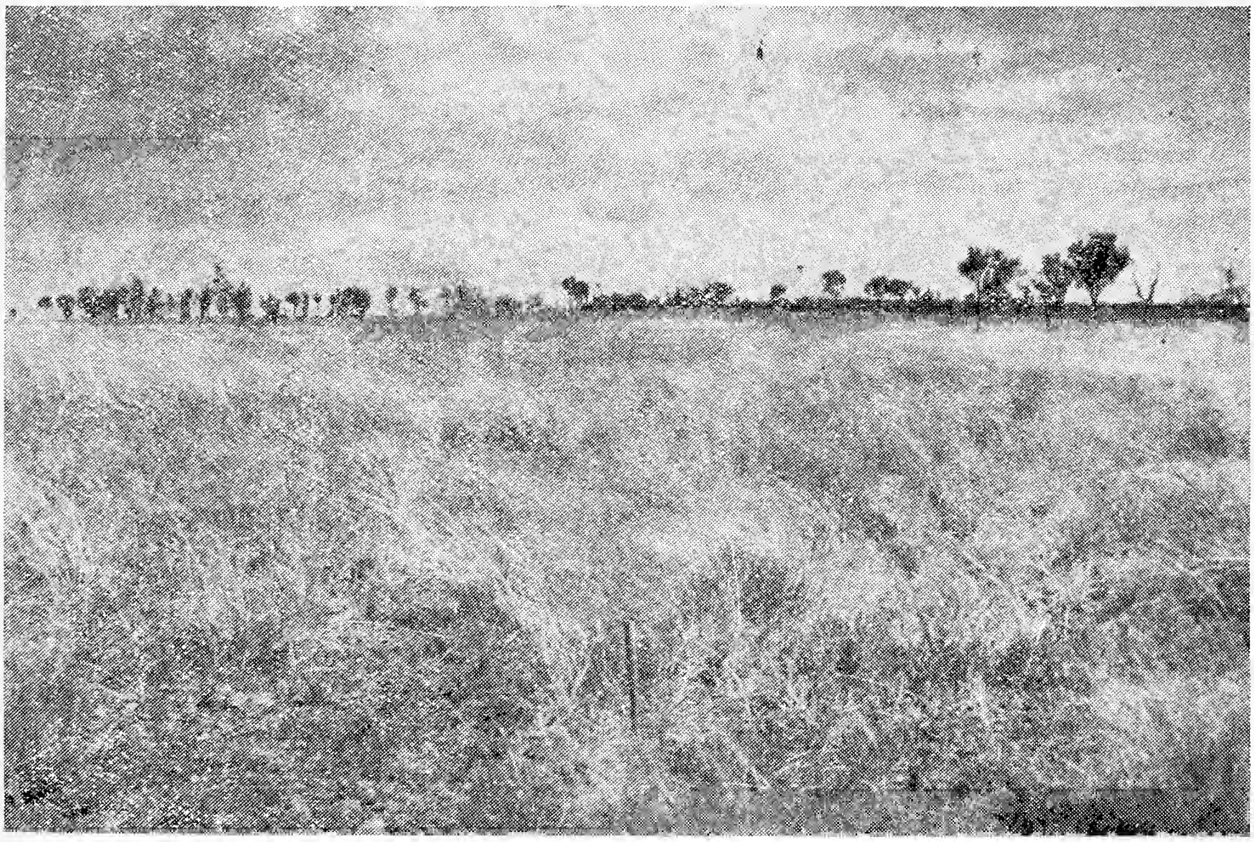

Fig. 2.—Chesterton. Blue-grass grassland with chiefly *Dichanthium sericeum, Thellungia advena, Aristida leptopoda, Bothriochloa erianthoides,* and *Themeda avenacea*; *Eucalyptus melanophloia* in the distance.

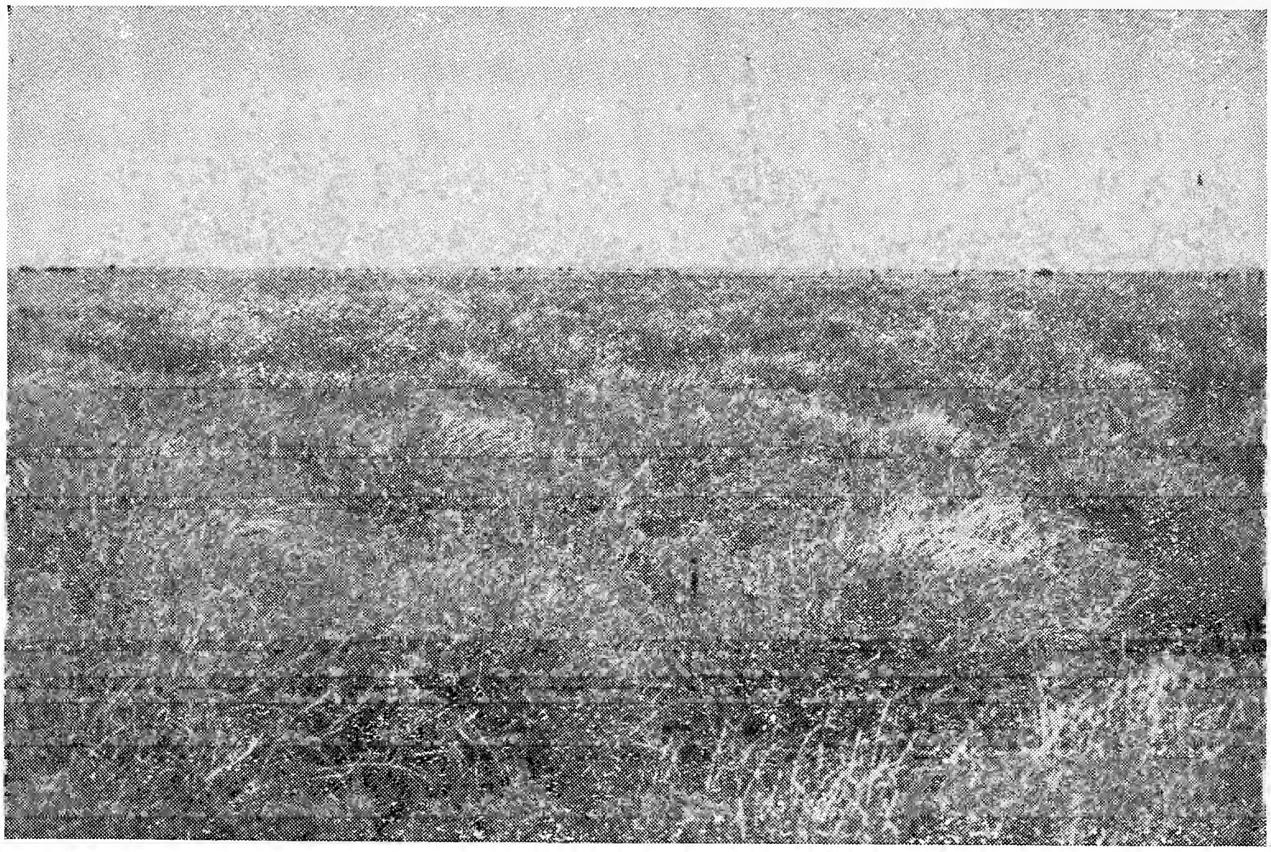

Fig. 3.—Frensham, near Kynuna. Ashy Downs with *Astrebla elymoides*, *A. lappacea*, *Iseilema* spp., and other plants.

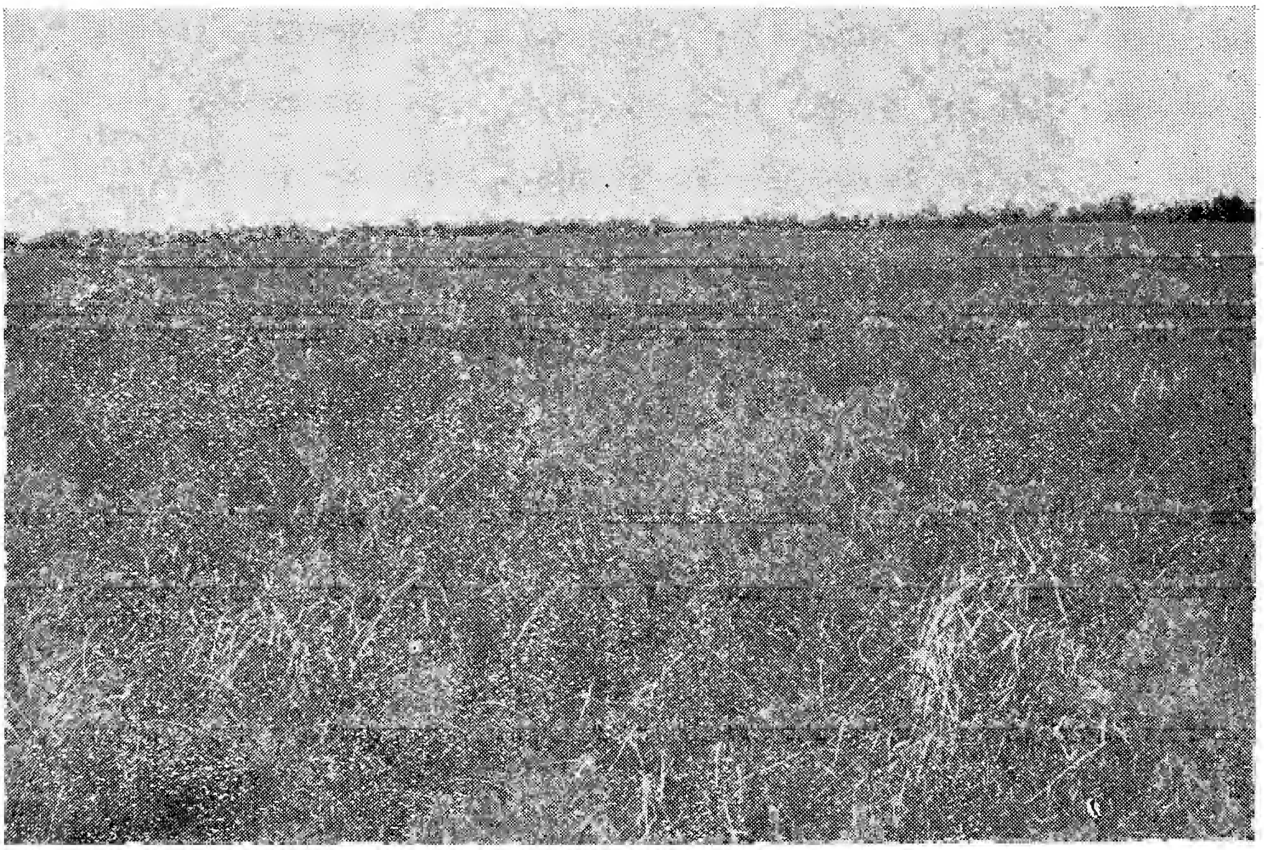

Fig. 4.—About twenty miles south of Wyandra. Ashy Downs (on old alluvium) showing *Astrebla lappacea*, *A. elymoides*, *Iseilema* spp. and other plants. Fringing forest in the background.

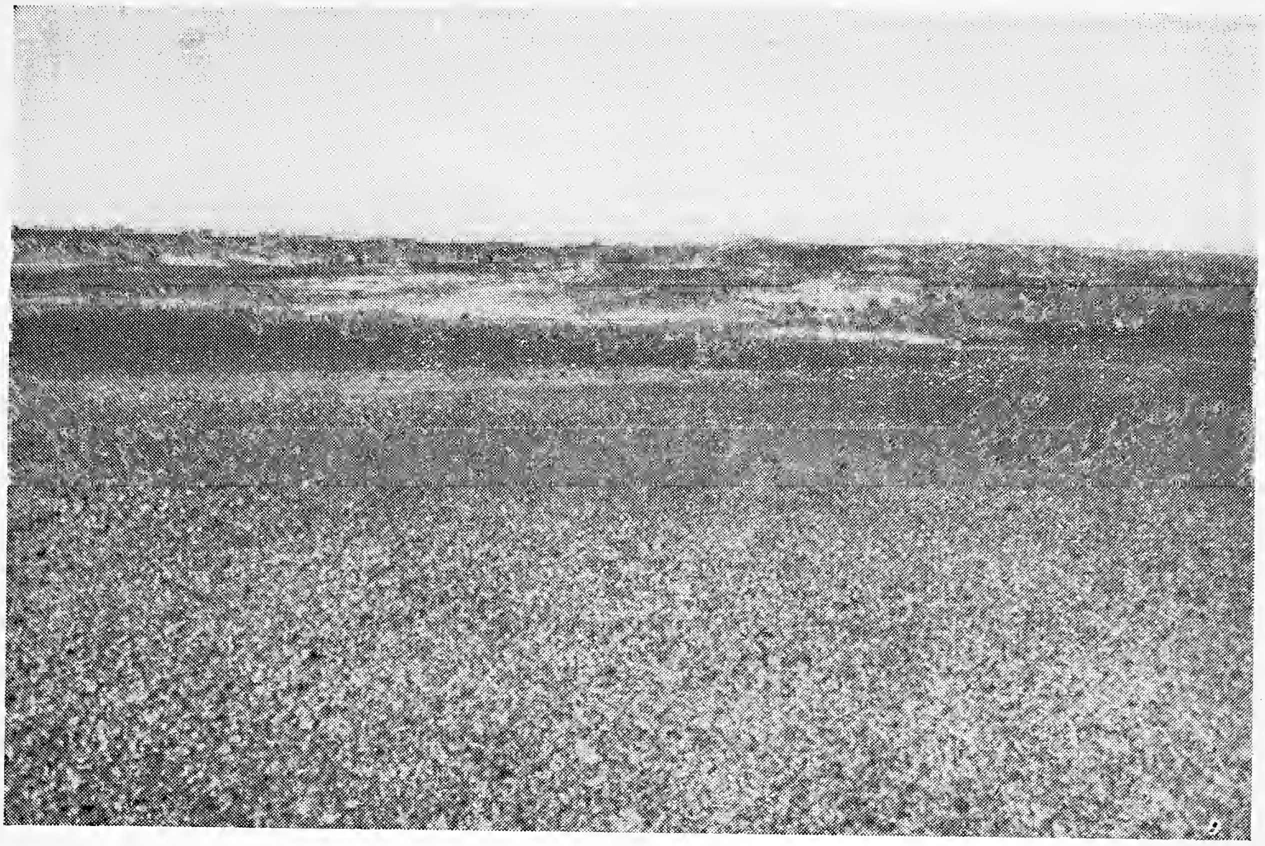

Fig. 5.—East of Birdsville, lat. 25° 45′ S. long. 140° E. on Sturt's Stony Desert; vegetation restricted almost entirely to a few shrubs of *Eremophila Latrobei* in the gullies of the ridges. A solitary plant of *Bassia* sp. aff. *divaricata* in left foreground.

Fig. 6.—South-east of Haddon Corner. Gravelly Downs showing crabholes; the plants, chiefly *Astrebla pectinata, Sporobolus actinocladus, Bassia* spp., and *Atriplex* spp., are restricted to the crabholes.

Fig. 7.—Elderslie Station, west of Winton. Gravelly Downs showing alterne of *Bassia lanicuspis* (in foreground) and *Astrebla pectinata*. Gidgea (*Acacia Cambagei*) in far distance.

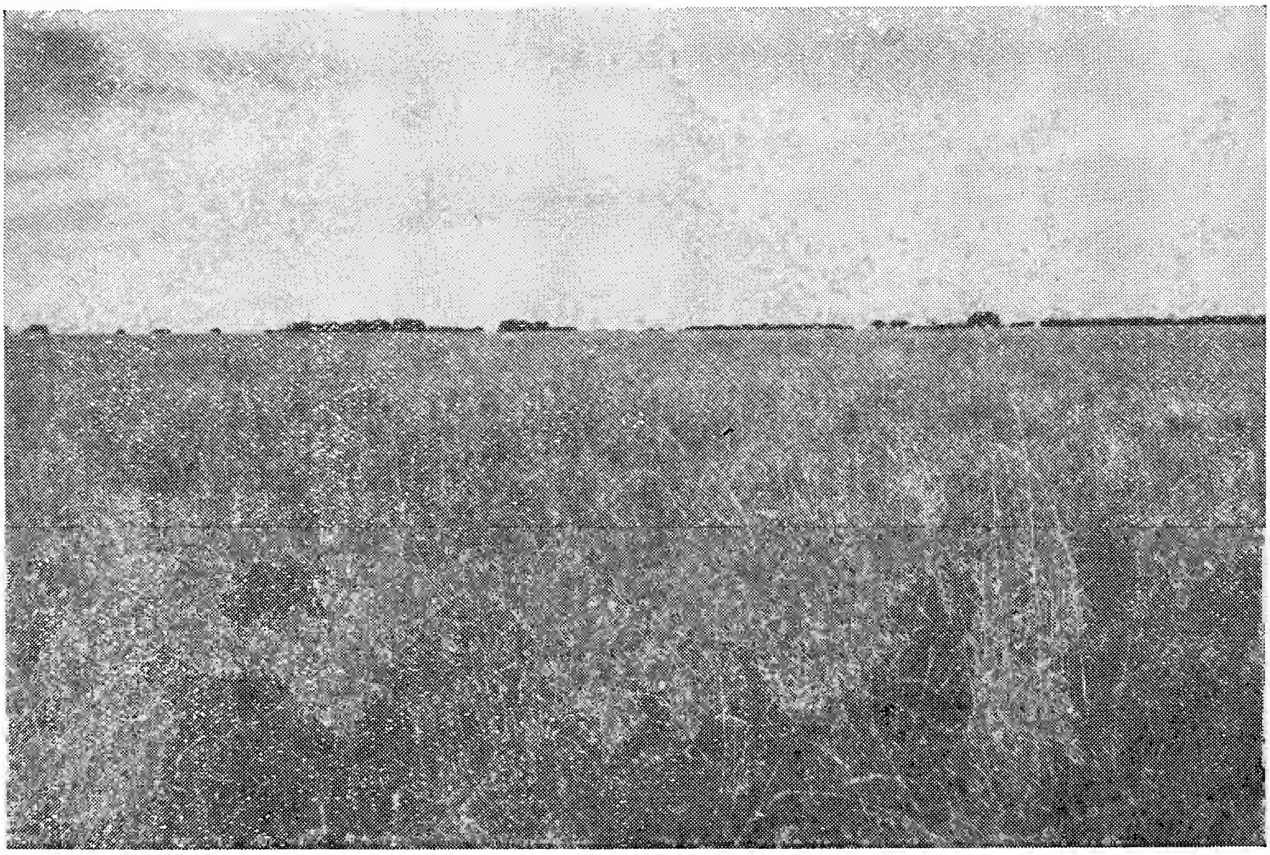

Fig. 8.—Elderslie Station, west of Winton. Gravelly Downs showing heavy coating of Mitchell grass, &c., chiefly *Astrebla pectinata* and *A. elymoides* with *A. squarrosa* in crabholes (as at bottom right), together with *Iseilema membranaceum*, *Panicum Whitei*, *Abutilon malvifolium*, &c.

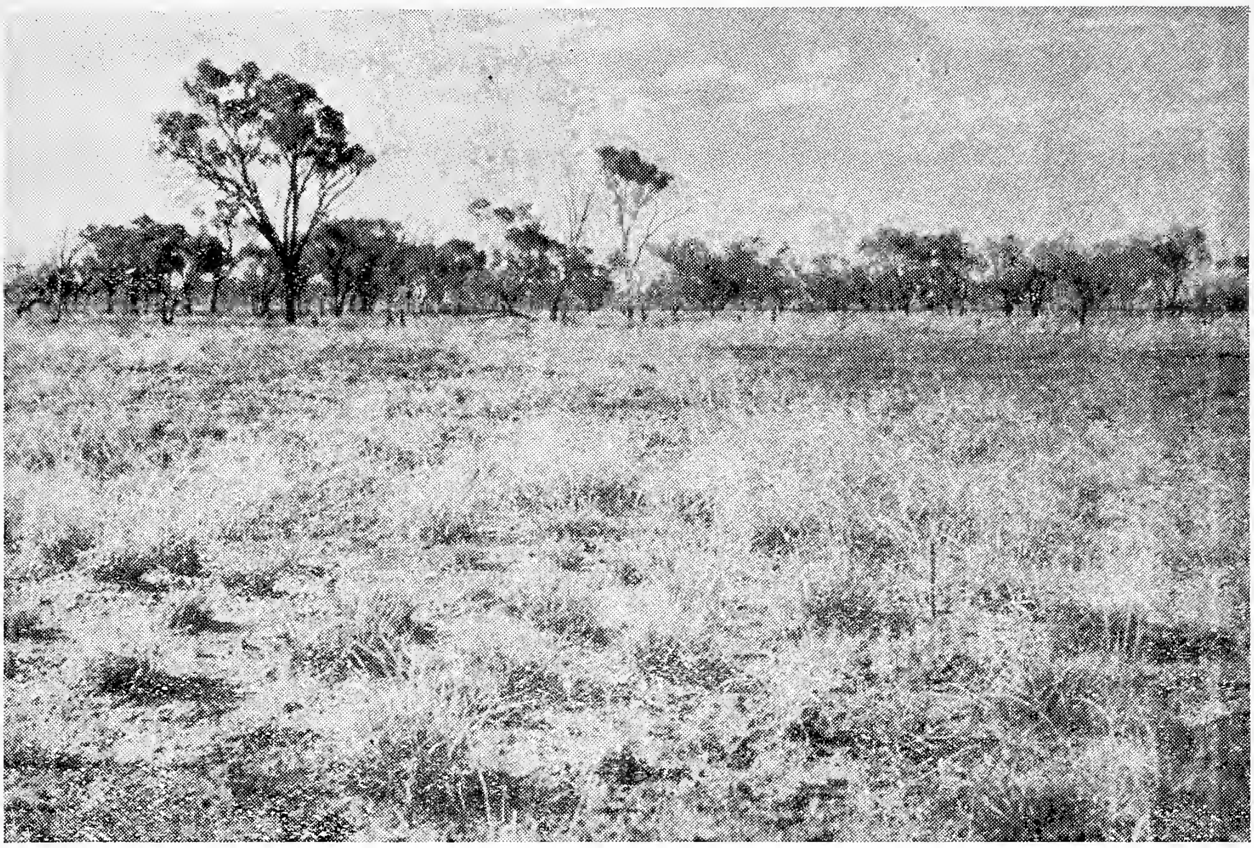

Fig. 9.—Near Longreach. Gidgea—boree Downs showing grazed Mitchell grass, chiefly *Astrebla pectinata* and *A. lappacea,* with *A. squarrosa* in crabholes; young *Atriplex Muelleri, Bassia echinopsila,* and *Salsola* also present. Most of the trees are gidgea, with boree in centre distance.

Fig. 10.—Kalkadoon Station, south-west of Winton. Gidgea and *Bassia* spp. being replaced by grass (the whitish plants).

Fig. 11.—West of Thargomindah on western slope of Grey Range. Gravelly Downs, herb steppe stage; chiefly *Bassia* spp. and *Atriplex* spp., with a few plants of *Astrebla pectinata* (whitish plants) and, in foreground, dead dwarf gidgea. In the distance is a gidgea-fringed creek, and on the skyline a range of desert sandstone hills.

Fig. 12.—About ten miles north of Birdsville. Gravelly Downs with drift sand carrying waddy (*Acacia Peuce*, the tree), *Kochia* sp., *Cassia* sp., *Stenopetalum lineare*, *Iseilema eremaeum*, and other plants.

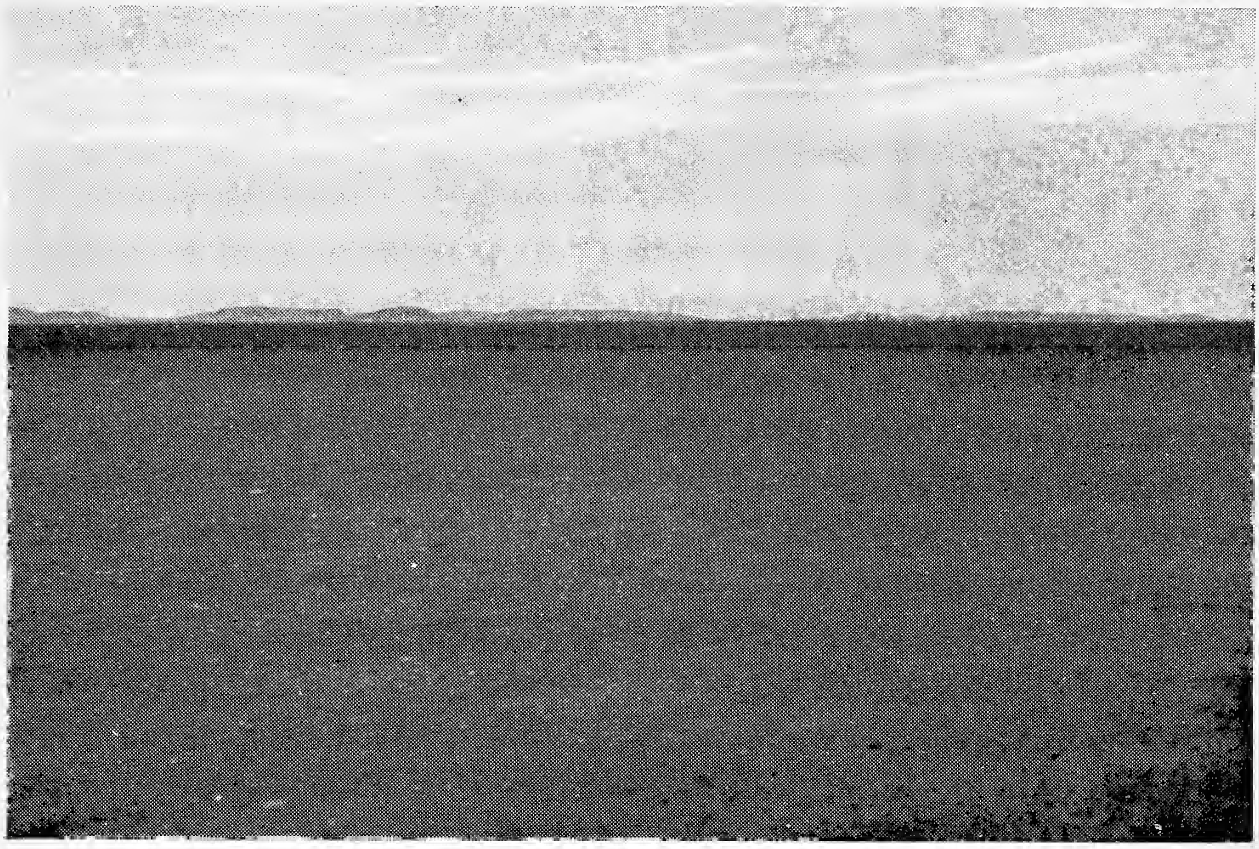

Fig. 13.—Near Middleton. Stock route on Gravelly Downs overgrazed to bareness. Hills of desert sandstone in the distance.

Fig. 14.—Cunnamulla. A claypan in an old alluvium, showing a sandy "island" with annual plants, including *Tragus biflorus, Aristida anthoxanthoides, Dactyloctenium radulans,* and *Bassia lanicuspis.* Fringing forest of *Eucalyptus coolabah* in the background.

Fig. 15.—Near Barcaldine. A boundary fence on Ashy Downs; on the right is a heavily-stocked paddock, showing a good growth of Mitchell grass; while on the left is vacant ground with a sparse vegetation of chiefly *Salsola* and *Euphorbia Stevenii.*

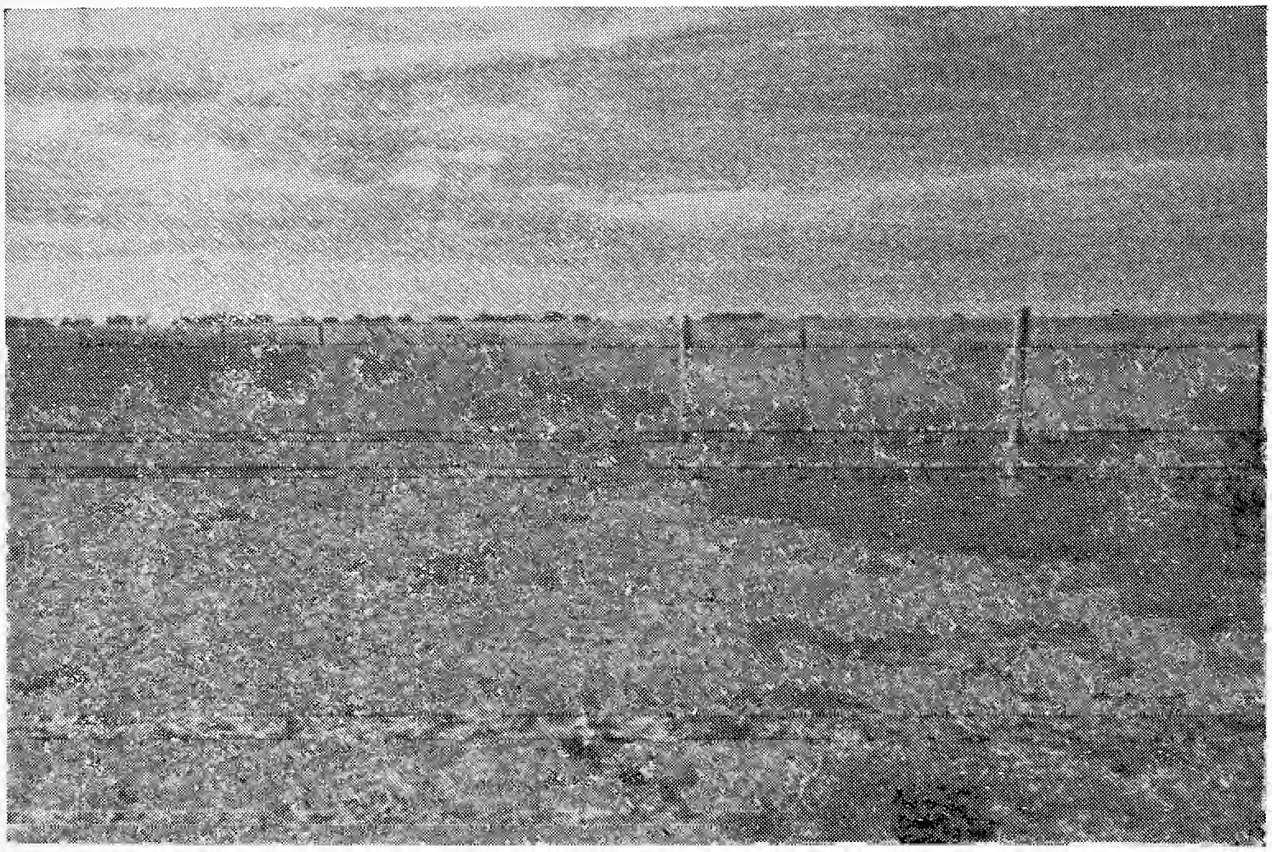

Fig. 16.—Essex Downs, south of Richmond. Dividing fence on grassland, running north-south between two paddocks which have been similarly stocked. The near side has been overgrazed, and the far side but slightly grazed, due to the tendency for sheep to graze into the prevailing easterly wind. The country is intermediate between true gravelly downs and ashy downs, but approaches the former.

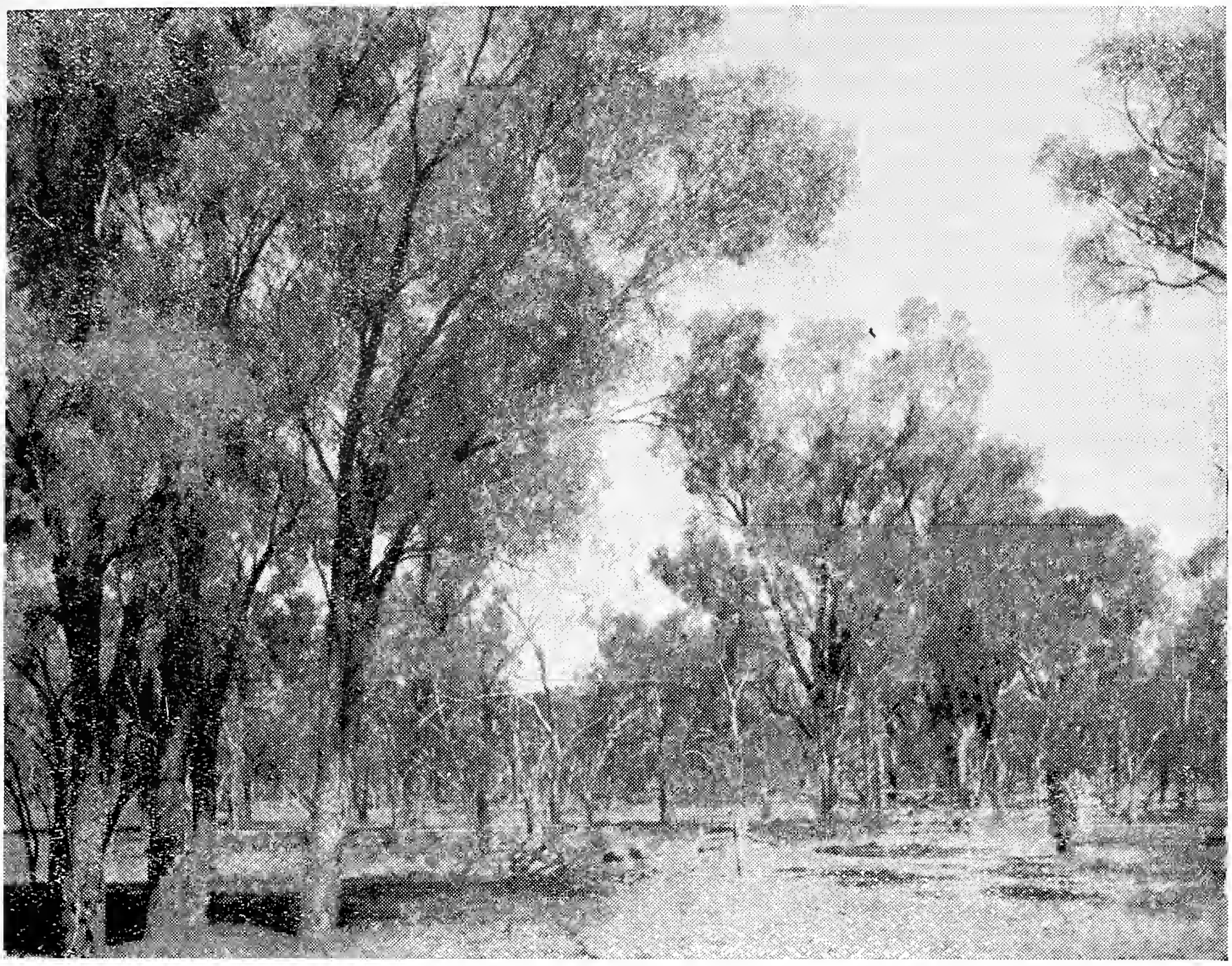

Fig. 17.—Twenty-five miles south of Wyandra. Gidgea scrub with a sparse ground cover of *Tripogon loliiformis*, *Atriplex* spp. and *Salsola*. *Eremophila Mitchellii* in right middle distance.

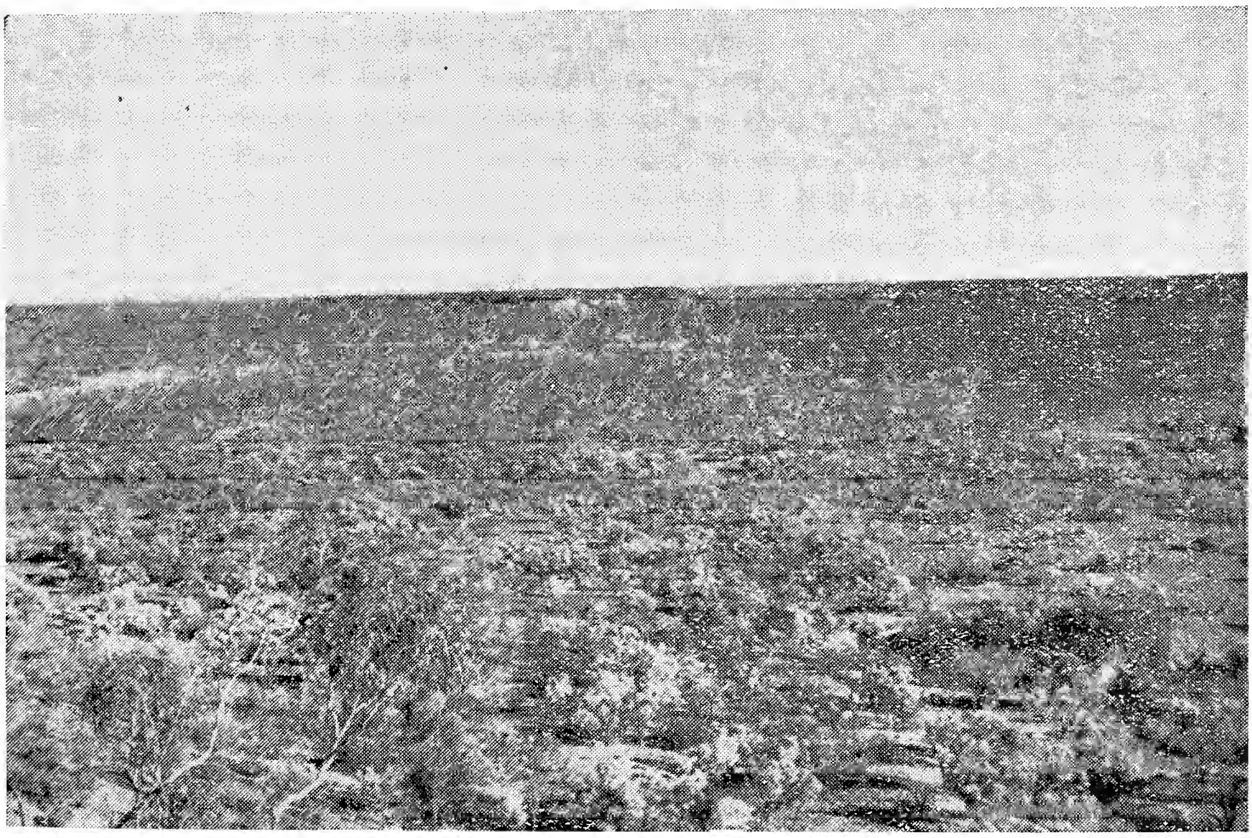

Fig. 18.—West of Eromanga, in hilly sandstone country. Overlooking mulga scrub, showing the spatial distribution of the trees. In the left foreground can be seen *Eucalyptus Thozetiana* growing on the side of the hill.

Fig. 19.—About twenty miles west of Cunnamulla. Mulga regenerating from pruning; *Enneapogon* sp., *Bassia* spp., and *Salsola* in foreground.

Fig. 20.—About forty miles south of Eromanga. Mulga country showing destruction caused by improper methods of cutting.

Fig. 21.—Near Birdsville. Sandhill desert; north end of sandhill showing sand blowing. Channel country of the Diamantina beyond.

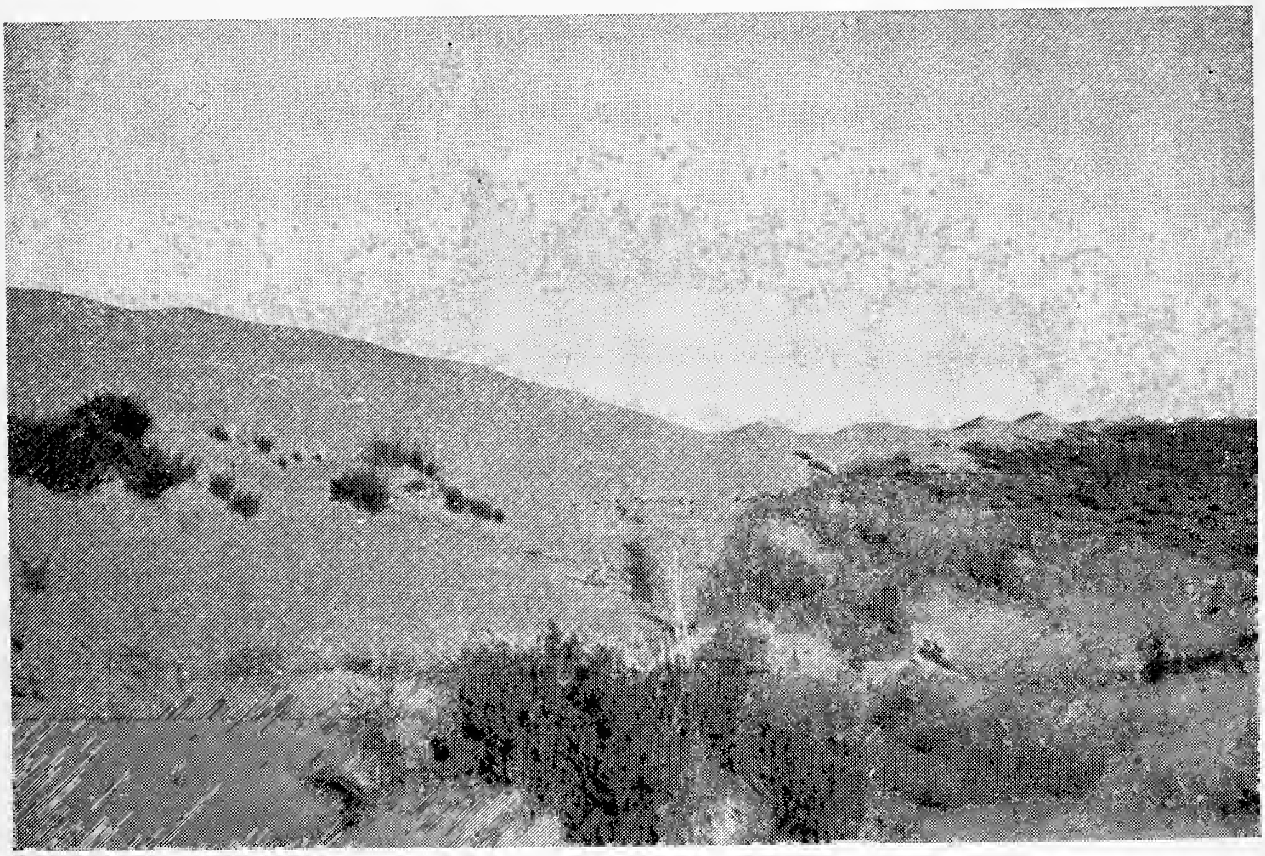

Fig. 22.—Near Birdsville. View along the length of the sandhill figured above (western side), showing the characteristic naked crest, and the sandhill canegrass (*Spinifex paradoxus*) holding the sand on the lower slopes.

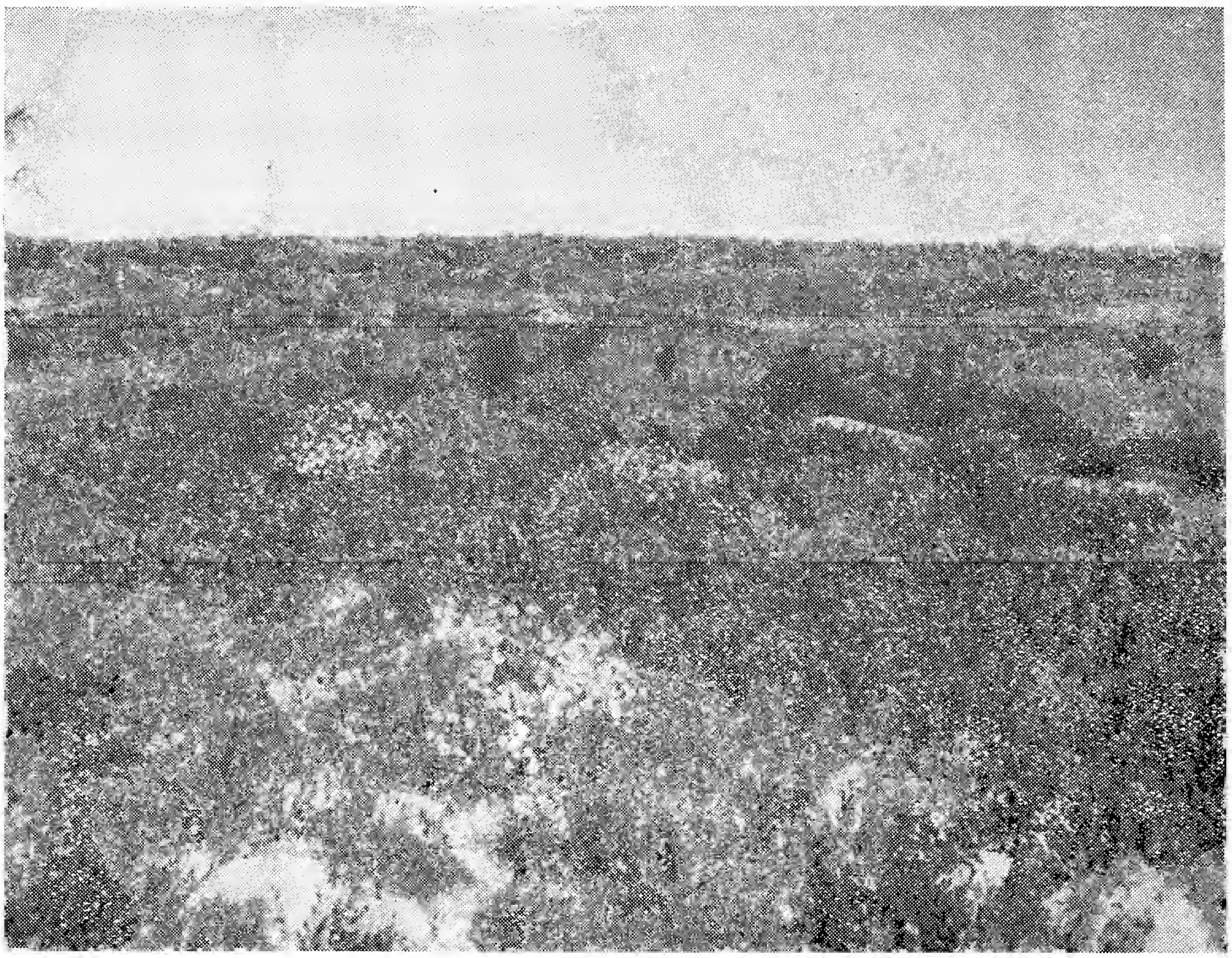

Fig. 23.—Near Birdsville. Near the base of the sandhill in Figs. 21 and 22, showing wealth of flowering annuals, chiefly *Goodenia cycloptera* ? (small flowers), and *Myriocephalus Stuartii* (with large flowers), together with *Blennodia canescens* and *Spinifex paradoxus* (the shrubby plants in centre).

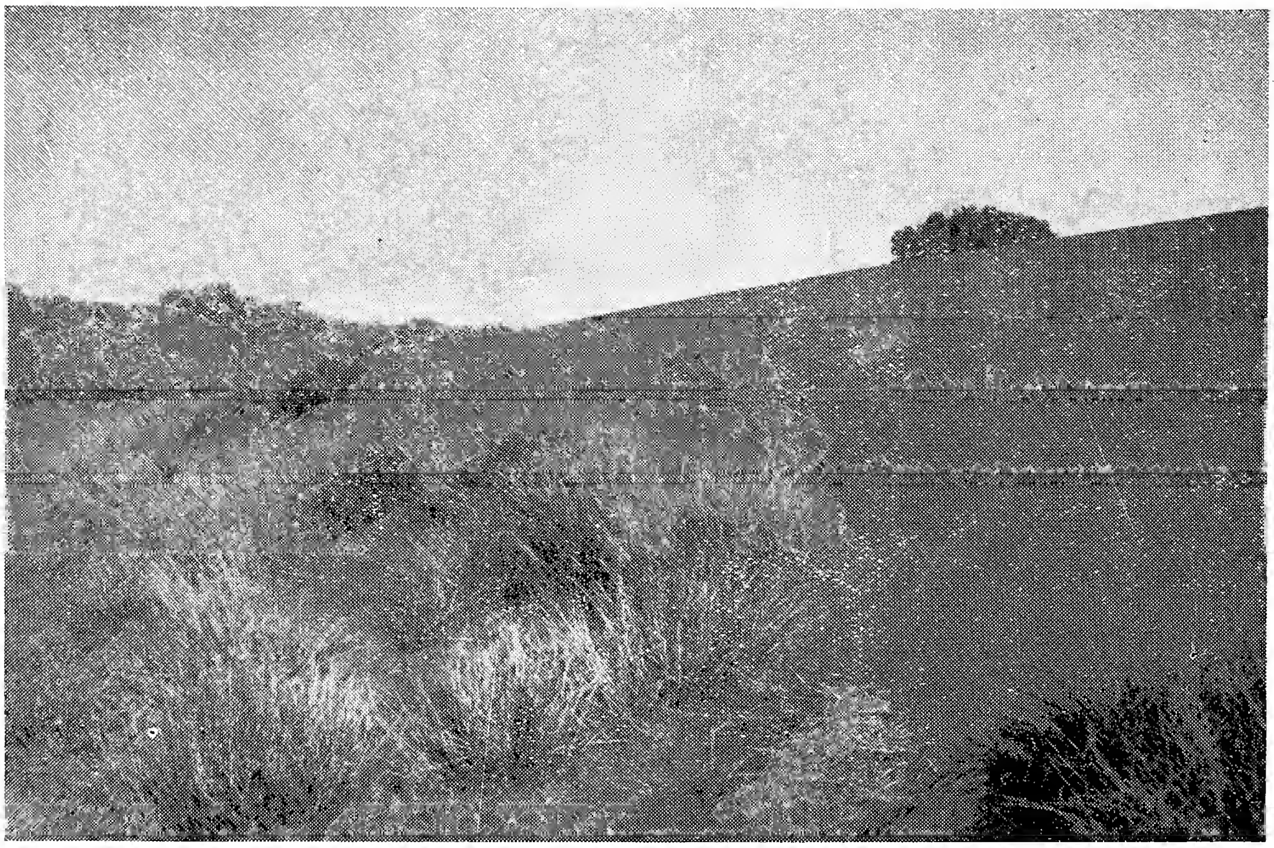

Fig. 24.—Nockatunga country. A sandhill of the marginal country, with *Plagiosetum refractum* colonising the bare side and a shrub of *Acacia ligulata* on top. Note the irregular direction of the hill.

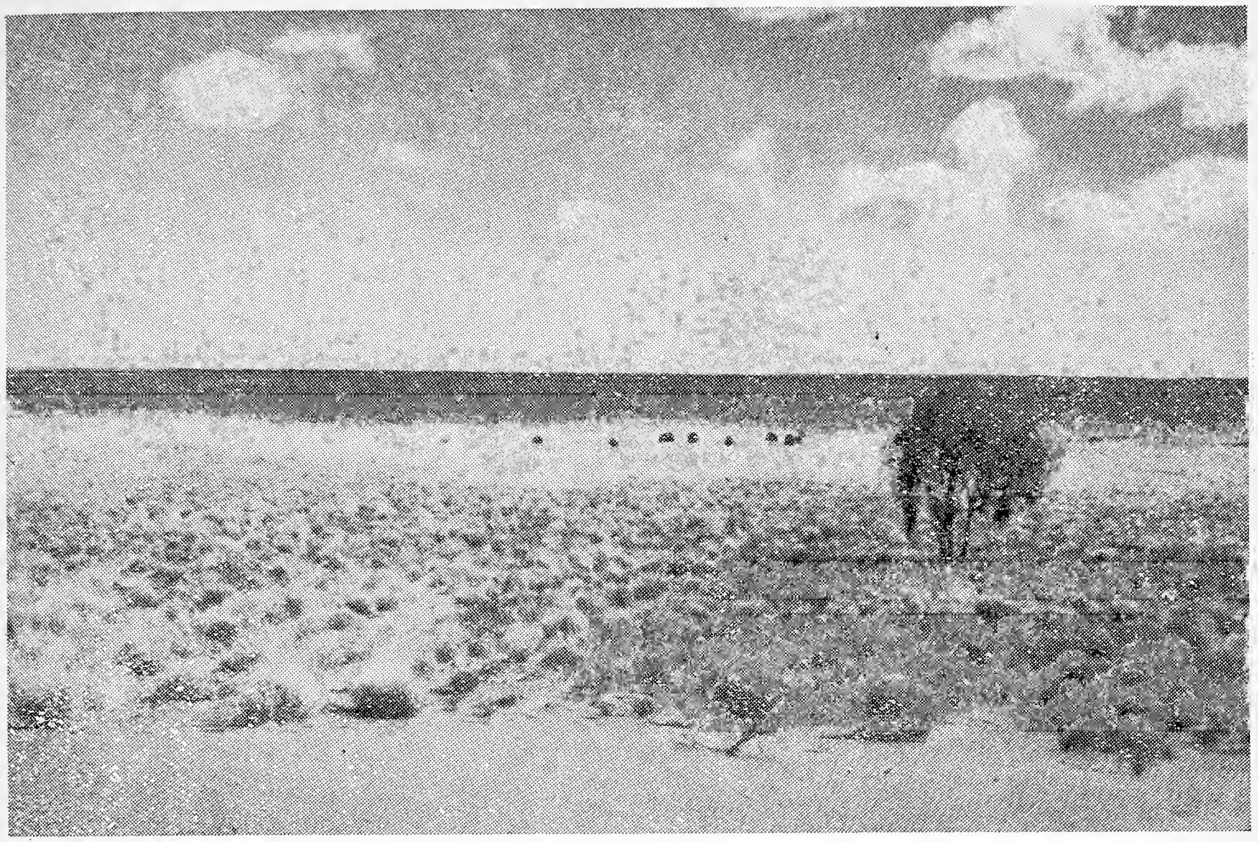

Fig. 25.—Mount Howitt. Marginal country showing "spread" of sandhill. The extent of the "spread" is shown by the whitish area carrying a mixed partly perennial vegetation, of which *Crotolaria eremaea* (small shrubs in foreground), *Eriachne* spp., *Aristida* spp., *Neurachne* sp., and *Salsola* are most prominent. The tree is a bloodwood (*Eucalyptus pyrophora*), the dark shrubs in the mid-distance are *Cassia* spp., and beyond is open plain (gravelly downs, *Bassia* stage).

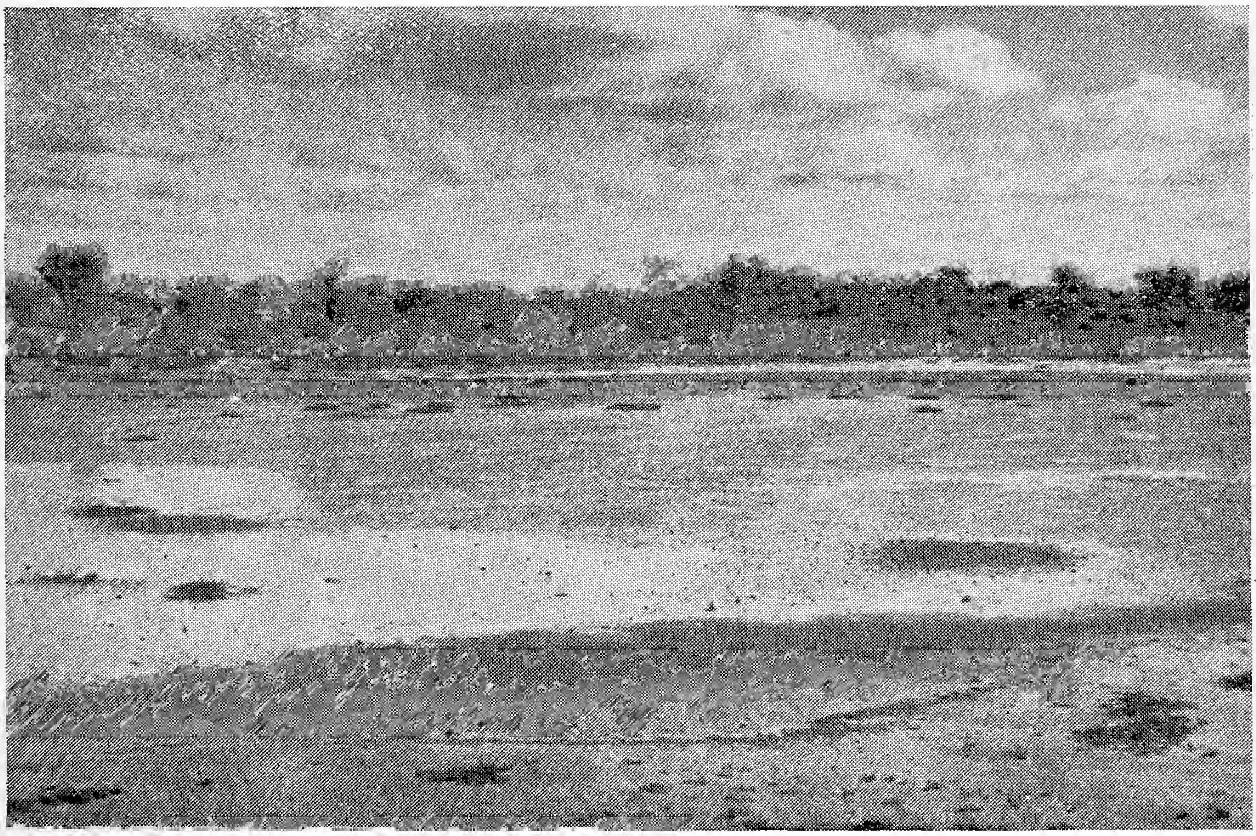

Fig. 26.—Mount Howitt. A shallow lake, not yet dry, actually in a sandhill, with pigweed (*Portulaca* sp.) and nardoo (*Marsilea Drummondii*), while beyond is a heavily-vegetated part of the ridge carrying, among other plants, *Hakea leucoptera* and *Rhagodia parabolica*.

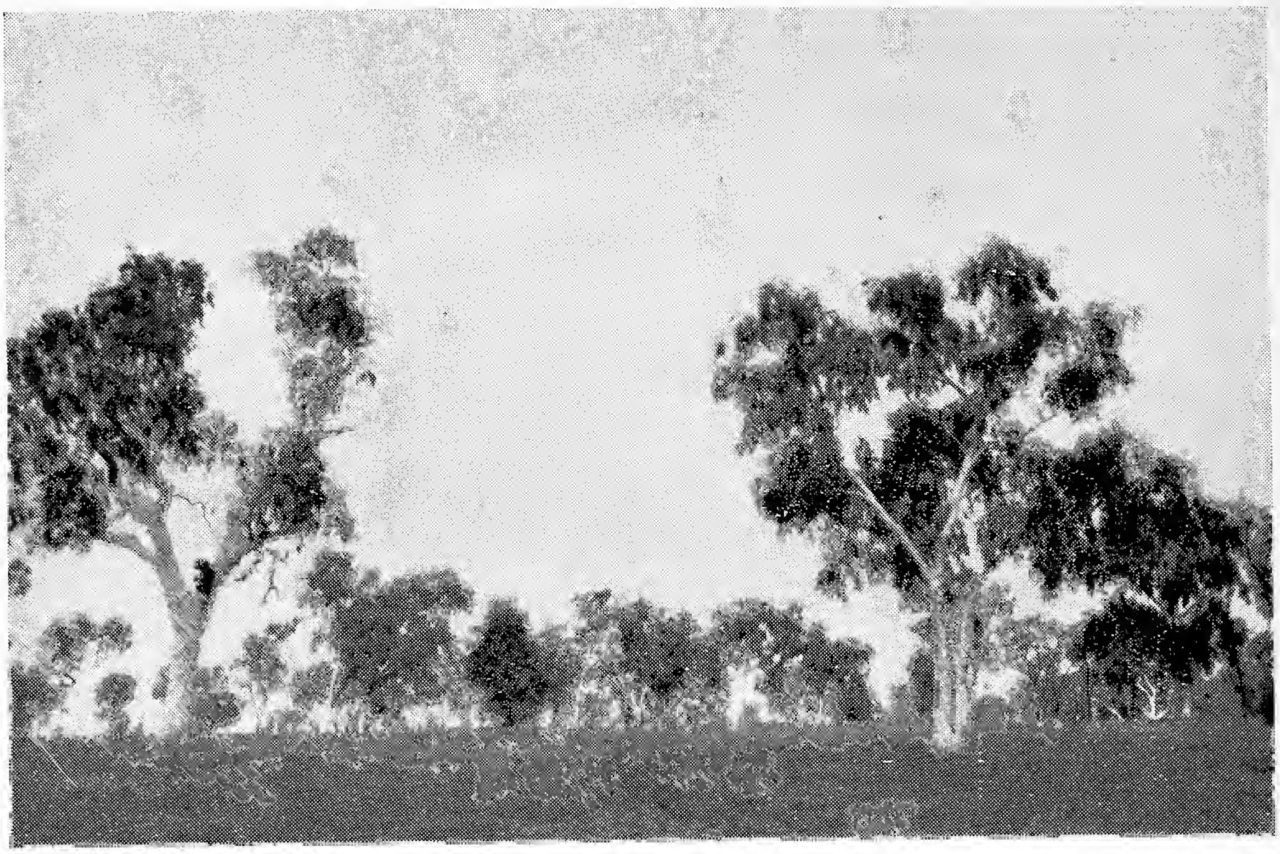

Fig. 27.—Near (south of) Boulia. The final stage in the degradation of the desert sandhills; a low, scarcely perceptible ridge of sand with large trees of *Euca yptus papuana.*

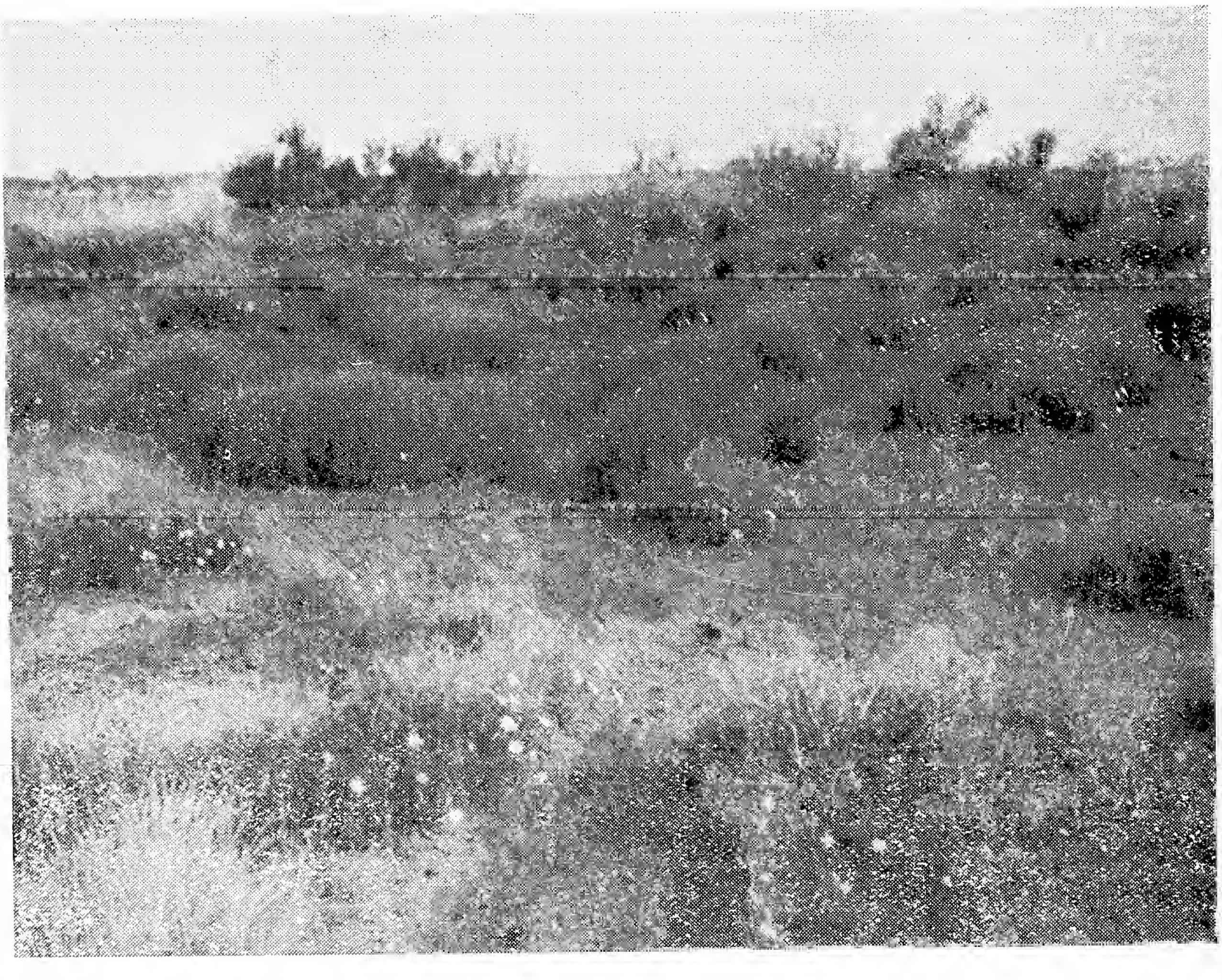

Fig. 28.—Tanbar country, south-west of Windorah. Spinifex sand-plain with *Triodia Basedowii*, *Senecio Gregorii* (the small, large-flowered plant) and shrubs of *Hakea Ivoryi* behind.

Fig. 29.—Tranby. Edge of part of the Desert Sandstone showing the characteristic flat-topped, duricrust-capped hills in various stages of weathering and vegetated by gidgea, lancewood, and *Triodia*.

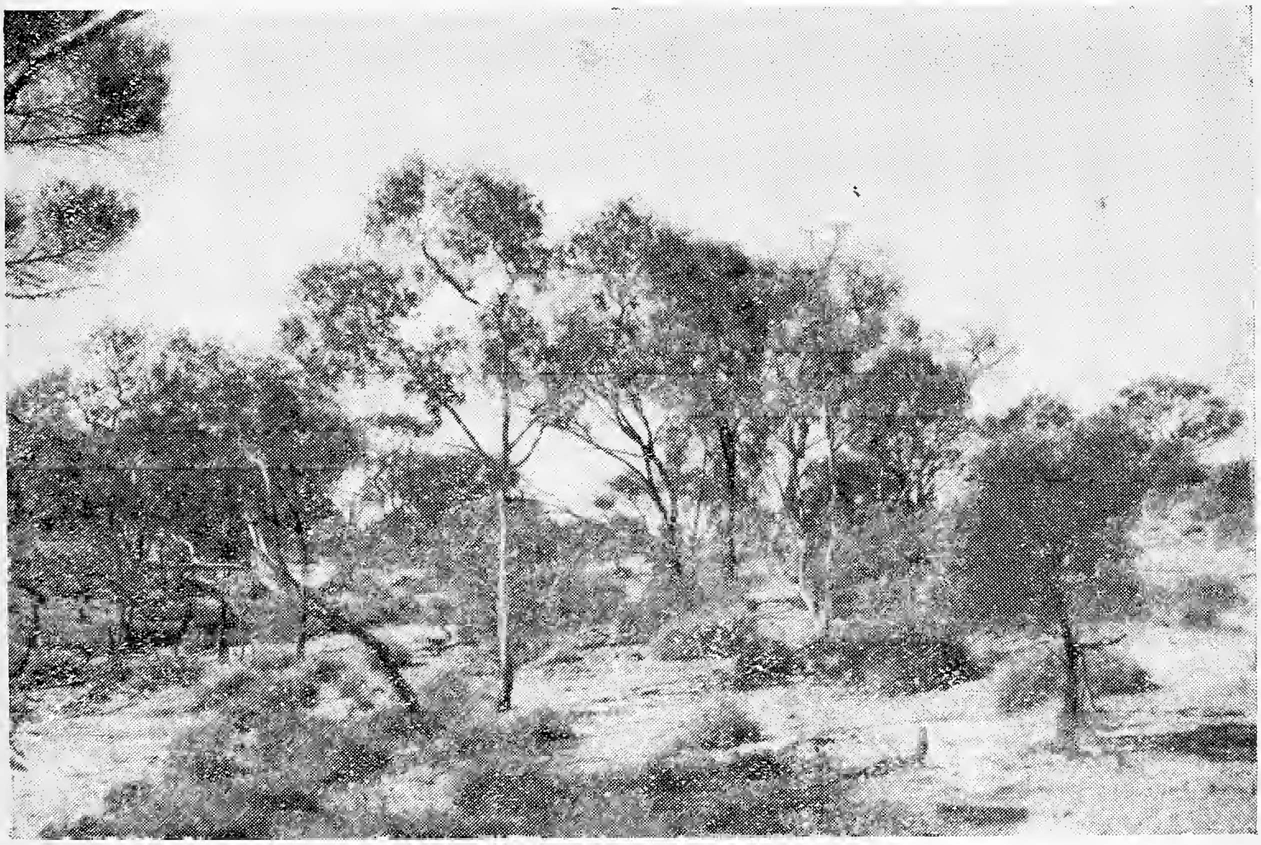

Fig. 30.—Tranby. Desert Sandstone tableland with lancewood and *Triodia*; *Eucalyptus* sp. in centre.

Fig. 31.—Tranby. A valley in the Desert Sandstone with *Eucalyptus normantonensis* and *Triodia*.

Fig. 32.—Between Duchess and Malbon. *Eucalyptus pallidifolia* and *Triodia pungens* with *Cassia* sp., and *Trichinium* sp.

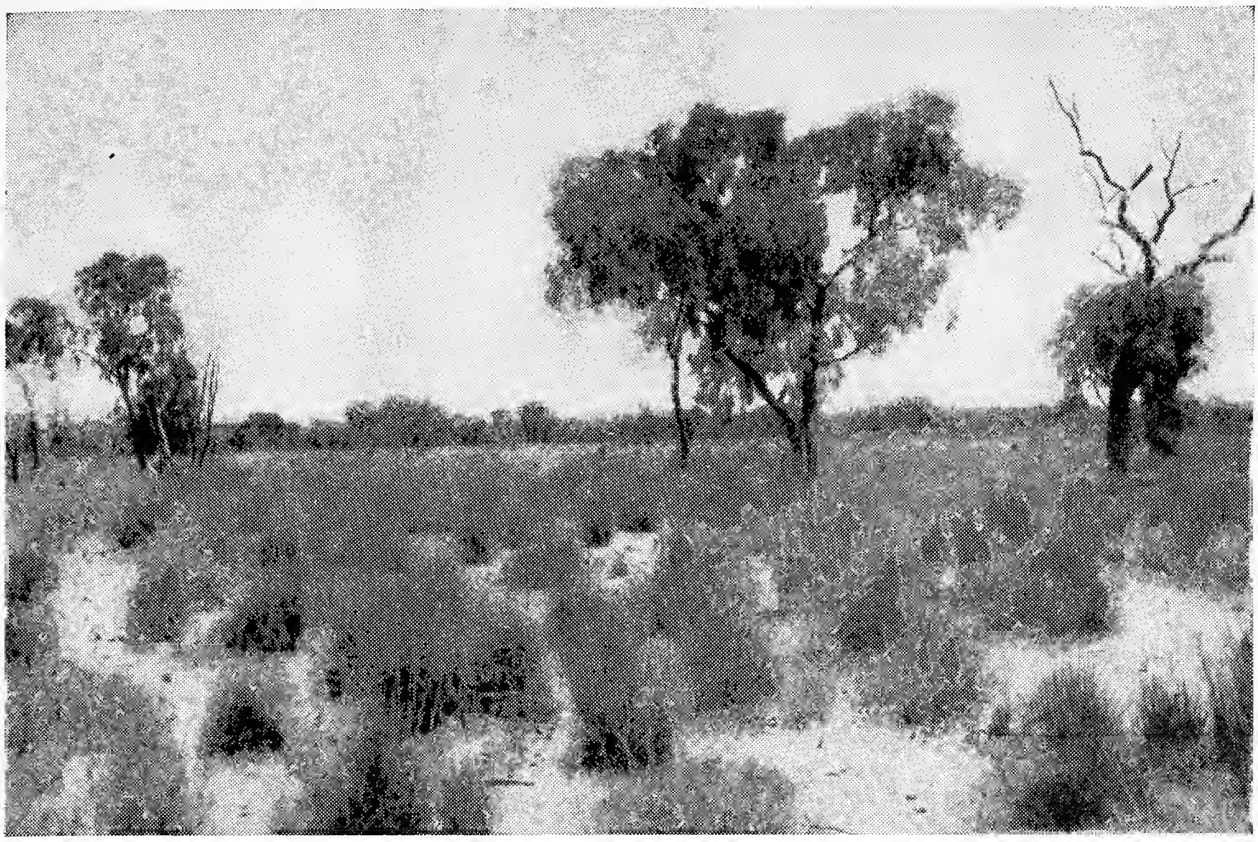

Fig. 33.—Near Alice. *Eucalyptus erythrophloia* and *Triodia Mitchellii* on red sand.

Fig. 34.—Minerva, north of Springsure. *Eucalyptus populifolia*—*E. melanophloia* forest.

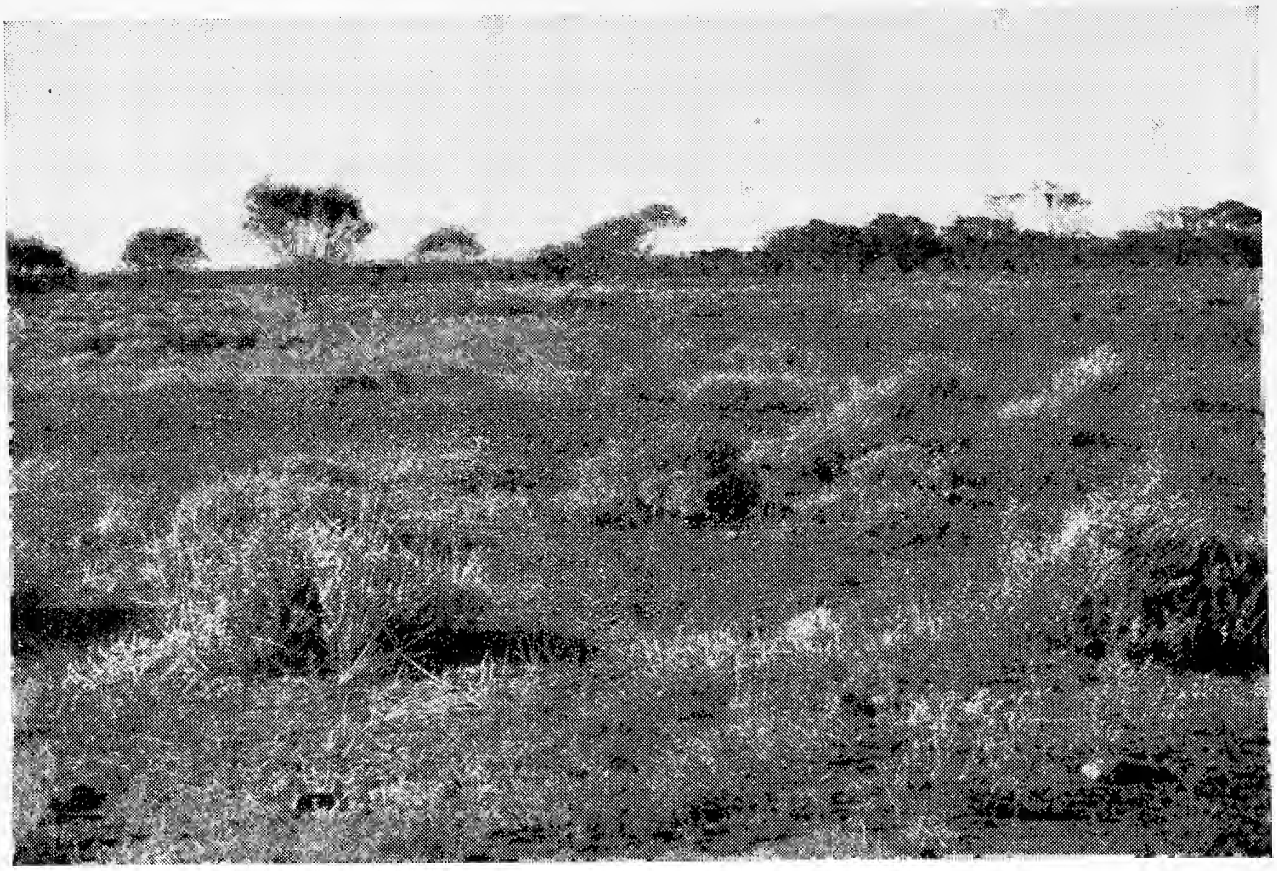

Fig. 35.—West of Thargomindah on slopes of the Grey Range. Saltbush steppe; the large bushes are *Atriplex vesicaria,* with chiefly annual spp. of *Atriplex* and *Bassia* between; in the centre distance is *Eremophila Dalyana* (shrubby trees) with gidgea beyond.

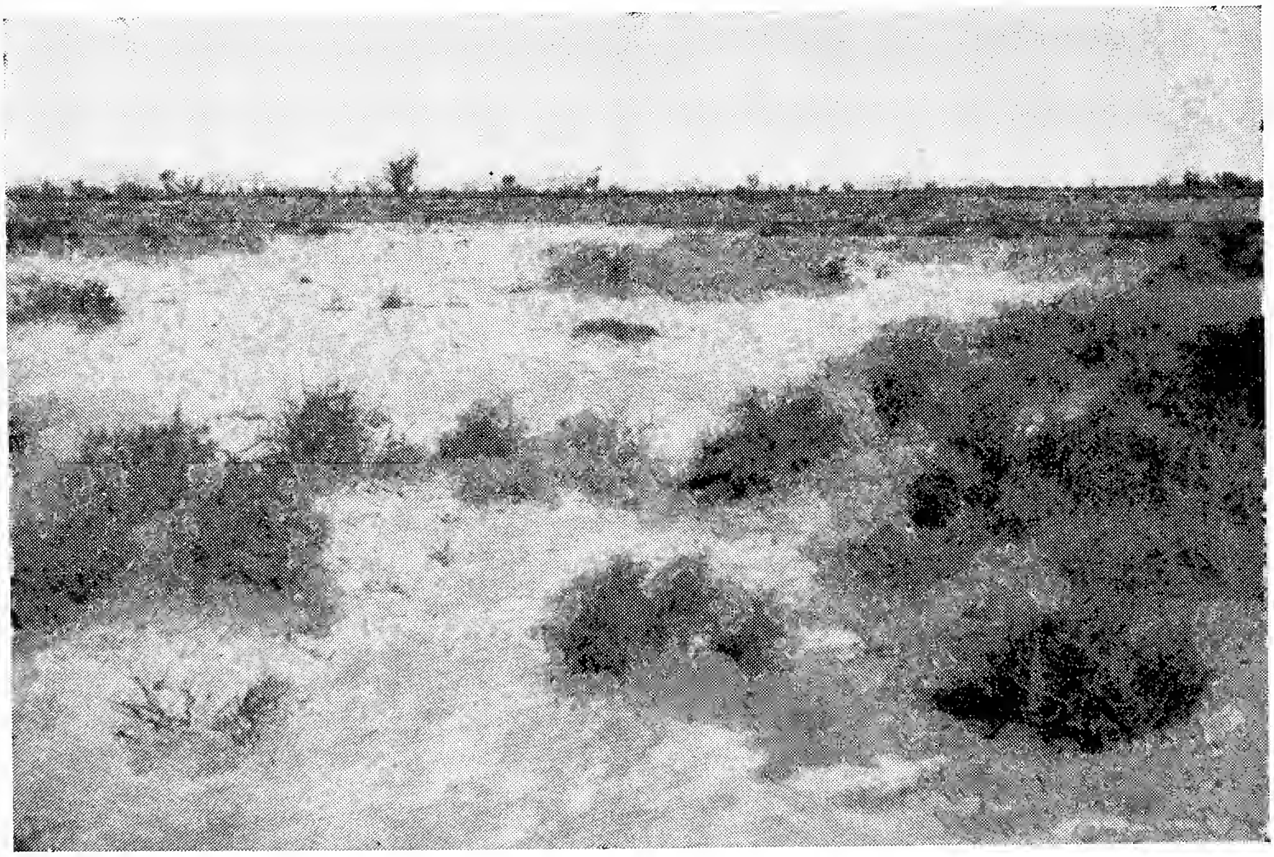

Fig. 36.—Nockatunga. Shrub steppe on silt bed, with *Kochia aphylla, Bassia* spp. *Eragrostis Dielsii* and spp. and other plants. Yapunyah (*Eucalyptus ochrophloia*) in the distance.

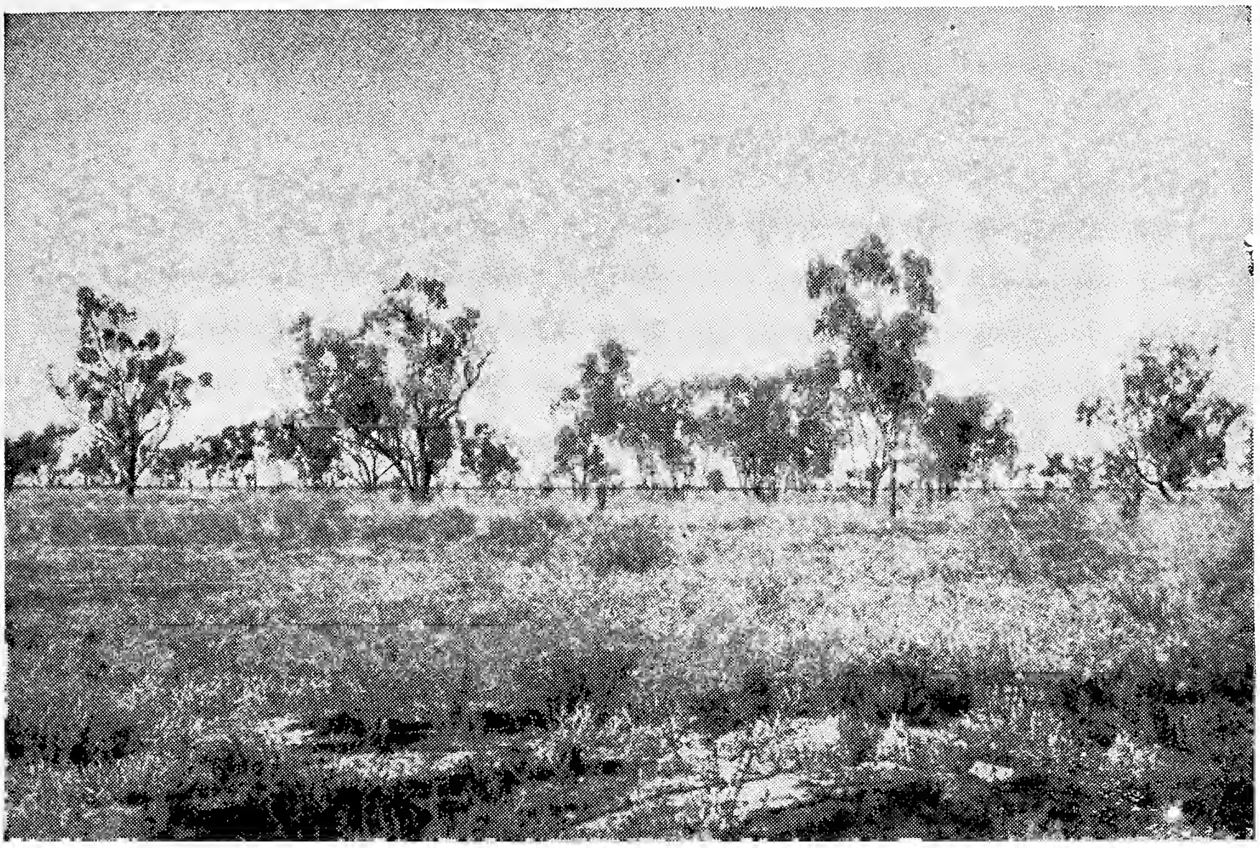

Fig. 37.—Nockatunga. Channel country of the Wilson River, showing a slight fringing forest of yapunyah (*Eucalyptus ochrophloia*) and coolibah (*E. coolabah*), bluebush, numerous annual chenopods, pepper grass, and *Eragrostis* spp.

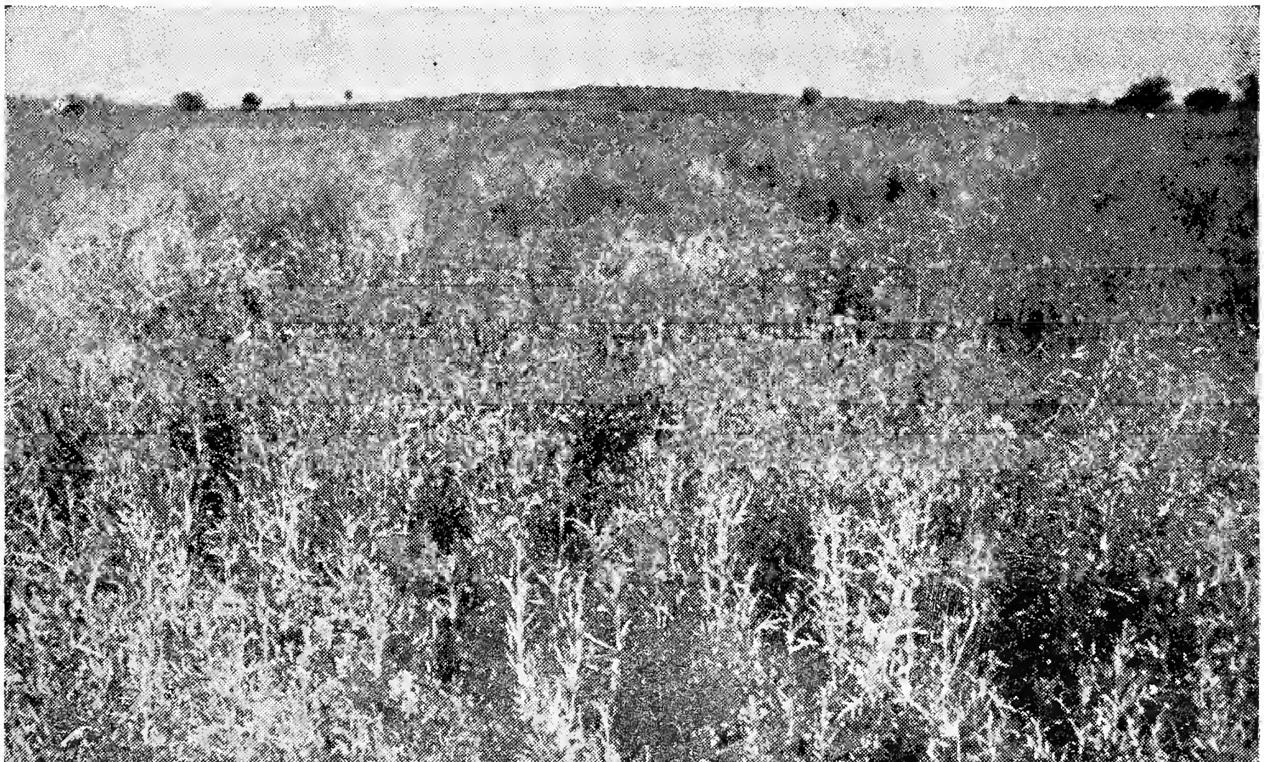

Fig. 38.—Mount Howitt. Channel country of Cooper's Creek with *Trigonella suavissima*, *Blennodia* spp., numerous composites, and pepper grass. In the distance is a low sandridge.

Fig. 39.—About sixty miles east of Birdsville overlooking the Diamantina River in partial flood. Lignum swamp in the foreground with fringing forest of *Eucalyptus coolabah* behind.

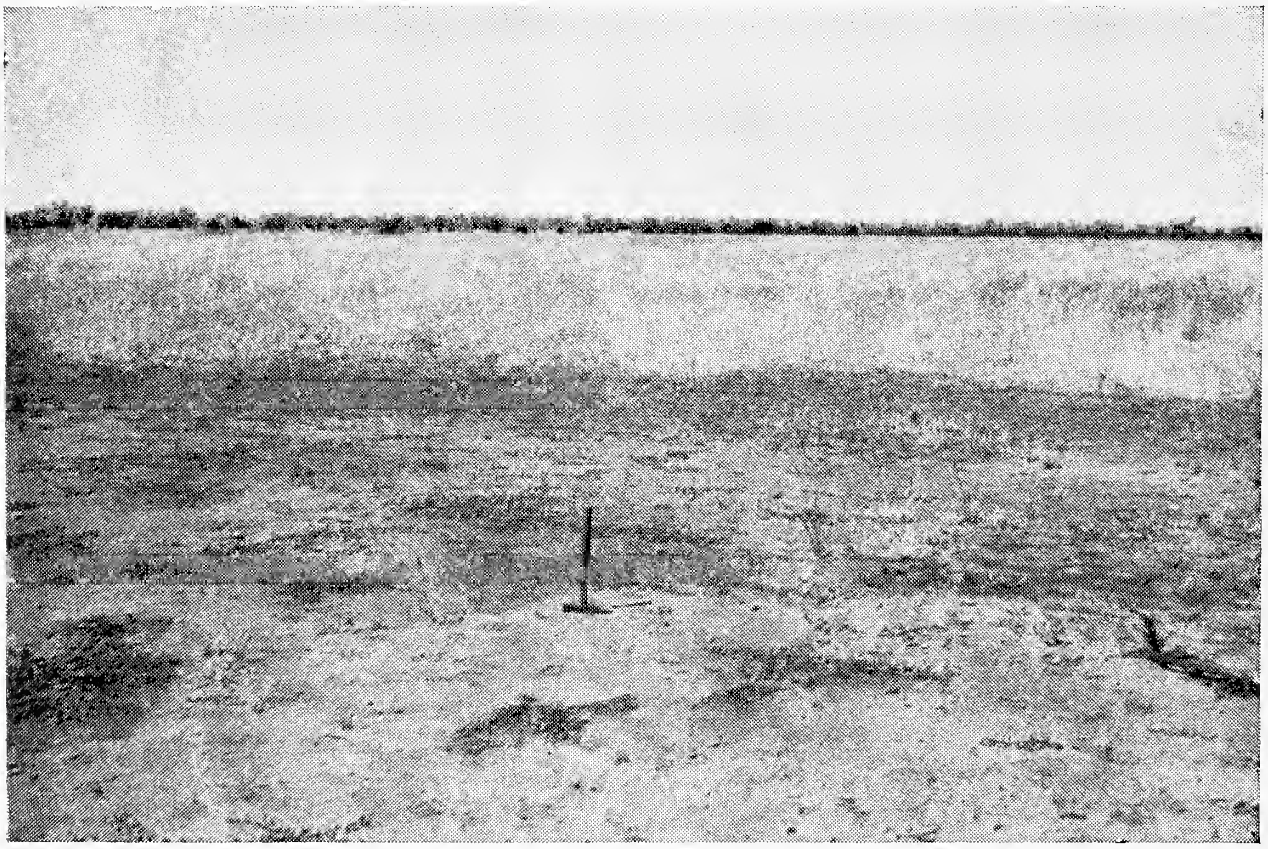

Fig. 40.—About twenty miles south of Wyandra. A claypan in grassland being colonised by pigweed, *Aristida anthoxanthoides, Bassia lanicuspis,* and button grass (*Dactyloctenium radulans*).

The Royal Society of Queensland.

Report of Council for 1936.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its report for the year 1936.

Ten original papers were accepted for publication in the Proceedings, and seven of these were actually read at ordinary meetings of the Society.

During the year the following lectures were delivered:—Dr. J. J. C. Bradfield on "The Story of the Brisbane River Bridge"; Dr. E. Hirschfeld on "Some Biological Problems of Western Queensland"; Professor H. C. Richards, D.Sc., on "Research, Ways and Means"; and Mr. A. R. Trist, M.Sc., on "Some Silvicultural Research Problems in Queensland."

Two special meetings were held, at the first of which His Excellency the Governor, Colonel the Right Honourable Sir Leslie Orme Wilson, delivered an address on "Queensland Assets"; at the other Mr. J. A. Steers, M.A., delivered an address on "Features of the English Shoreline."

One meeting was devoted to a series of short addresses on the history, geology, botany, and agriculture of South-Western Queensland, the speakers being Professor Cumbrae Stewart, Dr. F. W. Whitehouse, Mr. C. T. White, and Professor J. K. Murray.

At another meeting the main business was a symposium on "Concretions," the speakers being Dr. F. W. Whitehouse, Professor H. R. Seddon, Dr. N. M. Gutteridge, Dr. D. A. Herbert, and Dr W. H. Bryan

One evening was devoted entirely to exhibits, and as usual proved to be most interesting and attractive.

Your Council takes this opportunity of thanking those who assisted in the above phases of the Society's work; those who provided the numerous exhibits which were displayed for the interest of the members; the University of Queensland for housing the library and providing accommodation for meetings; and the Assistant Librarian of the University, Miss McIver, for superintending the lending of periodicals from the Library.

It is with great regret that the resignation of Mr. W. D. Francis was accepted at the end of the year. For several years, first as Secretary, and later as Librarian, he performed very valuable work for the Society, and your Council takes this opportunity of recording its appreciation of the service rendered by him.

During the year Mr. J. B. Henderson was elected an Honorary Life Member on the recommendation of the Council. Mr. Henderson was President on three occasions, and has been a member of the

Society for over forty years. He has retired from the position of Government Analyst after many years service during which he won the very sincere respect of the whole community. Your Council trusts that he will live to enjoy many happy years of well-earned rest.

At the meeting of the A.N.Z.A.A.S. which was held in Auckland in January, 1937, the Society was represented by Professor J. K. Murray and Mr. E. W. Bick.

A request was made to the Government to renew the subsidy which was discontinued during the depression. In the reply it was stated that it was impossible to make provision for such a grant on this year's estimates. Your Council recommends that another application should be made in 1937.

Realising that the time is rapidly approaching when the Society will be compelled to provide a home of its own, your Council has founded a trust fund as a step in this direction. It is hoped that members who are in a position to do so will aid the Council in this worthy objective. Donations, however small, will assist materially in building up a fund which will enable the Society, either alone or in conjunction with other scientific societies, to provide a central meeting place and suitable library accommodation.

The membership roll consists of 4 honorary life members, 7 life members, 4 corresponding, 176 ordinary members, and 7 associate members. During the year there were 8 resignations, and 23 new members were elected. It is with deep regret that the death is reported of Mr. P. Sylow, an old and valued member of the Society.

Your Council sincerely regrets the tragic death of Dr. R. J. Tillyard, F.R.S., who, though not a member, contributed several valuable papers to its Proceedings, and extends its deepest sympathy to his widow and daughters.

There were ten meetings of the Council during the year, the attendance being as follows:—L. S. Bagster, 7; F. Bennett, 3; E. W. Bick, 9; W. W. Bryan, 3; D. A. Herbert, 8; J. S. Just, 2; H. A. Longman, 5; E. O. Marks, 8; J. K. Murray, 10; F. A. Perkins, 8; R. Veitch, 9; W. G. Wells, 6; F. W. Whitehouse, 5.

In terms of Rule 19, Dr. E. O. Marks, Senior Member of the Council, automatically retires, but will be eligible for re-election in 1938.

THE ROYAL SOCIETY OF QUEENSLAND.

STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDED 31ST DECEMBER, 1936.

Cr. **Dr.**

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
Balance in Commonwealth Bank, 31st December, 1935 ..	107	0	8	Government Printer, Stationery	2	4	9
Subscriptions	189	11	0	Government Printer, Abstracts and Report	15	5	4
Sales, Reprints, and Volumes	5	1	0	*Government Printer, Volume of Proceedings	121	5	5
Interest	5	11	10	Hon. Secretary, Postages	12	0	0
Banked in Error	1	1	0	Hon. Treasurer, Postages and Duty Stamps	1	0	0
				King George Memorial, Donation	2	2	0
				State Government Insurance (Library)	1	5	10
				Lanternist	0	10	0
				Balance in Commonwealth Bank, 31st December, 1936 ..	152	12	2
	£308	5	6		£308	5	6

* This represents only part of the cost of publishing the volume for 1936.

Audited and found correct.

A. J. M. STONEY, B.E.E., Hon. Auditor.
3rd March, 1937.

E. W. BICK, Hon. Treasurer.

Abstract of Proceedings, 30th March, 1937.

The Annual Meeting of the Society was held in the Geology Department of the University at 8 p.m., on Tuesday, 30th March. The President, Professor J. K. Murray, occupied the chair, and about forty members and visitors were present. Apologies were received from Professors Goddard and Richards, and Dr. F. W. Whitehouse. The minutes of the previous meeting were read and confirmed. The following were proposed for ordinary membership:—Mr. C. S. Christian, B.Sc.Agr., by Professor Murray and Mr. Perkins; Mr. Lahey. B.Sc., by Professor Bagster and Dr. Jones; Mr. R. Peters, by Messrs. Wells and Perkins. Associate Membership: Mr. P. J. Callaghan by Messrs. Hines and Perkins.

The Annual Report and Balance Sheet were adopted on the motion of Dr. Hamlyn Harris, seconded by Mr. C. T. White.

The following officers were elected for 1937:—President, Professor L. S. Bagster, D.Sc.; Vice-Presidents, Professor J. K. Murray and Professor H. C. Richards; Hon. Treasurer, Mr. E. W. Bick; hon. Secretary, Mr. F. A. Perkins; Hon. Librarian, Mr. A. R. Riddle; Hon. Editors, Dr. D. A. Herbert and Mr. H. A. Longman; Hon. Auditor, Mr. A. J. Stoney; Members of the Council, Dr. J. V. Duhig, Mr. J. S. Just, Professor H. R. Seddon, Mr. J. H. Smith, and Dr. F. W. Whitehouse.

The retiring President, Professor J. K. Murray, delivered an address entitled "Agriculture and Migration in Queensland." A vote of thanks moved by Dr. W. H. Bryan was carried by acclamation.

A vote of thanks to His Excellency the Governor, Sir Leslie Orme Wilson, for his interest in the Society and his presence at the Annual Meeting was carried by acclamation.

Abstract of Proceedings, 23rd April, 1937.

The Ordinary Monthly Meeting of the Society was held in the Geology Department of the University at 8 p.m., on Friday, 23rd April. The President, Professor L. S. Bagster, occupied the chair, and about forty members and visitors were present. Apologies were received from Professors Seddon, Hawken, Richards, Drs. Bradfield, Hamlyn Harris, Messrs. White, Carroll, Wells, and Longman. The minutes of the previous meeting were read and confirmed. The following were proposed for Ordinary Membership:—Rev. Father Fahey by Dr. J. J. Bradfield and Professor J. K. Murray; and Mr. G. S. Bongers, by Messrs. Robertson and Perkins. The following were unanimously elected members of the Society:—Ordinary Membership—Messrs. C. S. Christian, R. J. Carroll, F. N. Lahey, R. Peters; Associate Membership—Mr. J. P. Callaghan.

Mr. S. T. Blake exhibited a series of grasses belonging to the genus *Ectrosia*, and collected by himself in 1935. The collections represented were used by Mr. C. E. Hubbard in his recent revision of the genus in Hooker's *Icones Plantarum* in which four new species from Queensland are described. These are *E. blakei*, C.E.H., from Croydon; *E. confusa*, C.E.H., from Normanton and district; *E. scabrida*, C.E.H., from near Normanton, whence it extends west to North Australia and north to the Mitchell River. A living plant of this species, which appeared spontaneously in his garden, was also shown. *E. anomala*, C.E.H., the fourth new species was not shown, as the only specimen found was still at Kew. A living plant of *Isulima membranacea,* Domin, found on a pathway at the University, was also shown.

The main business of the evening was an address entitled "A Scientist Abroad," by Dr. J. V. Duhig.

Dr. J. V. Duhig gave a description of the matters of scientific interest he had observed during a nine months' tour of the world. The speaker visited the Dutch East Indies and noticed a wide variation in customs and culture as one went from East to West. The colour and pattern, for example, of the sarong, the garment which covered the body from the waist down, differed enormously as in Macassar, the capital town of the Celebes, where the natives favoured single colours, extremely bright in hue—vivid green, peacock blue, and scarlet-mauve being those most favoured in these parts—from those of, for example, Central Java, which were mainly of Batik pattern in black or dark brown on a white ground. Racially also marked differences could be observed by anthropologists. The Dutch Colonial administration of Tropical Agriculture was highly scientific and eminently successful from the scientific point of view. Probably nowhere else in the world was such skilful use made of water resources as in these islands in connection with rice cultivation. Moreover, this industry was not only efficient but extremely picturesque. Sugar cultivation was most admirably conducted on scientific lines. The speaker visited the Sugar Experiment Station at Pasoeroean, one of three such on the island of Java. Every science which had any possible bearing on the industry was represented by University trained scientists working in a very large institution. One of the lines of investigation which struck the speaker most was the elaborately minute soil analyses and their results, mapped in colour. Here, too, the library was very large, and evidently a most important feature. The same care is given to coffee, rubber, and tobacco cultivation. The Sumatra leaf is actually exported to Cuba as cigar wrapping. The marvellous botanic garden of Buitenzorg, a short train journey from Batavia, was visited. It is a beautifully arranged museum of tropical botany, which must be unrivalled in the world.

The speaker next spoke of the physiography of Spain and its influence on the character of the Spanish people of different racial strains, and of their agriculture. Coming to the north of Spain, one noticed on the seaward slope of the Cantabrian mountains the beginning of the huge network of electric power extending all around the Bay of Biscay up as far as Bordeaux and across the northern foot of the Pyrenees, almost into Italy. All railway traction and industrial power in this corner of Europe was electric, drawn from the snows of the high Pyrenees. The speaker noticed an unmistakable turnover in the dietary and agricultural economy of the French people since his last visit in 1919 from, that is, animal husbandry and horticulture to cereal farming and its products. A very large proportion of the urban population was attempting to subsist on bread and wine. The speaker discussed the relationship of these facts with population problems generally in France and Europe.

After a description of the admirable forestry policies of Sweden and Finland, which the speaker visited, specially mentioning the exquisite beauty of the boat trip from Stockholm to Turku (Åbö) in Finland, he described the scientific work now being done in the Soviet

Union, which is enormous in scope, embracing the whole of the planned economy of the nation of nearly 180,000,000 people, and excellent in quality of which the work of N. I. Vavilof is a brilliant example. He is agreed to be the most outstanding authority on variation in plants since Darwin. With his 2,000 assistants he has a profound influence on the national nutrition policy. The whole basis of the national economy is Science. As the New York *Times* once said, ''Where the Soviet Union is spending thousands of rubles for research, we (U.S.A.) are spending pennies. There can be but one result. In another generation, perhaps in another decade, Soviet science may lead the world. . . . '' The speaker ended on a note of warning that the terrible effects of unregulated exploitation of natural resources in U.S.A. may be repeated here if not tackled immediately. One should read Stuart Chase's ''Rich Land, Poor Land.''

A vote of thanks, moved by Professor J. K. Murray, was carried by acclamation.

Abstract of Proceedings, 31st May, 1937.

The ordinary monthly meeting of the Society was held on Monday, 31st May in the Geology Department of the University at 8 p.m. The President, Professor L. S. Bagster, occupied the chair and thirty-five members and visitors were present. Apologies were received from Messrs. J. S. Just and F. A. Perkins and Dr. J. R. Vickery. The minutes of the previous meeting were read and confirmed.

Messrs. F. James and Cumming were nominated for ordinary membership by Professor L. S. Bagster and Dr. D. A. Herbert.

Professor H. C. Richards exhibited rock specimens collected at Cape Moreton.

Previous geological information about Cape Moreton, as recorded in the Queensland Mineral Index, indicated the existence of coal measures of Mesozoic age, while at Mt. Tempest some 8½ miles to the S.S.W. it was stated there existed an acid volcanic rock associated with the Mesozoic sandstones.

Some three or four years ago Mt. Tempest was visited by a small party of geologists and nothing other than coastal sand dune material was encountered all the way from Tangalooma to Mt. Tempest, while all around as far as could be seen similar material existed.

A visit to Cape Moreton on 30th May last by Drs. E. O. Marks, W. H. Bryan, A. K. Denmead and the contributor found the acid volcanic rock—fluidal rhyolite—very well developed at North Point and outcropping for about one mile in a south-westerly direction along the Pacific foreshore towards the Cape Moreton lighthouse.

Rocky Hill nearby rising to a height of 250 feet was capped with coarse quartzites which elsewhere overlie conformably carbonaceous shales containing *Thinnfeldia acuta* and other fossil flora remains.

The headland immediately to the east of the Cape Moreton lighthouse some 200-300 feet high is made up of sandstones and shales, in part coalbearing, and on the fossil evidence apparently belonging to the Ipswich series. They dip northerly at a very gentle angle. The coal-seams are small and not workable on the evidence of their outcrops.

Underlying the basal conglomerate beds of this coal-bearing series one may find the fluidal rhyolite, while boulders of rhyolite in the conglomerate are abundant. It is possible that this centre marks the focus of the rhyolitic volcanic activity which yielded the Brisbane Tuff material as the latter is found at the base of the Ipswich series in the neighbourhood of Brisbane.

The most southerly projecting headlands about one half-mile south of the lighthouse are made up of andesitic agglomerate very angular in character with abundant epidote developed and purplish colour generally. In these latter respects it bears some resemblance to the andesites of the Gympie goldfield.

Professor Richards' exhibit was discussed by Drs. Bryan and Marks and Messrs. Denmead, Tryon and Bennett.

A paper by Dr. Dorothy Hill, "Euryphyllum, a new genus of Permian Zaphrentoid Rugose Corals," was laid on the table on the motion of Professor Richards and Dr. Whitehouse, who stated that as Dr. Hill would be shortly returning to Queensland she might be asked to speak on the subject later in the year.

A paper entitled, "An Investigation of a Taint in the Rib Bones of Bacon; the Determination of Halophilic Vibrios (n. spp.)" was read by Mr. Frank Berry Smith.

The remainder of the evening was devoted to bacteriological exhibits.

Dr. Duhig exhibited a collection of bacterial cultures mainly of the pigment form types, pathogenic for man, with explanatory comments on the special features of the biology of different genera.

Dr. J. R. Vickery exhibited plates of a concentrated beef fat emulsion which had been inoculated with pure strains of (1) an asporogenous yeast *Geotrichoides sp.* and (2) *Pseudomonas sp. No.* 303. In both samples, extensive hydrolysis of the fat had taken place; in the case of the yeast, the liberated fatty acids had been, in part, broken down to caproic, caprylic and capric acids, giving the sample a characteristic sharp, cheesy flavour and odour. In the case of fat acted upon by *Pseudomonas sp. No.* 303, the nature of the malodorous degradation is unknown.

Mr. A. R. Riddle exhibited ultra-violet spectrograms of the mercury-in-quartz arc "photographed" in bacteria. Energy in certain regions of the ultra-violet spectrum possessed the power to kill bacteria. Hence when an agar plate coated with bacteria was exposed to spectrally dispersed ultra-violet radiation, the organisms at the points of impingement of all bactericidally potent wave-lengths would be killed. Upon incubation, these lines would show up as clear rectangles of agar. In that way the region of bactericidal potency could be determined and relative bactericidal power of the various wave-length roughly estimated.

Dr. D. A. Herbert exhibited specimens of crown gall (*Pseudomonas tumefaciens*) of turnips, root nodules of legumes and of *Casuarina Cunninghamiana*, and leaf galls on *Pavetta natalensis.* He spoke of recent developments in the study of symbiotic nitrogen fixing bacteria.

A vote of thanks to the exhibitors, moved by Professor Bagster, seconded by Mr. Longman, was carried.

Abstract of Proceedings, 28th June, 1937.

The ordinary monthly meeting of the society was held on Monday, 28th June, in the Geology Lecture Theatre of the University at 8 p.m. The President, Professor L. S. Bagster, occupied the chair, and about fifty members and visitors were present. The minutes of the previous meeting were read and confirmed. The following were proposed for ordinary membership:—Mr. C. Ellis, B.E. (Investigations Officer, Forestry Department, Queensland) by Mr. Perkins and Dr. Herbert; Dr. H. C. Webster, F.Inst.P., (Lecturer in Biophysics, University of Queensland) by Professor Bagster and Dr. T. G. H. Jones, Messrs. R. Greenham, S. Carter, and C. W. Ball (Students in the Geology Department of the University) were proposed for associate membership by Drs. W. H. Bryan and F. W. Whitehouse. The Rev. Father Fahey, and Messrs. G. S. Bongers, F. James, and R. Cummings were unanimously elected ordinary members of the society.

Dr. E. O. Marks exhibited some volcanic ash which was thrown out in the recent eruption and brought back by Dr. K. B. Fraser.

Dr. F. W. Whitehouse exhibited two australites from South-Western Queensland, one from Mooraberrie Station and the other from Bedourie. Apart from a reference in a popular book, "Our Sandhill Country" by Mrs. Duncan Kemp (Sydney 1932), where mention is made of australites at Mooraberrie, there does not appear to be any authenticated reference in literature to australites in Queensland (Professor H. C. Richards, in Memoirs Queensland Museum, Volume 10, page 67, 1930 has noted a doubtful occurrence of australites in Northern Queensland). The present specimens were presented to the University of Queensland by Mrs. Duncan Kemp (Mooraberrie) and Mrs. G. Gaffney (Bedourie). Bedourie and Mooraberrie are some 120 miles apart. According to local report the australites are not rare at Mooraberrie. So far as is known only this one specimen has yet been collected from Bedourie.

The main business of the evening was a lecture entitled "Interaction of radiation with living matter" by H. C. Webster, Ph.D., F. Inst. P.

The lecture was limited to one region of the spectrum of electromagnetic radiation, viz., that usually included under the terms X-rays and gamma-rays. The relation

$$Ve = h\nu_m = hc/\lambda_m$$

expressing the relation between the (peak) potential V applied to an X-ray tube, and the maximum frequency ν_m, and minimum wavelength λ_m of the radiation then emitted from the tube,—(h, e, c, being universal constants)—was used to determine frequency (strictly quantum energy) in terms of V, viz., in "electron-volts" (eV). The quantum theory, which states that when energy is transferred between radiation and matter, the radiation behaves as if comprised of particles (quenta) of energy h , where is the frequency of the radiation, will be used to describe the processes that occur when radiation of frequency (more correctly, quantum energy) between 150,000 electron-volts and 20,000,000 electron-volts reacts on matter.

The primary processes that occur are known to be limited to the following four:—

1. Photo-electric.

(Quantum + Atom) gives (Ionized atom + High speed electron)

2. Scattering.* (Compton effect).
(Quantum + Atom) gives (New Quantum (lower frequency) + Ionized atom + High-speed electron.)
3. Pair-production.
(Quantum + Atom) gives (Atom (unaffected) + High-speed electron + High-speed positron.)
4. Nuclear disintegration.
(Quantum + Nucleus) gives (New nucleus + High-speed proton or neutron)

(It should be explained that a positron is similar to an electron except that it has a positive instead of a negative charge. A proton is a normal hydrogen nucleus, a neutron is an uncharged particle of nearly the same mass as a proton.) The first two processes occur for all frequencies considered (the second always predominates in the case of living matter). The third process commences to occur for frequencies over 1,800,000 eV, but is unimportant compared with process 2 for living matter, except above about 5 million eV. The fourth process is known to occur only for a few types of nucleus, none of which are present, except in very small proportions, in living matter.

The third process, and in some cases the fourth, involve the conversion of energy into matter. This process, regarded as impossible until the advent of Relativity theory, has previously been discovered to occur in several types of nuclear disintegration.

Considering the action of the above processes on biological material, it is evident that the first step in the production of biological action by X- and gamma-rays is the creation of channels of ionized matter in the material. In the case of photo-electrons, for instance, these channels extend through 40 individual cells of the material cell assumed to have a diameter of 5×10^{-4} cm) for 150,000 eV radiation, and 800 cells for 1,200,000 eV radiation.

When considering the biological action of these rays it is usual to measure the "dose" in units which are approximated proportional to the amount of energy absorbed per unit volume of the material. It is therefore important to know the total length of ionized channel for unit dose, i.e., the total lengths of all the channels placed end to end. In the case of water, the major constituent of biological material, Mayneord has shown that the total length is approximately constant between 10,000 and 80,000 eV, decreases to a minimum near 100,000, increases to about seven times this value near 1,000,000 eV, then again decreases.

Referring these results to practical problems in cell destruction, Mayneord has shown that if one assumes that a single passage of an ionized channel through a cell kills it, gamma-rays are more effective for cell destruction than X-rays. If, however, a specified amount of ionization within the cell is necessary for destruction, gamma-rays may be more or less, or equally, destructive as X-rays, according to the dose. In actuality, of course, it is doubtful if any such simple assumptions are adequate.

A vote of thanks moved by Dr. J. Vickery was carried by acclamation.

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* The process of scattering without loss of energy, which sometimes occurs, is of no importance in the present connection.

Abstract of Proceedings, 26th July, 1937.

The ordinary monthly meeting of the society was held on Monday, 26th July, at 8 p.m., in the Geology Lecture Theatre of the University. The President, Professor L. S. Bagster, occupied the chair, and about thirty members and visitors were present. Apologies were received from Messrs. Just and Cummings. The minutes of the previous meeting were read and confirmed. Mr. V. Robinson was proposed for ordinary membership by Drs. W. H. Bryan and F. W. Whitehouse. Mr. C. Ellis and Dr. H. C. Webster were unanimously elected ordinary members of the society. Messrs. R. Greenham, S. Carter, and C. W. Ball were unanimously elected associate members of the society.

Mr. G. H. Hardy read a paper entitled "Notes on Australian Muscoidea III. Dexiinae, Phasiinae, and Tachininae." The paper includes keys to the more important genera and subfamilies. Valuable notes are also given on a number of species which have been bred from Lepidopterous caterpillars of economic importance in Eastern Australia.

The main business of the evening was a very interesting address by Mr. S. Clarke, B.E., on "the New Laboratories of the Division of Forest Products, C.S.I.R.; Its Equipment and Activities." The lecture was illustrated by a very fine set of lantern slides A vote of thanks, moved by Dr. Herbert and Professor Richards, was carried by acclamation.

Abstract of Proceedings, 30th August, 1937.

The ordinary monthly meeting of the society was held on Monday, 30th August, in the Geology Lecture Theatre of the University, at 8 p.m. The President, Professor L. S. Bagster, occupied the chair, and about 45 members and visitors were present. The minutes of the previous meeting were read and confirmed. Mr. C. Rowe was proposed for ordinary membership by Messrs. Christian and Perkins. Mr. V. Robinson was unanimously elected an ordinary member of the society.

Mr. S. T. Blake, M.Sc., read extracts from a paper entitled "The Genus Iseilema in Queensland."

The genus Iseilema, the group of grasses known collectively as Flinders Grass, which was revised by C. E. Hubbard in 1935. They are among the most valuable of the forage grasses of the interior of Queensland, and their field relationships were closely studied during the years 1934-1936, but particularly in the last year when they were very abundant. Two new species were discovered and are described, raising the known number of Queensland species to ten. A key to all known Australian forms is included, and a vernacular name is suggested for each species. The genus as a whole, and then each species, are discussed as to morphology, field characteristics, ecological requirements and economics. The distribution of each species is indicated by representative locality records. Some species are as yet known in but one or two localities. Two are very widely spread, while the distribution of some others depend on conditions of drainage. The probability of hybridism is discussed, and two new hybrids are indicated.

This paper was discussed by Messrs. White, Ogilvie and Bennett.

Miss M. Whitehouse read extracts from a paper entitled "The Zeolites of Queensland." This paper consists of a list of known zeolites in Queensland, twelve in number, with the mode and places of occurrence of each and its associated minerals. A short account of the mode of formation of zeolites in general and a bibliography of Queensland zeolites are also presented.

Professor H. C. Richards and Dr. W. H. Bryan commented on this paper.

Mr. Haenke read extracts from a paper entitled "Essential Oils from the Queensland Flora Melaleuca Viridiflora" (Part II), by T. G. H. Jones, D.Sc., and W. C. Haenke, B.Sc. (App.).

The essential oil of the cineol variety of the broad leaved Melaleuca has been examined in detail and the following constituents reported:— *a* Pinene, dipentene, terpineol, cineol, sesquiterpene and a crystalline alcohol apparently not previously described.

The oil thus in no way resembles that from the other variety of Melaleuca viridiflora, which contains mainly linalol and nerolidol.

This paper was discussed by Messrs. White, Blake, Bennett, and Bagster.

The main business of the evening was supplied by Messrs. C. S. Christian, B.Sc.Agr., and T. B. Paltridge, B.Sc.

Mr. Christian spoke about "Co-operative Pasture Plant Improvement Investigations in Queensland."

The subject of the lecture delivered by Mr. Paltridge was "Plant Introduction Investigations in Queensland."

Both lectures were very interesting and informative. A vote of thanks, moved by Professor Richards, supported by Professor Murray and Messrs. White and Blake, was carried by acclamation.

Abstract of Proceedings, 27th September, 1937.

The ordinary monthly meeting of the society was held on Monday, 27th September, in the Geology Lecture Theatre of the University, at 8 p.m. The President, Professor L. S. Bagster, occupied the chair, and about forty-five members and visitors were present. The minutes of the previous meeting were read and confirmed. Mr. R. Rowe was unanimously elected an ordinary member of the society.

Dr. E. O. Marks exhibited a coarse-grained gabbroid rock collected at Conondale. Professor H. C. Richards commented on this exhibit.

Mr. Ogilvie exhibited two examples of bore pipes 6 inches in diameter which were practically blocked by deposits of calcium carbonate. Mr. F. Bennett commented on this exhibit.

The main business of the evening was a series of short addresses on phosphorus. Dr. W. H. Bryan dealt with the inorganic source of phosphorus.

Every particle of phosphorus found in every living thing comes in the first place from the rocks forming the earth's crust, and in the end every particle returns there. Phosphorus does not occur in rocks as a native element like sulphur, but is always found in chemical combination. There are a number of phosphatic minerals, such as turquoise, wavellite, vivianite, pyromorphite, and apatite, but although each has an interesting story to tell they may all be ignored as sources of phosphorus save apatite. This mineral provides an overwhelming preponderance of the phosphorus found in living things, in spite of the fact that it rarely occurs in large quantities. But although it lacks impressive bulk it is virtually ubiquitous in the crust of the earth, occurring in practically every rock in small or smaller amount. It occurs in largest quantity in basalts, of which it forms one-half of 1 per cent., while granites and limestones contain about half as much and sandstones still less.

A certain amount of phosphorus is available to plants directly from apatite in the soil, especially that lying above igneous rocks, but much of the naturally acquired phosphates and all of the phosphates added by man have only a very indirect relationship to the original apatite. The history of the successive changes is not completely understood, but the essentials seem to be as follows:—

Much of the apatite in igneous rocks is leached out and carried away in solution, ultimately to reach the sea. Here it is taken up by marine animals and either expelled as ejecta or absorbed into the tissues, whence on the death of the animal it sinks with the skeleton to the sea floor. In this way marine deposits of phosphatic limestone slowly accumulate. If these are, as a result of great earth movements, converted into land the phosphorus content tends as a result of several different geological processes to become concentrated into various kinds of phosphatic deposits.

Variants of the cycle thus briefly outlined are found where the phosphorus secreted by animals is returned in the shape of cave earth, in which phosphatic skeletons occur mingled with phosphatic excreta; or on certain islands and shores where sea-birds congregate and great deposits of guano are formed. A particularly interesting extension of the phosphate cycle is found where guano accumulates on islands which are really uplifted coral reefs. In these cases phosphoric acid leached from the guano by occasional rains makes its way down to the coral, which it converts into calcium phosphate.

But always in the phosphorus cycle the main features are the same. The cycle starts with calcium phosphate and it ends with calcium phosphate. It is true that the initial material is crystalline and called "Apatite," and that the final product is amorphous and known as "Phosphorite," but chemically these things are identical, and the cycle is complete.

Dr. M. White briefly traced the course by which phosphorus becomes available to animals, and then devoted the main part of his address to the assimilation of phosphorus by the various classes of animals and its physiological role in the body proper.

The occurrence of phospho-proteins in the animal kingdom only was a notable feature. Casein in milk and vitellin in egg were the most studied phospho-proteins because of the ease of obtaining pure material. It is interesting to note that the milk of the egg-laying monotreme, the echidna, contained casein.

The importance of phosphorus in milk and the relation it bore to rate of development in the young of mammals was illustrated by showing the parallel in time taken to double birth weight and the phosphorus content of the milk.

The phosphorus requirements of ruminants was discussed and the methods employed in arriving at an estimate outlined.

The role of phosphorus in muscle contraction was described. The physiological importance of phosphorus in the skeleton, the blood, nuclei acids, hexose phosphates, fat and water-soluble phospholipides was stressed, and a brief outline of the functions of these groups given.

Dr. A. W. Turner gave an account of a phosphorus deficiency disease known as "Pegleg," which is very prevalent in two large areas in North Queensland, one near Charters Towers and the other north-east of Cloncurry. The disease is characterised by unthriftiness, a tendency to chew bones, a low reproductive index, and general poor condition. In the early stages of the disease the animals develop a stilted gait, the back becomes arched, and the bones readily fracture. Post-mortem examination shows a definite softening of the bony tissue. By repeating the South African experiments it was found that phosphatic supplements like dicalcium phosphate and finely ground bone meal were satisfactory.

Dr. J. V. Duhig spoke about the role of phosphorus in human nutrition and human pathology.

A rather prolonged discussion took place in which the following participated:—Professor H. R. Seddon and Messrs. Gurney, Bennett, Tryon, and Blake.

A vote of thanks to the speakers moved by Professor Murray was carried by acclamation.

Abstract of an Address given by Mr. C. S. Christian, B.Sc.Agr., M.Sc., on Co-operative Pasture Plant Improvement Investigations.

These investigations are being conducted by the Council for Scientific and Industrial Research in co-operation with the Queensland Departments of Public Instruction and of Agriculture and Stock.

Any method of pasture improvement involves one or both of two things: Firstly, by a change in the environment, rate, quantity, time, and quality of growth, together with the relative importance of the naturally occurring species, may be altered. Secondly, species new to the pasture may be utilised, either by sowing them, in mixtures or otherwise, on prepared land, to form an entirely new pasture, or by introducing them into the existing pasture merely as a part of the total population. It is with the provision of such new pasture plants that much of the Council for Scientific and Industrial Research work at Lawes is concerned. This talk deals with the work of the Genetics Section of the Council for Scientific and Industrial Research in this regard.

The problems included in the programme of work to be undertaken include several fundamental problems of pasture development in Queensland.

(1) The provision of suitable legumes for inclusion in grass mixtures is recognised generally as being one if not the most important pasture problem.

(2) Most native pastures in Queensland make their maximum growth in the summer, and grow poorly in winter. Requests are frequently received for winter-growing species. As most of Queensland pasture areas have a very limited winter rainfall it may not prove to be efficient farming to attempt to grow winter-growing perennials over a wide area. The possibility of producing a suitable winter-growing pasture plant is being investigated.

(3) Summer is the natural growing period in Queensland. Every possible advantage should be taken during that period of producing feed, not only for summer consumption, but, by some means of conservation, for utilisation during winter and during droughts. Summer species are being studied in an attempt to increase their yields, to prolong their growth period, thereby shortening the winter feeding period, and also to improve them in regard to their value as standing hay during the winter months.

The main species under investigation are *Medicago sativa* and related species, *Lespedeza* species, *Phalaris tuberosa* and related species, *Astrebla* species, and *Chloris gayana*.

Species are the product of evolution, but evolution is still continuing. Thus collections of material botanically known as the one species, from different localities, show inherited variations in general type and behaviour. Some of these regional strains are superior agronomic types, and their collection, testing, and multiplication are the first steps in plant improvement. Inherited variations also exist within each of the regional strains. It is the object of the geneticist to study as many of these variants as possible to determine their agronomic value, and then to produce pure-breeding or nearly pure-breeding strains of the best agronomic types. Breeding involves selection, strain breeding by controlled pollination, and interspecific hybridisation. The strains produced will be subjected to exhaustive field trials, and the best multiplied and distributed.

Some details of the work already done in each of the species were then given.

Reference was made to the unlimited scope of plant-breeding outside the recognised fields of selection and character combination within a species. In conclusion, a few remarks were made concerning the possibilities resulting from and the necessity for further information concerning the fundaments of inheritance of quantitative characters, fertilisation, cell division, origin and production of polyploid forms, interspecific and intergeneric hybridisation.

Abstract of Proceedings, 25th October, 1937.

The Ordinary Monthly Meeting of the Society was held on Monday, 25th October, in the Geology Lecture Theatre of the University, at 8 p.m. The President, Professor L. S. Bagster, occupied the chair, and about thirty members and visitors were present. The minutes of the previous meeting were read and confirmed.

The business of the evening was a series of papers which were read or communicated in part.

1. "*Euryphyllum*, a new genus of Permian Zaphrentoid Rugose Corals," by Dr. Dorothy Hill.

2. "Essential Oils from the Queensland Flora, Part XIII.; *Cinnamomum Oliveri*," by T. G. H. Jones and F. N. Lahey, was communicated by the latter.

This oil, previously investigated by Hargreaves, has been re-examined. We were unable to confirm the 60 per cent. camphor content recorded by Hargreaves, 51 per cent. being obtained from two samples of oil.

Other constituents not previously recorded were d-limonene, dipentene, myrcene, bornyl formate, a sesquiterpene and sesquiterpene alcohol, and methyl eugenol.

3. "The Establishment of a Seismological Station in Brisbane, Queensland," by W. H. Bryan, D.Sc.

A seismological station has recently been established in Brisbane. The station is maintained and operated by the Department of Geology of the University of Queensland assisted by a grant from the Commonwealth Government through the Australian Council for Scientific and Industrial Research.

The room in which the instruments are housed is in the basement of the new University Library. The equipment consists of two Milne-Shaw horizontal pendulum seismographs with electro-magnetic damping and optical recording. One of these instruments was presented to the University of Queensland by a generous donor who wishes to remain anonymous. The other was provided by the Australian Council for Scientific and Industrial Research.

Accurate time is provided by an electrically driven synchronome clock which is checked by radio against standard time signals.

The station is in continuous operation, and issues and transmits to many parts of the world monthly bulletins containing readings and interpretations of all earthquakes recorded at the station.

Situated as it is on the margin of the actively seismic Pacific basin, this new observatory should play an important part in international seismology, more particularly as it helps to bridge the large gap in the chain of circum-Pacific stations that has hitherto existed between Sydney and Batavia.

4. "The Gayndah Earthquake of 1935," by W. H. Bryan, D.Sc., and F. W. Whitehouse, Ph.D. (communicated by Dr. Whitehouse).

On 12th April, 1935, at about 11.35 a.m. Eastern Standard Time, an earth tremor was felt over a large area of South-Eastern Queensland. Some 200 personal records were collected and analysed. From a study of these data intensities of the shock were calculated. The disturbance originated from a region about 10 miles north-east of Gayndah. In the meizoseismal area intensities of at least R.F. 7 were felt. It was apparently a tectonic earthquake originating at shallow depth, probably along a north-easterly line. The distribution of apparent intensities had certain unusual features, and some curious correlations with geological structure have been noted. Following upon the main tremor a series of aftershocks occurred at intervals until 14th December. Seventy-three such aftershocks were recorded by an observer in the meizoseismal area between 12th April and 22nd July.

5. "Studies in Oriental and Australian Trypaneidæ, Part II. *Adraminæ* and *Dacinæ* from India, Ceylon, Malaya, Sumatra, Borneo, Philippine Islands, and Formosa," by F. A. Perkins, B.Sc. Agr.

In this, the second of a series of papers on the Oriental and Australasian Trypaneidæ, one genus, seven species and two varieties are described as new. Two species described early in the last century, and not since recorded, are redescribed. Keys are provided for all the larger genera. Most of the common species are discussed, particular reference being made to their distribution, variation, and synonymy. The new species are as follows:—*Strumeta nigrotibialis, S. nigrotibialis var lata, Strumeta tillyardi, Afrodacus javanensis, Nesodacus longicaudatus, Callantra splendida, Zeugodacus caudatus var maculatus, Zeugodacus pendleburyi,* and *Paradacus fulvipes.*

6. "The Upland Savannahs of the Bunya Mountains," by D. A. Herbert, D.Sc.

Grassy areas varying in size from a few acres to several hundred acres are interspersed with rain forest on the Bunya Mountains, about 30 miles north-west of Dalby. These replace the open eucalyptus forest at about an elevation of 2,800 feet. They represent a grassland subclimax, and only in isolated places does the *Eucalyptus tereticornis* forest climax become established. It is considered that the grassed slopes are the result of destruction of Eucalyptus forest, probably by fire by the blacks in the days when they gathered for the collection of bunya pine seeds.

The following took part in the discussions which followed the reading of the papers:—Drs. W. H. Bryan and D. A. Herbert and Messrs. F. Bennett, J. H. Smith, T. Jack, S. T. Blake, and C. Schindler.

A vote of thanks moved by Mr. G. H. Barker was carried by acclamation.

Abstract of Proceedings, 29th November, 1937.

The Ordinary Monthly Meeting of the Society was held on Monday, 29th November, at 8 p.m., in the Geology Lecture Theatre of the University. The president, Professor L. S. Bagster, occupied the chair, and about fifty members and visitors were present. An apology was received from Mr. Just. The minutes of the previous meeting were read and confirmed. The president drew attention to the death of Professor Howchin, and Professor Richards moved that a letter of condolence be sent to his relatives.

Professor Richards exhibited a graph of the Barrier Reef Bore at Hayman Island and showed some of the material obtained at different depths. Mr. Riddle showed some new apparatus for controlling temperatures in refrigeration work.

Mr. Watkins showed some pictures of a small vertical fault in the Spicer's Gap district.

Mr. J. H. Simmonds read short paper entitled "Alternaria passifloræ n. sp., the Causal Organism of Brown Spot of Passion Vine."

Mr. S. T. Blake read two papers entitled:—

1. "Notes on Australian Cyperaceae, Part II."
2. "The plant communities of Western Queensland and their relationships, with special reference to the grazing industry."

A vote of thanks to the speakers moved by Mr. White was carried by acclamation.

Publications are being received from the following Institutions, Societies, etc., and are hereby gratefully acknowledged:—

ALGERIA—
Societe de Geographie et d'Archaeologie d'Oran.

ARGENTINE—
Universidad Nacional de la Plata.

AUSTRALIA—
Commonwealth Bureau of Census and Statistics, Canberra.
Department of Agriculture, Melbourne.
Department of Mines, Melbourne.
Royal Society of Victoria.
Field Naturalists' Club, Melbourne.
Council for Scientific and Industrial Research, Melbourne.
Australian Chemical Institute, Melbourne.
Department of Mines, Adelaide.
Waite Agricultural Research Institute, Glen Osmond.
Royal Society of South Australia.
Royal Geographical Society of Australasia, Adelaide.
Public Library, Museum, and Art Gallery, Adelaide.
University of Adelaide.
Standards Association of Australia, Sydney.
Naturalists' Society of New South Wales.
Department of Agriculture, Sydney.
Department of Mines, Sydney.
Royal Society of New South Wales.
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OF

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Presidential Address.

ALCHEMY, ANCIENT AND MODERN.

By Professor L. S. Bagster, D.Sc.

(*Delivered before the Royal Society of Queensland, 28th March,* 1938.)

Perhaps the first step taken by one under the necessity of writing a presidential address is to find what his predecessors in office have talked about. I find, as is natural, addresses on general or particular scientific subjects, especially recent advances; though on several occasions speakers have rather discussed scientific aspects of human affairs in general, and our own in particular. This I consider all to the good. While a Royal Society exists for the encouragement of science and the extension of scientific knowledge, it would be quite wrong to neglect the relationship of that knowledge to the community.

With increasing application of scientific knowledge to practical ends and evidence that some social disturbance is so created, it is a bounden duty of the scientist to take his part in helping towards a scientific ordering of the general life. You may not agree with the suggestion that the people who pay the piper should call the tune, but those who pay certainly would. It is our duty to show that our music is the best—that a scientific outlook and ordering of affairs will lead to greater general progress.

If in my subject to-night—"Alchemy, Ancient and Modern"—I try to give a human interest to the historical development of science and to point to practical and useful results of most modern developments, I make no apology, for I feel that none is needed.

The popular idea of the mediæval alchemist as a knave and impostor taking advantage of the credulity of the time is far from the truth. The early history of science is largely the early history of chemistry, and the many important early discoveries are entirely the work of the alchemists.

As the first scientists, lost in prehistoric time, we may consider the men who reasoned out the cause of fire and learned how to produce it at will. Given fire, we have other prehistoric Newtons who developed crude cooking and metallurgy. Accidental use of ores, such as those of iron, in the fireplace would give rise to metal, followed by crude metallurgy. As chemistry deals largely with changes produced by change of conditions, we have here crude chemical operations—of course, treated as yet as arts.

By the beginning of the Christian era knowledge of arts had so developed that intelligent beings had sufficient facts to attempt to reason as to cause and effect.

The Greeks were among the first in the field with a theory of matter not very different from that at present accepted—that matter consisted of atoms alike for one type of matter, indestructible but composed of some common constituents. Though nearly true, it was based on speculation rather than evidence. The Greeks, and later the Romans, seem to have despised labour, and experimental work was hardly thought of. Soldiering and administration were accepted occupations; work was left to slaves. Even the engineers of Greek and, especially, Roman times were often slaves. (I have even heard friends in that profession suggest that their case is not very different now.) Practical achievement only began when the Greek theories were taken up practically by workers in Egypt at Alexandria, where alchemy apparently originated. It has been suggested that actually there was a considerable chemical knowledge in Egypt centuries earlier, in the hands of the priests. If so, they were careful to keep their knowledge secret, and we know nothing of it. It would be a valuable source of miracles and wonders with which to amaze and awe a very ignorant and superstitious populace. Be this true or not, there is no doubt that by the third century A.D. a considerable knowledge of chemical operations was gained, classed under the name, at first, of "chemeia," later by the Arabs named "alchemy." Alchemy is now usually associated with the early period when, following Greek theory, transmutation of elements was considered possible, and early experimental work was chiefly directed to this end, particularly the conversion of base metals to gold.

Much of the Alexandrian knowledge has been lost to us through this belief. Though most of the workers were honest and convinced of the possibility of converting one metal to another, there were, as at present, those ready to take advantage of an opportunity, and these, selling various alloys as gold, finally became such a nuisance that the Roman emperor Diocletian, who was in control of Egypt, ordered all books on alchemy to be destroyed. Although Egypt was the birthplace of alchemy, its cradle was Arabia, for by the sixth century Islam had spread over Asia Minor, Arabia, North Africa, and Spain. The centres of this empire were Damascus and Baghdad, where culture and knowledge were encouraged, the learning of Greece and Egpyt being fully utilised. Here from 600 to 800 A.D.—the European dark ages—learning flourished and alchemy grew exceedingly. Its exponents were still guided by the search for transmutation, believing in the common origin of matter. They were not impostors, however, but serious and exceedingly intelligent workers. The ordinary chemical operations of calcination, extraction, filtration, distillation, &c., were developed. Naturally, many new substances were produced, including nitric acid—not an easy substance to handle.

The most famous of these Arabians—Geber—lived and worked at the time of Haroun al-Raschid. He wrote a number of works still in existence describing his discoveries, and I might quote from one to show his outlook:—

> "The first essential in chemistry is that thou shouldst perform practical work and conduct experiments, for he who performs not practical work nor makes experiments will never attain to the least degree of mastery. But thou, O my son, do thou experiment so that thou mayst acquire knowledge.
>
> "Scientists delight not in abundance of material; they rejoice only in the excellence of their experimental methods."

With the revival of learning in Europe which was coincident with the decay of the Arab empire, Arabian knowledge spread to Europe, particularly through the monasteries.

Through the Middle Ages the practice of what we may call "alchemy" flourished and increased in Europe. Still transmutation was a guiding principle. Though workers believed in the "philosopher's stone" that, if discovered, would enable them to achieve their object of making gold, they followed up any discoveries with a true spirit of inquiry. Apart from the monks, interest spread among the nobility—the only other group with leisure and wealth to devote to it. In England Prince Rupert was a skilled worker. Often princes and rulers, interested but not skilled, would support and employ alchemists. This naturally lead to imposture, and several impostors in Europe were hanged for their pains. One alchemist, wiser than most, refused the invitation of a German noble on the grounds that if he could make gold he had no need for the prince, and if not the prince had no need for him. Another German prince and his court were persuaded by an Arab impostor that he could make gold, but that he needed some gold to start his process. The whole court gathered in the workroom and threw their contribution into a furnace. The Arab threw in his own preparation, when there was an explosion, with much fume and smoke. When the smoke cleared, so had the Arab and the gold.

Happenings of this sort do not alter the fact that the real alchemist was an investigator who made many discoveries of new chemical compounds and investigated their properties. Astrology and similar nonsense were mixed with the more serious work at times. This mixture of humbug and valuable knowledge is used by Scott in "Kenilworth," where Weyland Smith poses to the ignorant as something of a magician, but on occasion is able to provide drugs necessary for saving of life. The humbug doubtless impressed the ignorant, and from them could be collected the wherewithal to carry on.

Although the doctrine of transmutation persisted until the seventeenth century, it was realized by the fifteenth century that its actual achievement was unlikely, and gradually interest turned to various substances discovered and their possible use in medicine.

The most famous name in this connection is Paracelsus, a Swiss, born in 1493, the son of a physician, who taught him the scientific knowledge of the time. Time would not permit an account of his life, but while quite young he wandered through Europe gathering further knowledge of alchemy, astrology, and medicine. Possessed of forceful personality and great conceit of his own ability, he was able to persuade others to take him at his valuation, and secured the post of city physician at Basel. Being exceedingly bombastic and quarrelsome, he soon had the whole of his medical fraternity "by the ears." He attracted general attention by his attacks on alchemy as then practised, and he preached the doctrine of medical chemistry, possibly mainly to be in opposition to his colleagues. While one shudders at the probable sufferings of the mute, inglorious victim of his experiments, his preaching did much to start alchemy on more useful lines.

Before leaving the alchemists I will mention one of the earliest scientific nutrition experiments of which we have record. This was due, according to tradition, to a German monk—Basil Valentine—who is supposed to have lived at the same period as Paracelsus, but who, unlike him, was the author of a large volume of chemical discovery, including antimony and some of its compounds. His antimony residues were thrown out and eaten by the monastery pigs, who grew and flourished exceedingly. Ascribing this to the antimony, Valentine decided to see whether it would have a similar effect on his fellow monks. With true scientific spirit, he added an antimony preparation to their food, but, in accord with scientific procedure, he used a control whose food had no antimony added. He himself was the control. The derivation of the word "antimony" is supposed to be "anti moine" —monks' enemy. Evidently pigs and monks present different nutrition problems.

This tale of the old alchemists ends with the Civil War in England. A new one begins with Charles II. During his reign lived two of England's most famous men—Newton and Boyle. During his reign, also, was founded the Royal Society of London. To Boyle we owe the final abandonment of the doctrine of transmutation accepted for nearly 2,000 years. He set out the actual position of what he called the elementary substances, which could by no means be split up. From Boyle's time—say, 1660—until the end of the last century, we have what we might call the "atomic period," when it was accepted that the group of about ninety substances so called elements were quite indestructible and unchangeable—as, indeed, they were with the means, chemical and physical, at that time available. It was J. J. Thomson, of the Cavendish Laboratory, who in 1897 first shattered the beliefs of the chemists in the unique nature of their atoms when he showed that electrons less than one-thousandth the size of the smallest atom (hydrogen) could be produced by electric discharge from all types of atoms, and that all atoms furnished identical negatively charged electrons. The discovery of radium and other radio-active elements a little later, in the hands of Rutherford—Thomson's successor at Cambridge—gave rise to what I may call the modern period of alchemy where first elements were shown to be changing and later new elements were built up.

One need refer but briefly to the general facts of radio-activity—that radium and other radio-active elements emit radiation of three types—a very penetrating group: first, gamma rays, which are a true radiation of the same nature as X-rays; second, the beta rays, identical with the negatively charged electrons of the electric discharge tube; and third, the alpha radiation; this was found to consist of positively charged particles of considerable mass, actually about four times as heavy as the hydrogen atom. The alpha particles were soon shown by Rutherford and Soddy to end their life as helium atoms. Helium is a gas present in very small amount in the air. It has not been very difficult to prove that the loss of alpha particles leaves new and lighter atoms behind until finally an inert residue of lead only remains. This disintegration theory is now generally accepted, and consequently the nineteenth-century conception of the atom as something unalterable and indestructible has had to be modified. Until quite recently, however, man had no control over such atomic disintegration. No change of condition within his reach had any effect whatever on the rate or nature of radio change. Of these radiations, the alpha particles have proved the most interesting scientifically, as they have enabled the interior of the atom to be explored and for the first time have enabled the actual breakdown of non-radio-active atoms to be accomplished. The alpha particle moves with a velocity of tens of thousands of miles per second and can penetrate not only through matter but through the atoms themselves, usually in a straight path. This path can be determined by electrical measurements and actually demonstrated photographically. Occasionally the particles are deflected from the straight path. A study of the deflection enabled Rutherford to give us a very definite picture of an atom. The atom consists of a small central nucleus positively charged, with sufficient negative electrons, forming a sort of planetary system, just to neutralise the positive charge of the nucleus. By study of spectra, of alpha particle scattering, and of the nature of X-rays emitted from different elements, the actual number of electrons has been determined for all atoms, the extremes being one only for hydrogen and ninety-two for the heaviest atom—uranium. The weight of an atom lies in the nucleus; the simplest and lightest atom (hydrogen) is considered to have a simple nucleus. This hydrogen nucleus or proton is almost certainly the unit from which the nucleus of heavier atoms is built. The proton carries a positive charge of electricity. Heavier atoms contain in the nucleus sufficient protons to balance the total negative charge of the surrounding electrons. The atoms in general have, however, a greater weight compared with hydrogen than can be accounted for by the number of electrons (and corresponding number of protons). The extra weight is accounted for by neutral groups consisting of pairs of electron plus proton actually contained within the nucleus. Those electrons are in addition to what may be called the free electrons surrounding the nucleus. Such neutral pairs, called "neutrons," have recently actually been detected, driven from atomic nuclei by alpha-ray bombardment.

The chemical properties of atoms are due almost entirely to the external electron grouping; the weight and certain physical properties depend on the nucleus. Recently it has been found possible to separate most chemical elements into separate fractions whose atomic weights are slightly different though their chemical properties are identical. For our purpose we may consider the atomic weight as the weight of an atom compared with the weight of an atom of hydrogen; thus the atomic weight represents the number of protons and neutrons in the atom. The different atoms with the same electron grouping have the same chemical properties, and all represent chemically one element. They are called "isotopes." They differ only in the number of inert neutron groups in the nucleus. While a few elements have no isotope, some have two and many have several; tin has about a dozen. Except in one case, the isotopes of one element have atomic weights close together. The exception is hydrogen, which contains but the one proton and one free electron; it is the one element that contains no neutron.

It has one isotope now called "deuterium," which still has one free electron and one proton, but has also one neutron in the nucleus. In this case one isotope is twice as heavy as the other; this great difference causes considerable difference in properties, and deuterium is the one isotope that has been separated in a pure state. Hydrogen and its isotope differ from other atoms in another way. I have already told how a high-tension electric discharge in a vacuum can remove electrons from atoms. Actually, it is very difficult to remove more than one electron, so that hydrogen and deuterium are the only elements that have a bare nucleus left in the process.

Atoms with an electron removed have, of course, a positive charge and are said to be ionised. Such ionised gases quickly pick up the necessary electron and revert to ordinary atoms. The only other particles with no electrons that we know of are the neutron already mentioned and the alpha particle. This last is formed by break-up of the nucleus of radio-active elements. It is formed of two neutrons and two protons. Ejected with high velocity, it quickly slows down and picks up the necessary electrons to form helium. Although the bare particle can apparently penetrate actually through atoms, the final helium atom has lost this power. While the planetary electrons occupy only a minute fraction of the effective volume of the atom, they are in such rapid movement that different portions are continually occupied and interpenetration is entirely prevented. Thus it is easy to remove an electron, but very difficult to reach the nucleus, which it is necessary to attack if a permanent change in the atom is to be effected. Success has been attained by the use of four high-speed particles free from planetary electrons—the proton, deuteron, alpha particle, and neutron. Of these, the neutron is itself obtained by bombarding atoms of small atomic weight with alpha particles, and is itself a product of actual atomic break-up.

All four are now used to attack the nucleus, and all cause nuclear rearrangement with the actual formation of new elements. The first and classic experiment is that carried out in Rutherford's laboratory, where nitrogen gas was exposed to alpha-ray bombardment. There is a very beautiful method for following the passage of the alpha or similar fast-moving particles through moist gas, where they leave a trail of ionised gas in their track. The ions act as nuclei for condensation of water vapour and produce a thin fog track which can be photographed. The alpha-ray track is nearly always a straight line, but in nitrogen very occasionally a forked track appears, one branch of the fork being longer than the original tracks. From its behaviour, this new track could only be ascribed to a proton or hydrogen nucleus, which, of course, as it slowed down, would acquire an electron and become an ordinary atom. The second branch of the fork is shorter than the original. As we have to assume that the helium and nitrogen nuclei have collided and the proton has escaped, we must regard the second track as due to the combined residues. From the number of protons (8) and neutrons (9), we should have a new combined nucleus with an atomic weight of 1-17, but with an electron grouping and chemical properties of oxygen, atomic weight 16—an oxygen isotope. It is interesting to know that quite recently this isotope has been found to exist in small proportion in the atmosphere, and a partial separation has even been effected. This experiment, carried out in 1925, is an effective demonstration of the first artificial transmutation of an element. The actual amount of material changed was almost infinitely small and quite incapable of chemical recognition. Later it was found that protons could be driven from most of the lighter elements up to potassium, but that the heavier elements could not be attacked, possibly because the greater number of positively charged protons in the nucleus exerted so great a repulsive force on the positively charged alpha particle that it could not approach the nucleus.

Rutherford's explanation of transmutation was at first regarded as ingenious and very probable, but later accumulation of evidence has shown him to have been actually correct. The most important of the recent discoveries was that made by the daughter of Madam Curie, the discoverer of radium, in collaboration with M. Joliot. They found that some of the lighter elements already known to undergo nuclear change also acquired a temporary radio-activity which persisted after removal from the alpha-ray bombardment. Next it was shown that both protons from hydrogen and deuterons from its isotope, accelerated to high speed in an electric field, could also induce temporary radio-activity.

There is no doubt that we have here an actual transmutation with formation of new elements. The projectile particles penetrate the atomic nuclei, forming new and unstable atoms. So far the quantities produced have been far too small for actual chemical isolation, but there is undoubted chemical proof that new properties have been developed. Electrical methods are far more sensitive than chemical, and the radio-activity of the minute quantities is readily detected and may be used to follow the atoms during chemical reactions. As an example, we may take aluminium bombarded with alpha particles. The aluminium is dissolved in acid containing a small amount of phosphate. The added phosphate is then separated from the aluminium. All the radio-activity is now with the phosphorus, and no chemical process will separate it. The new element is thus a new isotope of phosphorus; in fact, all of the many new radio-active elements are isotopes of common stable elements. During their radio change they revert sometimes to an ordinary stable form of an element, sometimes to a new stable isotope. If carbon is bombarded with protons and then burnt, a minute quantity of gas is produced which gives all the tests for nitrogen except that it is radio-active. From the numbers of protons and neutrons involved, this unstable nitrogen has the same 7 protons as nitrogen, but has 6 instead of 7 neutrons and an atomic weight of 13 instead of 14. Both these new elements have a short life, half-disappearing in a few minutes.

Transformations produced by protons and deuterons are more definitely artificially produced than those first discovered with alpha particles, as these are natural products, while the protons are themselves artificial and the whole series of changes becomes artificial.

An interesting feature of many of the large number of artificial elements now known is that they emit, not electrons, but particles of electron size with a positive instead of negative charge. These positrons had just been discovered as a product of the strange cosmic rays that reach us from space, when their production in quantity from the new elements was discovered. They disappear when they lose their velocity, by interaction with electrons, both apparently being converted to some form of radiant energy. The loss of a positron causes a positive proton of the nucleus to change to a neutron, and the nucleus, with now a different total charge, forms a new type of atom naturally more stable. Thus the active nitrogen previously described has in its nucleus 7 protons and 6 neutrons. The radio change evolves a positron, leaving a nucleus with 6 protons and 7 neutrons. This will hold externally 6 electrons, as does carbon, of which it will be an isotope.

The neutron, already mentioned as a nuclear constituent and as a product driven from lighter nuclei by alpha particles, can itself be used as a projectile with most interesting results. Having no electric charge, it can penetrate the larger nuclei that, as already explained, the charged proton and alpha particle cannot reach.

An Italian worker (Fermi) claims to have thus added a neutron to the nucleus of uranium, the heaviest known element, producing a new element heavier than any natural one.

With sulphur, neutrons produce an isotope of phosphorus that must be assigned an atomic weight of 32. This is different from natural phosphorus of atomic weight 31, and also it is radio-active. It is also different from the active phosphorus from aluminium, which must have an atomic weight of 30. This sulphur product has a life of several weeks, instead of the few minutes of the aluminium product. All three forms of phosphorus have the same chemical reactions and cannot be separated from one another. All have 15 protons in the nucleus, but the different forms have 15, 16, and 17 neutrons.

The sulphur product gives off electrons from the neutrons in its nucleus and reverts to sulphur. Not all the active elements revert to their original parent. Sodium bombarded with deuterons sets free protons which can be detected by the method already described for nitrogen.

The neutrons of the deuterium are absorbed by the sodium. This produces no change in the electron system. The new product is still sodium, but it is an isotope, and the new nucleus is unstable; the product is radio-active. Like the phosphorus just described, it gives off an electron from its neuclear neutron. This electron omission, of course, is readily measured. The original sodium contained 11 electrons and 12 neutrons in the nucleus; the radio-active sodium 11 electrons and 13 neutrons. After emitting an electron from a neutron, the nucleus will contain 12 electrons and 12 protons. This is a change to an entirely new element—magnesium. At present some of the changes have an entirely speculative basis. I have described some of the chemical evidence in the case of the radio-active bodies, but once stable products are formed this method fails, and, as the quantities are so small, we are left only with the evidence of the various types of interacting groups and emitted particles. In this case there is no direct evidence for the magnesium.

This radio-active sodium is one of the most interesting of the new bodies. Professor Lawrence, of California, has built an exceedingly powerful apparatus for producing by electrical acceleration a very intense stream of deuterons. With this he has produced sufficient radio-active sodium to have for a few hours an activity nearly equal to a milligram of radium—a quantity often used medicinally. This has two important aspects: First, it suggests a cheap source of material for cancer treatment—a material, moreover, that would in a few days become a harmless natural substance already in the body in quantity, while radium products may maintain harmful activity; second, with a more powerful deuteron stream, which is possible, quantities sufficient for chemical examination and determination of nature of final product may be obtained.

As another example of the practical value of the new discoveries, I will describe how radio-active phosphorus from sulphur has been used to trace the history of the phosphorus in living organisms. Rats have been fed with a ration containing sodium phosphate which itself contained sufficient radio-phosphorus for easy detection electrically. All chemical tests have shown that the active and ordinary phosphorus are quite inseparable, and where one is the other will be.

By examining the excreta and finally killing the animals, it was possible to trace the movement of all the phosphorus fed. It was thus shown that the average phosphorus atom only stays in the body of the rat a couple of months, and even in the skeleton 30 per cent. of the element is replaced every three weeks. Similar experiments were made with maize seedlings. These were grown in ordinary nutrient medium containing phosphate till two leaves had fully developed, when radio-phosphorus was added to the solution and the two next leaves were developed. Both sets of leaves had the same radio content, showing that phosphorus taken up later was added equally to all the leaves. This, of course, means that the element was continually shifting and that phosphorus compounds are not permanently fixed in a plant. Possibly we are at the beginning of a new era in physiological as well as chemical and physical history.

Essential Oils from the Queensland Flora—Part XIV.—Eucalyptus Conglomerata.

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(*Read before the Royal Society of Queensland, 27th June,* 1938.)

The botanical characters of this Eucalypt have been described by Maiden and Blakely. As pointed out by them, it closely resembles the common stringybark, *Eucalyptus eugenioides,* except that it favours sandy, swamp country, whence its common name—Swamp Stringybark. Unlike *E. eugenioides,* however, its distribution seems to be limited to a few small areas, those recorded being at Beerwah (Queensland) and Glen Innes (New South Wales).

Mr. C. T. White, Government Botanist, drew our attention to it, growing in the swamps around Beerwah. It was found easy to distinguish it from *E. eugenioides* by smelling the crushed leaves of each, for the odour of the former is very unusual and, if anything, unpleasant, while that of the latter is the common cineol-pinene odour. The oil from the leaves of this Eucalypt has been investigated.

The yield of oil obtained from the leaves was low, ranging from ·12 to ·2 per cent.

The principal constituents identified in the oil are 1-α-phellandrene, two sesquiterpenes, a sesquiterpene alcohol, a trace of cineol, and an unidentified alcohol. Pinene was not identified, although it may have been present in amounts too small to be recognised. Of particular interest was the isolation of a white crystalline solid from the aqueous distillate from the steam distillation of the leaves. The solid appeared to be soluble in water, for it came out of solution very slowly on standing, but was rapidly thrown out on the addition of salt. The same solid was also found in the residue in the still after the first distillation of the oil. The present paper deals only with the preliminary work carried out on this solid. The work so far seems to indicate that the substance has not been described previously, and consequently a thorough investigation into its properties and constitution is necessary. This work is in progress.

EXPERIMENTAL.

Leaves and terminal branchlets weighing 250 lb. were subjected to steam distillation, and yielded 140 c.c. of oil. The water from the steam distillation was kept and coarse salt dissolved in it. The crude white solid which came out was filtered off. This weighed 7 grams. Three hundred and forty pounds of leaves, collected in November, 1937, yielded 305 c.c. of oil and 15 grams of crude solid from the aqueous distillate.

The two samples of oil had the following constants:—

A		B	
$d_{15\cdot5}$	·9451	$d_{15\cdot5}$	·9547
$[\alpha]_D$	5·7	$[\alpha]_D$	7·3
n_D^{20}	1·4980	n_D^{20}	1·4986
Ester Value ..	0	Ester Value ..	0
Ester Value after Acetylation	62·8	Ester Value after Acetylation	56
Acid Number ..	0	Acid Number ..	0

The oil (B) was subjected to fractional distillation at 2mm. pressure, when the following fractions were obtained:—

	$d_{15\cdot5}$	$[\alpha]_D$	n_D^{20}
1. Oil collected in liquid ammonia trap ..	·8636	18·5	1·4723
2. 70–80°C.	insufficient for determinations		
3. 80–92°C.	·921	11	1·5033
4. 92–112°C.	·961	6·3	1·4984
5. 112–128°C.	(a thick green oil).		

The residue in the flask solidified on cooling. After removing the adhering oil on a porous plate and purifying further by recrystallisation, the solid proved to be identical with that separated from the aqueous distillate from steam distillation.

The characteristic odour of pinene was not observed in the oil collected in the liquid ammonia trap. Furthermore, the oil failed to yield any sign of a nitrosochloride. This fraction, however, readily gave a nitrosite in good yield, which when recrystallised from acetone—water, melted at 112° C. and was identical with 1-α-phellandrene- -nitrite.

The remainder of this fraction was shaken with 50 per cent. resorcin solution. From this was recovered a trace only of cineol. No solid derivative of cineol was formed, but the unmistakable odour and the method of extraction are taken as proof of its presence.

The oil recovered after this treatment (1½ c.c.) was oxidised with permanganate, but no trace of pinonic acid was found.

The small fraction b.p. 70-80°C. at 2 mm. had a very pleasant odour and gave no reaction with 2, 4-dinitro-phenylhydrazine. Combustion results indicated the presence of an oxygenated body. As only one c.c. was available, an attempt was made to identify the probable alcohol by means of its naphthyl urethane. Although a small quantity of urethane was obtained, it was never isolated in a sufficiently pure state to be identified by its melting point.

Fractions 3, 4, and 5 gave on repeated fractionation three principal fractions, two of which contained sesquiterpenes, and the third a sesquiterpene alcohol. These fractions had the following constants:—

(*a*)	80–82°C. (distilled over potassium	$d_{15\cdot5}$	·9144
		$[\alpha]_D$	−8·4
		n_D^{20}	1·4913
(*b*)	91½–92°C. (distilled over potassium)	$d_{15\cdot5}$	·9272
		$[\alpha]_D$	+ 22·1
		n_D^{20}	1·4950
(*c*)	107–109°C.	$d_{15\cdot5}$	·986
		$[\alpha]_D$	+8·2

The constants of fraction (*a*) somewhat resembled those of aroma dendrene. Five c.c. of this oil in carbon tetrachloride were treated with ozone until absorption was complete. The oil recovered after decompositoin of the ozonide with warm water had the characteristic odour associated with aromadendrone, although none of the latter crystallised out even when kept for two months in the ice-chest.

Ten c.c. of the same fraction were treated with selenium at 280°C. for two hours. A small quantity of an azulene (m.p. of picrate 120°C.) was separated by means of phosphoric acid. The main bulk of the recovered oil had density ·9062 and gave combustion results indicating it to be a $C_{15}H_{26}$ body.

Combustion results:—Found—	C 86·9	H 12·3
$C_{15}H_{26}$ requires	C 87·38	H 12·62

Similar results were obtained with the other sesquiterpene (b.p. 91½-92°C. at 2 mm.) on treatment with selenium. The recovered oil this time had $d_{15·5}$ ·9156.

Combustion results:—Found—	C 86·9	H 12·26
$C_{15}H_{26}$ requires	C 87·38	H 12·62

No trace of either cadalene or eudalene could be found in either case.

The results of combustion of fraction (*c*) supported the belief that it was a sesquiterpene alcohol.

Found—	C 80·8	H 11·8
$C_{15}H_{26}O$ requires	C 81·09	H 11·71

On treatment with formic acid under reflux for one hour, the alcohol was converted into a sesquiterpene with the following constants:—

$d_{15·5}$	·9208
$[\alpha]_D$	— 28·2
n_D^{20}	1·4942

Combustion results—	C 87·7	H 11·9
$C_{15}H_{24}$ requires	C 88·23	H 11·77

Unidentified Crystalline Solid.—This solid was removed from the aqueous distillate derived from steam distillation by filtering at the pump. It was purified by recrystallisation from petroleum ether, from which it crystallised in white glistening needles m.p. 63-64°C. The combustion results do not conform closely with any particular formula, and the substance may therefore be a mixture of two homologues. The formula which best fits the results is $C_{13}H_{18}O_4$.

Molecular weight determinations by Rast's method gave values of 227 and 246, and by the depression of freezing point of benzene a value of 227 was obtained.

$C_{13}H_{18}O_4$ has molecular weight 238.

Methoxyl results of 39, 38·9, 36, and 39·4 per cent. were obtained. Three methoxyl groups are equivalent to 39·07 per cent. based on formula $C_{13}H_{18}O_4$.

On treatment with bromine in carbon tetrachloride the bromine was only slowly absorbed with the evolution of HBr yielding a mixture of bromides which could not be separated by recrystallisation.

On treatment with hot concentrated nitric acid, dense fumes of oxides of nitrogen were evolved. On pouring the resulting solution into water a small quantity of a reddish solid was isolated. This had m.p. 165°C. The amount of this material available was too small for analysis. It was thought that it might be identical with dinitrophloroglucinol-trimethyl-ether, a white solid which rapidly turns reddish-brown on keeping and has m.p. 165°C. This substance was synthesised, but greatly depressed the m.p. of the nitro body mentioned above.

Oxidation and other reactions which are expected to throw light on its constitution are at present being carried out, and the results of these will be published at a later date.

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l-α-Phellandrene and its Monohydrochloride. Part I.

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(*Read before the Royal Society of Queensland, 27th June,* 1938.)

The present paper contains a description of the following work:—

(*a*) Isolation of pure l-αphellandrene and determination of its physical constants;

(*b*) Observations on the loss of optical activity of α-phellandrene, and its stabilisation;

(*c*) Investigation of the products obtained by hydrolysis of phellandrene monohydrochloride.

(*a*) The α-phellandrene used was obtained from the essential oil of *Eucalyptus dives* by fractional distillation under diminished pressure. Besides phellandrene, the oil was known to contain pinene; piperitone, and a little cineol. Repeated fractionation removed the pinene and piperitone, while the cineol, whose boiling-point is too close to that of phellandrene to admit of separation in this way, was removed from the product in the final stages by extraction with resorcinol. As phellandrene is extremely susceptibile to change on heating, the temperature during distillation was kept as low as possible by working at pressures between 1 and 5 mm. of mercury. The phellandrene fractions then distilled at temperatures below 45°C. Any rise in temperature above about 50° resulted in rapid destruction of the phellandrene, as indicated by impoverished yields and a falling-off in the rotation of the product. The final material obtained had a much higher specific rotation than any previously recorded in the literature, and so may be regarded as the purest samples of l-α-phellandrene hitherto obtained.

The first lot of oil distilled, consisting of about 1,400 c.c., yielded 122 c.c. of phellandrene with the following constants:—

b-p	(5 m.m.) 41°C.
$d^{15 \cdot 5}_{4}$	·8455
n^{20}_{D}	1·4727
$[\alpha]_D$	—133

A fresher sample of oil used to obtain material for later work yielded a product of still greater purity. The purest sample obtained consisted of about 240 c.c. with the following constants:—

b-p	(4-5 m.m.) 39°C.
d^{20}_{4}	·8369
n^{20}_{D}	1·4728
$[\alpha]_D$	—168·5

The purest sample previously described in the literature (Smith, Hurst, and Read, 1923), obtained also from *E. dives,* had the constants:—

d^{20}_{4}	·8410
n^{20}_{D}	1·4732
$[\alpha]_D$	—112

The phellandrene used in the experiments on the hydrolysis of phellandrene hydrochloride had specific rotations of between -136 and -146, and material of this quality could be obtained in yields of about 12-14 per cent. of the original oil.

By repeated fractionation of the residual phellandrene fractions to remove phellandrene as far as posssible, a product was obtained with a rotation of —1°, and n_D^{20} 1·4880. This was identified as practically pure p-cymene.

(*b*) *The Loss of Activity of* 1-α-*Phellandrene and its Stabilisation.* —The instability of phellandrene to heat has already been remarked on. It also undergoes rapid decomposition on standing in contact with air at atmospheric temperatures, with diminution of rotation, finally turning to a yellow, viscous, and extremely sticky material. Observations on the change in rotation with time were taken, with a view to finding the conditions necessary for succesful preservation of samples of pure phellandrene. The use of solid hydroquinone as a preservative was suggested by the known efficacy of this substance as an antioxidant in other cases. The accompanying table contains readings, taken over a period of several months, of the rotations of two samples of phellandrene, to one of which hydroquinone was added, while the other served as a control. No special care was taken to exclude air, the test-tubes containing the samples being stoppered with ordinary corks. It will be seen that the hydroquinone has the effect of diminishing the rate of change and, finally, after a value of about —80° had been reached, of stopping it entirely. Hydroquinone was added to samples of phellandrene intended for use, but the most important precaution was found to be the use of tightly-fitting rubber stoppers to exclude air, for it can be seen from the table that hydroquinone alone will not entirely prevent the very rapid initial fall that the rotation of highly purified phellandrene suffers. A sample of phellandrene, of initial rotation –102·2°, without preservative, but very carefully stoppered, showed a diminution in rotation of only 0·4° on keeping in the dark for three months. On removing the stopper and allowing to stand for a further two days, the rotation fell by 3·0°.

TABLE SHOWING THE EFFECT OF HYDROQUINONE ON THE OPTICAL ACTIVITY OF 1-α-PHELLANDRENE.

Days.	Sample 1 (Control).	Sample 2 (1 gm. Hydroquinone).
0	105·2	105·2
2	102·0	103·5
9	93·5	98·2
14	87·0	94·7
24	74·9	88·1
35	64·4	85·8
52	54·8	82·7
72	45·0	81·3
100	39·8	81·1
154	28·1	80·0
218	14·9	79·3
246	9·0	78·8
356	0	78·8

Curves on the attached graph are from the above figures.

(The above figures are actual rotations in degrees, not specific rotations.)

(*c*) *Hydrolysis of Phellandrene Hydrochloride.*—Bacon (1909) has described a monohydrochloride of α-phellandrene, prepared by passing dry hydrochloride acid gas to saturation into a solution of the phellandrene in light petroleum. On distilling off the solvent, he describes the monohydrochloride obtained as distilling at 80-83° (10 mm.), undergoing slight decomposition if heated above 84°C, and having the constants:—

d^{30}_{4} .. .. ·960

n^{20}_{D} .. .. 1·4770

Cl = 20·2 per cent. (theoretical for $C_{10}H_{17}$ Cl = 20·6 per cent. erroneously given at 20·3 per cent. in the original paper).

On treatment under reflux for six hours with alcoholic soda, he claims that the material is converted to dipentene, which he identified by means of its tetrabromide. Referring to Bacon's work, Simonsen (1931) says: "These results are somewhat unexpected, since the formation of dipentene requires a curious rearrangement of the ethylenic linkages, and the formation of α-terpinene might have been anticipated. Wallach has, in fact, shown that, with an alcoholic solution of H_2SO_4, α phellandrene does isomerise to α-terpinene, and a possible explanation of Bacon's results is that the α-phellandrene used contained some dipentene." The present work fails to confirm Bacon's results, either as to the nature of α-phellandrene monohydrochloride, or as to the formation of dipentene. On the contrary, it is shown that the hydrolytic product is a mixture of substances, among which the expected product, α-terpinene, is actually present.

To prepare the hydrochloride, 1-α-phellandrene with (specific rotations of between 136 and 146 was used. It was treated with HCl, as in Bacon's experiment, using a solution of the material in an approximately equal volume of petroleum ether. In order to determine the number of molecules of HCl added per molecule of phellandrene, an analysis was carried out on a small portion of the hydrochloride obtained as described above. The passage of HCl was continued until copious evolution of fumes indicated that saturation had been reached, and the material was then transferred to a known volume of standard alcoholic soda. The whole was boiled under reflux, and the excess NaOH titrated with standard acid. The result indicates only a small excess of HCl over that required for the monohydrochloride, so that the formation of dihydrochloride does not appear to occur to any appreciable extent.

Details:—

2 c.c. of phellandrene taken—i.e., 1·688 gm.

Hydrochloride treated with 30 c.c. alcoholic NaOH, equivalent to 22·8 c.c. N.Acid.

After hydrolysis 9·5 c.c. of acid was required to titrate excess NaOH.

∴ HCl used = 13·3 c.c.; 1 mol. of HCl requires 12·4 cc.

An attempt was made to isolate the phellandrene hydrochloride in the pure state by removing the solvent at the water-pump. Contrary to Bacon's observations, however, it was found that the material underwent considerable decomposition with loss of HCl during this process, and that, on attempting to distil the material obtained, under a pressure even as low as 3 mm., complete loss of HCl occurred, although the temperature was much lower than the published boiling-point of 83° (10 mm.).

The material obtained after removal of the solvent at the water-pump had the following constants:—

$d_{15 \cdot 5}^{15 \cdot 5}$	·9000
n_{D20}	1·4731
$[\alpha]_D$	—45°

A chlorine analysis gave the result Cl = 12·3 per cent., very much lower than the theoretical—viz., 20·6 per cent.

This material smelled strongly of HCl, and gave off fumes at the room temperature. It was then distilled at 3-4 mm.; distillation occurred at 40-44°, and the distillate gave no reaction at all when tested for the presence of chlorine. Its constants were:—

$d_{15 \cdot 5}^{15 \cdot 5}$	·8476
n_D^{20}	1·4770
$[\alpha]_D$	—44°

Combustion results:—C = 88·0 per cent., H = 11·9 per cent. (theoretical for $C_{10}H_{16}$:—C = 88·2 per cent., H = 11·8 per cent.).

Examination disclosed the presence of α-phellandrene and α-terpinene. α-Phellandrene was identified by means of its nitrosite, which melted after recrystallisation at 112°C. A portion of the substance was next subjected to oxidation with alkaline permanganate in order to obtain the characteristic oxidation product of α-terpinene. This substance, αά -dihydroxy α-methyl ά isopropyl adipic acid, after repeated crystallisation from ethyl acetate melted at 190°C., and showed no depression in a mixed melting-point test with a sample of the acid obtained from authentic α-terpinene. The terminal decomposition of phellandrene hydrochloride is thus found to follow the course expected in theory.

In the first experiment on the hydrolysis of phellandrene hydrochloride with alcoholic soda, as performed by Bacon, the product was partially separated into two fractions. These had the constants:—

(i) b.p. below 45° (4 m.m.)

$d_{15 \cdot 5}$	·8645
n_D^{20}	1·4802
$[\alpha]_D$	—30°

(ii.) b.p. 50°–65°

$d_{15 \cdot 5}$	·8793
n_D^{20}	1·4660
$[\alpha]_D$	—31°

Combustion results (i.) C = 87·8 per cent. H = 11·8 per cent.
(ii.) C = 80·1 per cent. H = 11·8 per cent.

These figures are consistent with the assumption that the fraction (ii.) is an oxygenated compound of formula $C_{10}H_{16}O$ or $C_{10}H_{18}O$, contaminated with fraction (i.) of the formula $C_{10}H_{16}$. Fraction (i.) contained α-phellandrene and α-terpinene; no tetrabromide could be obtained, contrary to Bacon's observation. Fraction (ii.), which, in view of its physical constants, was thought to be of a ketonic nature, gave a product containing nitrogen after treatment with hydroxylamine, but only a very small amount of semicarbazide could be prepared.

In a second experiment, using 180 c.c. of phellandrene, the hydrochloride was submitted to hydrolysis without previous removal of the light petroleum solvent, in order to ensure that the alcoholic soda played the greatest possible part in bringing about the removal of HCl. The product was then treated with semicarbazide, which yielded only a small amount of non-volatile material. The portion recovered was separated into two fractions:—

(i.) b.p. 40–45° (4 m.m.)

$d_{15 \cdot 5}$	·8519
$n_{D_{20}}$	1·4751
$[\alpha]_D$	—20°

(ii.) b.p. 60–66° (4m.m.); 207–210° (760 m.m.)

$d_{15 \cdot 5}$	·8828
$n_{D_{20}}$	1·4450
$[\alpha]_D$	—36°

Fraction (i.) appeared to be similar to the hydrocarbon fractions obtained in previous experiments.

Fraction (ii.) was found to absorb bromine readily, indicating an unsaturated character. A combustion gave the following results:—

C = 77·3 per cent., H = 11·6 per cent. (theoretical for $C_{10}H_{18}O$:— C = 77·9 per cent., H = 11·7 per cent.), which suggest an unsaturated secondary alcohol of the formula $C_{10}H_{18}O$.

A portion (10 c.c.) was submitted to oxidation with chromic acid; 4 c.c. of a material was recovered with the constants:—

b.p. (760 m.m)	200°
$d_{15 \cdot 5}$	·9148
$n_{D_{20}}$	1·4783
$[\alpha]_D$	— 29°

A combustion gave the results:—

C = 78·9 per cent., H = 10·7 per cent. (theoretical for $C_{10}H_{16}O$:— C = 79·0 per cent., H = 10·5 per cent.).

On the assumption that fraction (ii.) above consists of secondary alcohol, this substance would be the corresponding ketone. Attempts to determine the constitution of the material in fraction (ii.) by isolation of the decomposition products firstly with permanganate in acetone solution and secondly with aqueous alkaline permanganate were, however, unsuccessful.

A third and much larger sample of phellandrene (400 c.c.) was used to obtain material for further investigation of the oxygenated products. This, treated as previously described, yielded a hydrolytic product, which was separated into the hydrocarbon fraction and a higher boiling fraction, these being obtained in equal amounts (180 c.c. of each). The hydrocarbon fraction was similar to that obtained in the other experiments and had the constants:—

$d_{15 \cdot 5}$	·8476
$n_{D_{20}}$	1·4770
$[\alpha]_D$	− 22°

A different method (Read and Storey, 1930) was used in this case to establish the presence of α-phellandrene and α-terpinene—viz., by separating the mixed nitrosites with ether, making use of the solubility of the α-terpinene nitrosite and the insolubility of α-phellandrene nitrosite in this solvent. After recrystallisation, the phellandrene nitrosite melted at 113°, and the terpinene nitrosite at 146°.

The higher fraction was found to be non-homogeneous, as further fractionation resolved it into two further fractions:—

(i.) 240 c.c.	b.p. (5 m.m)	65°–68°
	$d_{15 \cdot 5}$	·8840
	$n_{D_{20}}$	1·4580
	$[\alpha]_D$	− 24°
(ii.) 10 c.c.	b.p. (5 m.m)	72°–75°
	$d_{15 \cdot 5}$	·8914
	$n_{D_{20}}$	1·4634
	$[\alpha]_D$	+ 34°

The most striking difference here is the change of sign of rotation of the second fraction.

With the object of removing any possible ketonic material, fraction (i.) was treated under reflux with semicarbazide. An unexpected result was here obtained, as, when the material was distilled to separate what should have been unchanged product, the latter was found to have been practically completely decomposed, and now distilled uniformly at 52° C. (7-8 mm.), and had the constants:—

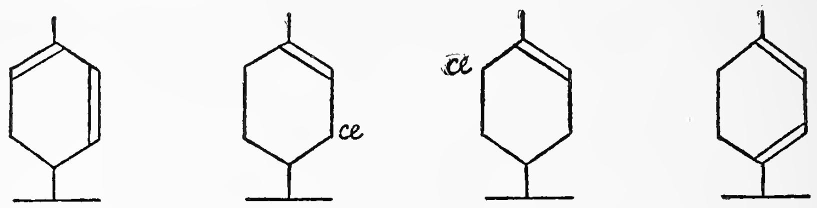
$d_{15 \cdot 5}$	·8428
$n_{D_{20}}$	1·4730
$[\alpha]_D$	− 76°

It consisted of α-phellandrene and only a small amount of α-terpinene. The semicarbazide obtained in this experiment was decomposed with 10 per cent. oxalic acid, and the liberated ketone recovered by steam distillation. It had the constants:—

$d_{15 \cdot 5}$	·8751
$n_{D_{20}}$	1·4741
$[\alpha]_D$	− 35°

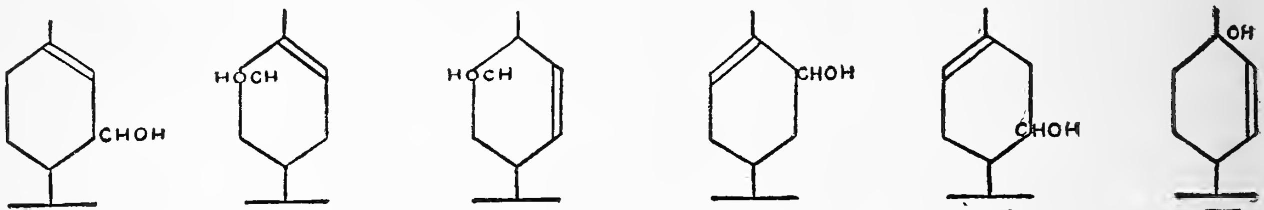
As it was considered that the acetic acid generated in the course of treatment with semicarbazide might be responsible for the behaviour described above, a small portion of fraction (ii.) was treated under identical conditions, but with 2 per cent. acetic acid and no semicarbazide. The material was, however, recovered quite unchanged. It was also recovered unchanged after treatment with semicarbazide alone; a faint nitrosite test was obtained, but its constants were not appreciably affected, and no material of lower boiling point could be obtained on distillation.

Theoretical Considerations.—α-Phellandrene has the constitution I. Assuming the addition of HCl proceeds in the normal manner to the conjugated double-bond system, phellandrene monohydrochloride has either of the constitutions II. or III. Loss of HCl from III. would then be expected to regenerate the original α-phellandrene, while II. would be expected to give α-terpinene, IV., and it is difficult to see how any other product, especially dipentene, could be formed.



I II III IV

I. These expectations have been confirmed by experiment. If, however, instead of causing the -Cl atom to unite with a neighbouring H-atom, the hydrolysis were to bring about the exchange of a -Cl atom for an -OH group, one would expect an alcohol. The following are possibilities:—Assuming normal addition of HCl to the conjugated system, we might obtain V. or VI., or in the event of abnormal addition, to one or other of the double bonds individually, VI., VIII., IX., or X. might result:—



V VI VII VIII IX X

Of these, VIII. is identical with VI. V. is the known alcohol piperitol, while the others have not been described. The physical constants of piperitol, however, are completely unlike those of the substances actually obtained. There is still the possibility of some more complex change, but the reconversion of the oxygenated material to phellandrene seems to preclude this.

Summary.—l-α-Phellandrene has been prepared in a higher state of purity than hitherto described, and its constants recorded. Addition of dry HCl in petroleum ether gives a monohydrochloride which is very unstable and readily decomposes to a mixture of α-phellandrene and α terpinene. Decomposition with alcoholic soda yields, not dipentene, as previously stated, but (*a*) a mixture of the above two hydrocarbons and (*b*) a complex mixture of substances of higher boiling point with the probable formula $C_{10}H_{18}O$, which have not yet been identified and which probably have not been previously recorded. No trace of α-terpinene was observed in any of the terpene fractions examined. Further work is in progress in connection with the alcohol recorded above, and the action of HCl gas on phellandrene in other solvents is also being investigated.

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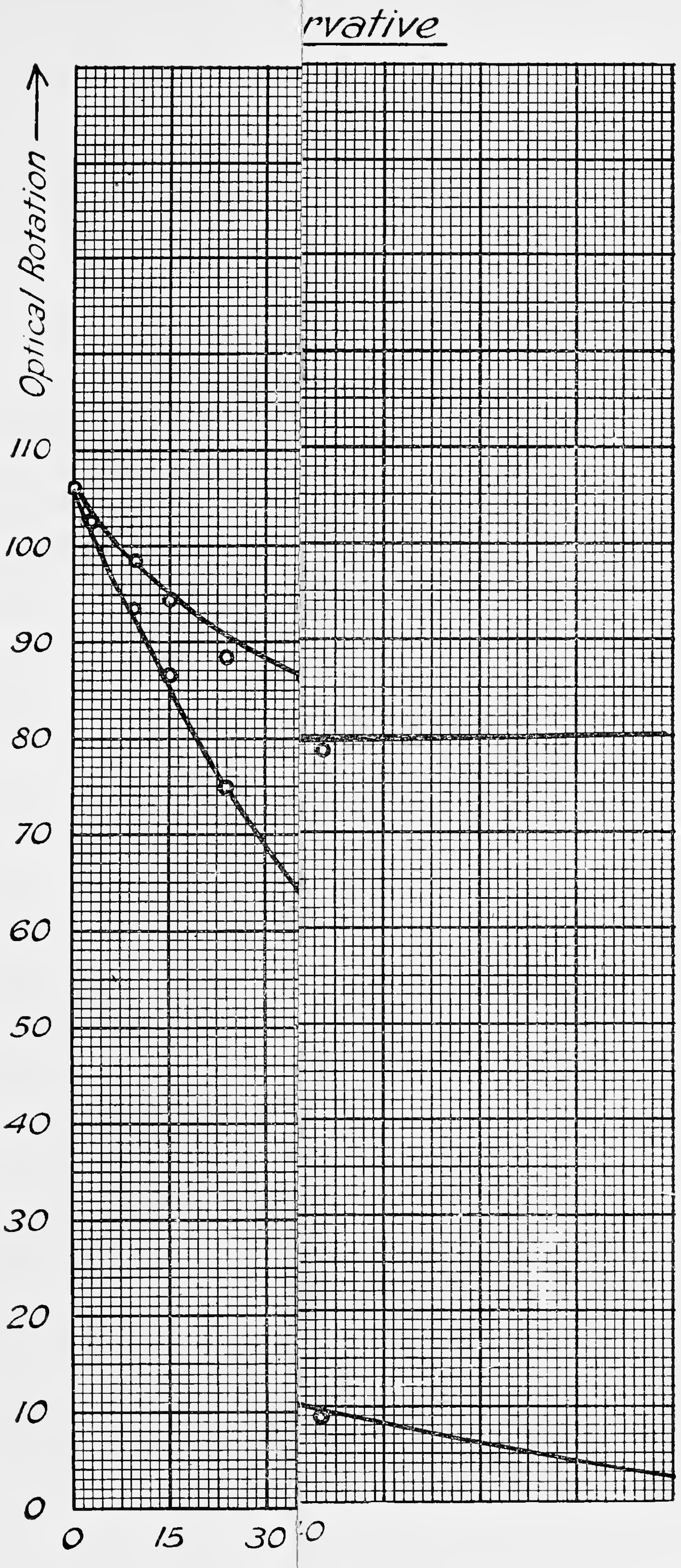
ERRATUM.

Page 20, line 31. α-terpinene should read γ-terpinene.


rvative
Optical Rotation
110
100
90
80
70
60
50
40
30
20
10
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0
15
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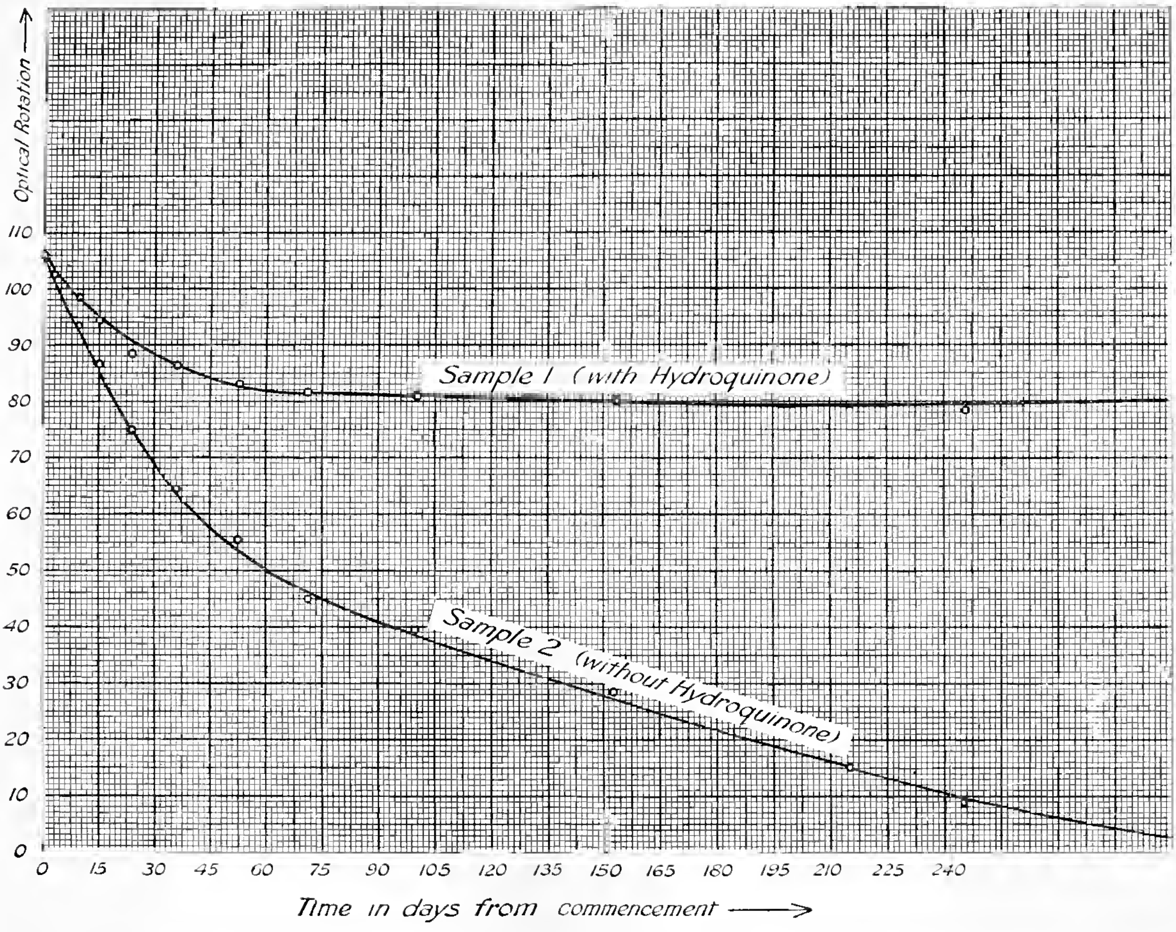
GRAPH

Loss of Optical Activity of α-Phellandrene with and without Preservative



The Red Earth Residuals and Their Significance in South-Eastern Queensland.

By W. H. Bryan, D.Sc., Department of Geology—University of Queensland.

(*Read before the Royal Society of Queensland, 25th September, 1938.*)

(Plates I., II., and III.)

I. GENERAL STATEMENT.

During an investigation into the distribution of soils in South-Eastern Queensland one particular group was found to be of especial interest. Although this suite embraced a considerable variety of soils, in accordance with the somewhat varied lithological terrain on which it was developed, its essential unity was shown not only by the generic characters that these varieties possessed in common, but by the important differences that divorced them from the other soils of the area.

The points possessed in common are notably: (1) Their relatively great depth; (2) their striking red colour; (3) their loamy texture; (4) the presence of a well-defined zone of ironstone nodules; and (5) the absence of any other sharp change in the profile. These place the group as such in the Red Earths, with a tendency to laterisation as a characteristic feature.

The soils of this group have, too, their peculiar agricultural and horticultural value, supporting, as they do, many market gardens and small-crop farms.

In contrast with the Red Earths, the great majority of the soils of the area are of relatively shallow depth, are grey in surface colour, and their profiles are sharply divided into eluvial and illuvial horizons that differ in colour, in texture, and in structure. Clearly, podsolisation was the dominant process in their formation. They are for the most part of little agricultural value.

These podsolic soils are found over a wide variety of rock types and have a wide topographical range. They are present, too, in various stages of development on the alluvial river terraces. As Bryan and Hines (1931) have shown, there is every reason for regarding them as the normal soils of the area under present climatic conditions[1].

The one and only link connecting the Red Earths with the Podsolic Soils is the fact that the former often show mild podsolisation, the upper part of the soil being rather paler in colour and somewhat lighter in texture.

The most satisfactory explanation alike of the many marked differences between these two soil series and of the one point of resemblance is that the Red Earths were formed, as such, under an earlier climate, and one considerably different from that in operation at present; and that mild podsolisation has been superimposed on them by the current pedogenic process.

---

[1] Cf. Prescott's Soil Map of Australia, which shows this area as occupied by "Podsolised Soils."

Having arrived at this conclusion solely from a study of the soils, attention was transferred to the physiographic conditions under which the Red Earths are found.

As a result of numerous observations in the field, it became more and more apparent that the Red Earths commonly occupied a series of isolated flat-topped areas—plateaux in miniature—with gentle scarps. The disposition of the individual plateaux clearly indicated that they were not to be considered as complete in themselves, but as remnants of a once continuous surface. This is abundantly clear in the field, and is apparent, too, on the military maps, although the large contour interval of these is too great adequately to demonstrate the remarkable homogeneity and independence of this physiographic unit.

The conclusion seems inescapable that the Residuals once formed part of a continuous and relatively level surface, out of which many of the present surface features have been carved.

Thus, just as the strictly pedogenic evidence points to the Red Earths as a distinct soil suite inherited from an earlier climate, so does the strictly geomorphic evidence point to the Residuals that they occupy as a distinct topographical feature inherited from an earlier physiographic epoch.

Moreover, these two independent lines of evidence are mutually confirmatory where, on the scarped edges of the plateau remnants, the profiles of the Red Earths are clearly bevelled and exposed by the present physiographic contours.

This convergence of evidence fortifies one in the belief that the Red Earth Residuals may be regarded, not merely as an interesting survival of an earlier landscape, but almost as a stratigraphic unit—a datum to which earlier and later events might be referred.

In the absence on the one hand of any evidence of Pleistocene glaciation, and on the other of any sedimentary series later than the Oligocene, such a datum should be doubly welcome in South-Eastern Queensland.

The value of the Red Earth Residuals from this stratigraphical point of view will largely depend on the possibility of recognising them or their legitimate equivalents elsewhere. Consequently, it is of prime importance to establish reliable criteria for their recognition in the field. To this end it seems advisable to select and describe a particular development in a named locality that may then be regarded as the type.

II. DEFINITION OF TYPE.

The type locality has been selected at a site on the Eight-mile Plains where these are crossed by the Brisbane-Southport road. The exact position can be described in terms of the Military Survey of Australia as "Beenleigh, B, 17, d, 3-3."

The following description of the soil profile at this point has been kindly supplied by Mr. R. Mitchell, M.Sc.Agr., who is at present assisting the author in a study of the soils of Greater Brisbane:—

> "The soil at the type locality at Eight-mile Plains as selected by Dr. Bryan appears to be considerably deeper than 113 inches.
>
> "The following is a description of the profile as found immediately below the 200-ft. level of a small plateau. The surface is practically flat at this point.

"The surface soil to a depth of about 7 inches is a dark-brownish orange in colour[1], a coarse sandy loam in texture, with a soft and loose consistency and a single grain structure. Grass-roots are numerous.

"The soil gradually changes to a dark yellowish red loam which is soft, loose, and of a single grain structure.

"Between 56 inches and 113 inches the soil becomes compact with a clay loam texture, and the colour changes to a dark pinkish buff which varies to a light reddish yellow.

"Ironstone nodules form an important feature in the profile. In the upper part they occur in the form of a few rounded individuals. With increase in depth these nodules are more numerous and the individuals larger and less regular. Between 90 and 113 inches they form a band of very irregular nodules which makes up the bulk of the soil.

"Throughout the profile small pebbles of quartz are found. In the upper part these are few in number, but they become relatively abundant between 90 and 113 inches.

"The vegetation forms a Eucalyptus open forest association with a moderately close canopy. The principal species are *Eucalyptus gummifera, E. micrantha, E. paniculata, Tristania suaveolens, Acacia Cunninghamii, A. aulacocarpa,* and *Aristida vagans.*"

III. VARIATIONS FROM THE TYPE.

(*a*) *Variations in the Soils.*

Direct field evidence shows that a considerable amount of variation is present even in the Red Earth Residuals immediately surrounding the type area. Thus where, as in the type, the soils are developed from sandstone the band of limonite nodules is strongly developed, but where the parent rock is a shale this striking feature is absent or but poorly developed. On the other hand, one character absent in the type, but present in many other sections, is the presence of a noticeable colour mottling ("Flecken zone") towards the bottom of the profile.

The more important of the variants from the type and the way in which these grade laterally into each other in the field is indicated in Plate III., Fig. 1. But, since a too liberal interpretation of possible variants renders less effective the value of the series as a basis of correlation, a more critical examination of the criteria is necessary.

Taken individually, it might at first appear that, of the more notable features of the Red Earth suite, colour would be the most persistent character, and, as such, the most useful single criterion on which to base correlation. Indeed, place names such as Redcliffe, Redland Bay, and Redbank Plains are based on this striking property, and it is fitting that it should be recognised in the name of the suite.

But, since the most pronounced effect of the pedogenic processes now in operation on the Red Earths is in leaching the iron oxides from the upper part of the profile, it is only to be expected that, where the

[1] All colour names used in this description are of air-dried samples, and are based on the Soil Classification Colour Charts of the Queensland Main Roads Commission.

local conditions are especially favourable for rapid podsolisation, much of the original red colour might by now have been washed out of the soil; hence it would seem inadvisable to use colour as a sole criterion.

Depth of soil, too, is only of limited use as a criterion, although the average Red Earth is far deeper than the average Podsol in the area, depths of 30 feet being common. But the Red Earth may be unusually shallow in some places, due to the removal by erosion of the overlying portion, while, on the other hand, Podsols may form locally and under optimum conditions relatively deep soils.

The presence of large masses of nodular pseudoconcretions, concentrated into a well-marked band, is perhaps the safest single criterion. There are two chief reasons for this. In the first place, assemblages of this type are never found in those soils which show evidence of having been formed by present-day activities (although true concretions may be found in limited quantities). Secondly, these nodules, protected as they are by skins of insoluble limonite, are virtually indestructible by soil-forming processes. It follows that, even if a Red Earth be bleached nearly white by podsolisation, even if the upper horizons be truncated and lost by erosion, these masses of limonitic nodules remain as evidence of the original nature of the soil. It is indeed fortunate for the purposes of correlation that this horizon was so commonly developed in the Red Earths.

(b) Variations in Topography.

Although the shape and appearance of the Residual plateaux are sometimes so striking that one would be tempted to claim them for the series on this evidence alone, a safer and more conservative attitude is to regard the physiographic evidence as inadequate without the complementary evidence of the soils.

On the other hand, it is demanding too much to insist on the presence of the perfect development of plateau topography as an essential accompaniment when the more important soil criteria are satisfied.

It is quite clear that a number of relatively steep-sided hills, of the more resistant rocks, rose above the level of the plateau remnants (in much the same way as they now rise above the general surface), and it is likely that the almost flat-topped residuals were connected with these steep-sided hills by slopes of an intermediate value. Within the old erosion surface, too, there were almost certainly valleys, and even if these were wide and shallow they would give rise to appreciable slopes. But although it is reasonable to expect to find occasional patches or pockets of the Red Earths on remnants of these slopes, and although it would be difficult to explain their presence there in terms of present processes, nevertheless a safe policy, in so far as the physiographic criterion is concerned, would seem to be the insistence on the presence of a relatively level and mature surface out of which the present valleys are being carved.

(c) Admissible Variants of the Red Earth Residuals.

Combining the pedologic and physiographic criteria discussed above, the following basis for the correlation of lateral equivalents with the Red Earth Residuals as typically developed may be stated:—

Where deep red soils and/or large accumulations of limonitic nodules occur associated with plateau remnants, or with mature surfaces at a higher elevation than the immediately surrounding area, they may be regarded as acceptable variants of the Red Earth Residuals and correlated with them.

IV. DISTRIBUTION OF THE RED EARTH RESIDUALS.

Red Earth Residuals as defined above may be readily recognised in a group of occurrences all of a similar nature, the centre of which lies about 10 miles south of Brisbane. The group comprises Rochdale, Eight-mile Plains, Sunnybank, Cooper's Plains, Brown's Plains, Acacia Ridge, and Park Ridge[1]. The combination of the plateau topography and Red Earths is well shown where the Brisbane-Southport, Brisbane-Beaudesert, and Sunnybank-Mount Gravatt roads cross the region. The plateau tops are remarkably level and are for the most part about 200 feet above sea-level, but at two spots they coincide roughly with the 300-foot contour. A particularly good vantage point for contrasting the old topography with the new is near the Sunnybank School.

Essentially similar, but less striking, occurrences are found as one proceeds north from Brisbane. First in the Albany Creek-Raff's Hill area, then near Strathpine, and again in the neighbourhood of Dakabin, the series is clearly represented, while still farther north in the Glass House Mountains region the Red Earth Residuals are seen again in their complete development.

West of Brisbane, and away from the coast, the series has few representatives, although typical occurrences may be seen at Redbank Plains, between Ipswich and Marburg, and where the Ipswich-Esk road crosses Wivenhoe Hill.

Along the coastline the series is strikingly developed at Redland Bay, Cleveland, Wellington Point, Manly, Sandgate, Redcliffe, and Scarborough. These occurrences are in large part on basalt, and all occupy quite flat or relatively level areas about 30 feet above Moreton Bay, to which they present steep cliffs, and into which they project elongate flat-topped peninsulas. The former extension of the Red Earth Residuals beyond the present shoreline suggested by these occurrences is confirmed by the finding of typical examples on St. Helena Island, Peel Island, and other islands of Moreton Bay. Associated with the more normal developments of the Red Earths in these coastal regions, and quite patently variants of them, are laterites very similar to those originally described by Buchanan from the Malabar Coast of India, and recently redescribed by Fox (1936). Of the local laterites, that at Scarborough has already been briefly described by Bryan (1929), while that at Sandgate is shown on Plate II.

It should be pointed out that, while the above list of occurrences aims at being sufficiently long and representative to establish the Red Earth Residuals as a series that does exist in fact, there has been no attempt to make the list all inclusive.

V. THE PROBLEM OF THE BASALTIC RED LOAMS.

One very important series, the inclusion of which within the Red Earth Residuals warrants careful consideration, is made up of deep red soils found on basaltic plateaux. Such are numerous in South-Eastern

[1] The "ridges" from which Acacia Ridge and Park Ridge get their names are, in fact, long narrow plateaux.

Queensland and may be exemplified by the occurrences at Tamborine to the south, Toowoomba to the west, and Maleny to the north of Brisbane respectively.

A decision on this point is of vital importance, for, if the red volcanic soils are admitted as legitimate variants of the Red Earths, then, at one stride, the geographical scope of the Red Earth Residuals is enormously extended.

These basaltic soils are almost identical with those members of the Red Earths developed on basalts. But they also resemble the other (non-basaltic) Red Earths in so many ways, but especially in colour, depth, texture, and fertility, that the latter are often wrongly, but in all good faith, advertised, sold, bought, and farmed as "Volcanic Soils," even when they are found covering shales and sandstones. The farmer and the horticulturist would certainly not hesitate to correlate the two series, which, indeed, they regard as identical. Chemical analyses also show that the silica/alumina ratios of the Red Loams as a group are in striking accord with those of the Red Earths, and suggest that both series were formed under the same climatic conditions.

The volcanic soils under discussion are classified by Prescott (1931) as Red Loams, and are described by him as follows:—

> "Throughout the length of eastern Australia a series of deep-red to chocolate loams, developing principally on basalt, are characteristic of the zone of high rainfall. They are associated with wet sclerophyll forests with its undergrowth of ferns, and with the true rain-forests. Amongst characteristic localities for these red loams are the Atherton Tableland, the Woongarra Scrub near Bundaberg, the Dorrigo Tableland, and the north-west coast of Tasmania. In spite of the high proportion of fine particles revealed in mechanical analysis, these soils are highly permeable and possess a loamy texture. They are usually very deep and uniform, the parent basalt in many cases being 50 to 80 feet from the surface . . . . These red loams do not possess any obvious profile, although in some cases a definite separation of concretionary oxides of iron and manganese is to be noted."

One gathers from this description that the relationship between the Red Loams, the vegetation they support, and the present climate is so harmonious that the soils may be regarded as in equilibrium with existing conditions, in which case it may seem gratuitous to suggest that they represent an inheritance from the past.

But that the Red Loams are found, too, under climatic conditions that seem eminently unsuitable for their formation is shown by Prescott and Hosking (1936) in an account of "Some Red Basaltic Soils from Eastern Australia," where it is stated that "There is a general relationship between rainfall and the [silica, alumina] ratio—the higher the rainfall the lower the ratio. The Clifton samples afford a notable exception. This characteristic red loam is out of keeping with the local climatic conditions, and the soil characteristics may have been imposed in a previous climatic cycle of greater rainfall." (Mr. W. R. Winks, B.Sc., who collected this soil for Professor Prescott, informs the writer that it was obtained from the top of a flat-topped ridge rising abruptly above the general level and entirely surrounded by black basaltic soils).

Even where the basaltic Red Loams appear to be in harmony with their present environment, and may, indeed, be forming at the present day, their extraordinarily great depth is surely an indication of considerable age—a conclusion with which Prescott is in complete agreement.

In keeping with this deduction is the fact that the most recent of the basaltic flows to be seen in Queensland (those occupying the present valleys) have shallow soils even under climatic conditions closely resembling those under which the deep Red Loams are found.

But perhaps the strongest argument for correlating the two soil series is the fact that the same red basaltic soil at Wellington Point that satisfies the most stringent application of the writer's criteria for inclusion in the Red Earth Residuals has been claimed (Prescott and Hosking (1936)) as a typical Red Loam.

The apparently contradictory items of evidence noted above may be reconciled, but in only one way—namely, by regarding the Red Loams as having been initiated contemporaneously with the Red Earths, and as having, in part, persisted in development up to the present day where the environmental conditions remained sufficiently favourable.

In the light of this discussion, it would appear wise to claim as the equivalents of the Red Earth Residuals only those members of the Volcanic Red Loams that satisfy a very strict application of both the pedologic and physiographic criteria. In particular, insistence on the combination of great depth of soil with plateau topography seems advisable.

But even the least liberal interpretations of the criteria will bring within the definition of the Red Earth Residuals many occurrences of the basaltic Red Loams.

VI. THE PLACE OF THE RED EARTH RESIDUALS IN LOCAL GEOLOGICAL HISTORY.

If the Red Earth Residuals are completely to fulfil their purpose as a datum, it will be necessary to assign them definitely and surely to their proper period. It may be that at some time in the future this will be done, but at present it is impossible to do more than place them approximately.

The next best thing is to determine the relative position of the series in the local sequence of events, and here the position is more satisfactory.

A convenient starting point for a study of the historical sequence is to be found in the deposition of the Redbank Plains Series on which the Red Earths are typically developed.

Of the age of this series Hills (1934) states: "The Redbank Plains Series may therefore be tentatively (in view of the paucity of comparative material) referred to the Oligocene . . . . "

Succeeding the deposition of this series was a great outpouring of basalts and the contemporaneous deposition of fresh water shales and limestones. Together these form the Silkstone Series, which is conformably related to the underlying Redbank Plains Series.

Following the formation of the Silkstone Series, but after an unknown interval, there was a movement of uplift accompanied by a relatively mild orogeny.

At a still later date and after prolonged erosion, the folded sediments and basalts were truncated to form a relatively level surface.

It was on this surface that the Red Earth Residuals were developed in the type area.

In other areas the sequence as set out above was modified by the outpouring, after the folding (but possibly before the subsequent erosion had proceeded very far), of a series of basalts and rhyolites several thousand feet in thickness. On these, after only a short erosion interval, those basaltic Red Loams were developed which have been correlated with the Red Earth Residuals.

Unfortunately, it is at present impossible definitely to state the age of the volcanics, but Richards (1915) placed them in his "Upper Division" of the volcanic rocks of South-Eastern Queensland, and regarded them tentatively as of "Upper Cainozoic" age.

The evidence from the type area, and the somewhat different kind of evidence from the basaltic plateaux, both suggest that the Red Earths were formed no earlier than a period late in the Cainozoic era—perhaps Pliocene.

COMPARISON OF SEQUENCE OF EVENTS IN THE BASALTIC PLATEAUX WITH THAT IN THE TYPE AREA.

	Basaltic Plateaux.		*Type Area.*
? Pliocene ..	Red Loams "Upper" Volcanics	=	Red Earths Erosion
? Miocene ..	Erosion Uplift and Orogeny		Erosion
? Oligocene ..	Silkstone Series Redbank Plains Series		

The event immediately succeeding the formation of the Red Earths appears to have been the deposition, within their wide shallow valleys, of gravels formed in part of pebbles and boulders of the more resistant parts of the Red Earths. Thus at Nudgee Waterhole (See Plate 2, Fig. 4) boulders of comparatively soft ferruginous and manganiferous laterites are indiscriminately mixed with well-rounded pebbles of quartzite (including "Billy") and other resistant rocks. The quartzites may have travelled great distances before deposition, but the less resistant lateritic boulders must have been derived locally, for they would not travel far in such company.

It is clear that some of the present valleys have been carved out of those containing these redistributed Red Earths, thus forming valley-in-valley structure. Indeed, the present stream system may well be largely coincident with this earlier one, but, since the redistributed Red Earths are such as would readily be removed by erosion, it is not surprising that remnants of them are rare.

The redistributed Red Earths clearly antedated the formation of the raised river terraces of the present stream systems, which terraces are occupied by soils for the most part well podsolized. These terraces in turn are earlier than the low-level flood plains with their immature alluvial soils that mark the present physiographic stage.

The sequence of events following the formation of the Red Earths may be represented as follows:—

Recent	Flood Plains
? Pleistocene	Raised Terraces (podsolized) Redistributed Red Earths
? Pliocene	Red Earths

The evidence outlined above suggests that the Red Earths were formed no later than late Pliocene times.

Collateral evidence is provided by a study of those parts of the shoreline where the Red Earth Residuals reach the coast, for it is clear that the Red Earth topography was in part "drowned" by the rise in sea-level that took place supposedly in Pleistocene times.

VII. SIMILAR OCCURRENCES ELSEWHERE.

(*a*) *Australian Occurrences.*

(i.) In seeking formations comparable with the Red Earth Residuals of South-Eastern Queensland, one looks first to the eastern margin of Australia. Not only does one expect to find physiographical homologues in this region, but, since there is a very notable similarity in the present soil-forming processes from Cape York to Tasmania, it may well be that, while the Red Earths were developing in Southern Queensland, similar soils were being formed in the coastal regions to the north and to the south.

In accordance with this expectation, several occurrences examined by the writer between Brisbane and Sydney seem to fit quite neatly into the series, both as regards physiography and soil type. The following excerpts from field notes made in August, 1932, are to the point:—"Red Earths very similar to those developed over the Tertiary shales about Brisbane were seen in the fruitgrowing district of Moorland, north-east of Taree, and again to the south of Port Macquarie." "At Port Macquarie a deep, red, lateritic soil very similar to that at Scarborough is developed on serpentine." "In places, as at 'Nutbank,' between Gosford and Sydney, the Hawkesbury sandstone develops a sandy soil over a B horizon crowded with ferruginous concretions, the whole profile resembling that over the (?) Bundamba Sandstone at Peel Island."

These hurried observations are in keeping with the more mature considerations of Browne (1928) in the Sydney-Blue Mountains region, as is shown by the following statement from his paper "On the Probable Tertiary Age of Certain New South Wales Sedentary Soils":—

> "On the flat tops of the residual surface of the plateaux, and on the very gentle slopes of the former mature valleys, there are to be found the soils, sometimes of quite notable depth, whose formation the writer considers took place before the Kosciusko [late Pliocene] uplift."

Among the instances described in support of these generalisations may be mentioned "the dissected plateau surface about the suburbs of Arncliffe and Earlwood, to the north-west of Botany Bay. The peneplain has been uplifted here to a height of 150 feet above sea-level and has been dissected . . . . " and "in numerous places on the level upland surface . . . . may be seen a variable thickness of rather sandy soil containing, or underlain by, abundant irregular nodules of brown ironstone, sometimes aggregated into a solid layer on top of the sandstone. In certain places the soil resting on the sandstone is very dark red in colour . . . ."

Again Browne writes:—

"The Wianamatta shale itself around Sydney occupies perhaps mainly the lower-lying areas, where uplift has been small and relief is still but slight . . . ." ". . . . the soil, particularly, it would appear, near the base of the formation, is of a dark-red colour and very ferruginous. A common characteristic of these dark shale soils is the presence of irregular nodules of ironstone . . . . These may be quite thickly embedded in the soil, or where the finer-grained soil has been washed away they may form a thin capping of the so-called 'ironstone gravel.' "

These quotations can only suggest what a perusal of the paper itself makes evident—namely, that ten years ago, as a result of the combination of pedologic and physiographic observations, Browne had reached for the Sydney-Blue Mountains region conclusions almost identical with some of those now recorded by the writer for South-Eastern Queensland.

It appears from these descriptions that on the plateau surfaces in and around Sydney there are developed several of the variants of the Queensland Red Earths as shown in Plate III., Fig. 1.

(ii.) Which of the very many examples of basaltic Red Loams that occur sporadically throughout the whole length of the eastern Australian coastal region are to be correlated with the Red Earths can be decided only after a careful examination of the evidence provided by each individual occurrence, but the writer anticipates that many of them will prove to be old soils inherited from Tertiary times.

(iii.) The correlation of the Red Earths with occurrences in the interior of Australia is likely to be less direct and not so readily achieved, for it involves the solution of several problems that do not obtrude themselves in the coastal areas. It is hoped that a contribution to the solution of these problems may be made by an investigation now nearing completion.[1] It would be unwise to anticipate in detail the results of this inquiry, but it may be said that the evidence is strongly in favour of the "Desert Sandstone," "Duricrust," and "Laterite" of Western Queensland having been formed, in part at least, concurrently with the Red Earth Residuals.

(*b*) *Extra-Australian.*

No deliberate search of the literature has been made for occurrences outside Australia comparable with the Red Earth Residuals. Nevertheless, that cases closely parallel to that outlined for South-Eastern Queensland do in fact exist is shown by the following examples which the writer has encountered:—

Thus Marbut (1927) suggested that certain of the Red Earths of Florida were "fossil soils" in the sense that they were formed in an earlier physiographic cycle under conditions somewhat dissimilar from those now existing.

Fowler (1928), in his account of "Iron Accumulation in Soils of the Coastal Plain of the South-Eastern United States" (where climate and topography are closely similar to that of South-Eastern Queensland), suggests "that they [the soils showing iron accumulation] are possibly remnants and the sole remaining representatives of old soils of a former cycle of topographic development."

Milne (1935), in discussing the soils of East Africa, describes concretionary ironstone ("murram"), and states that it "occurs frequently in parts of the red-earth areas." "Some of these occurrences," he continues, "belong properly to the set of soil-forming

[1] "The 'Lateritic' Residuals of Western Queensland," by W. H. Bryan and F. W. Whitehouse (in preparation).

phenomena now current, but to explain others, past physiographic conditions—those of mature land surfaces existing before the formation of the Rift Valley—will have to be taken into account.'' Again Milne (1936) mentions ''some of the occurrences of the Uganda catena, where the denuded remnants of an old ''plateau soil,'' with its resistant beds of concretionary ironstone, are found as a capping of the flat-topped hills, on whose slopes and the intervening bottom-lands the succession is continued in soils of current development.''

Thorp (1935), in his important paper on ''The Geographic Distribution of the Important Soils of China,'' states that the ''The slightly podsolized red soils are to be found mainly on discontinuous intersected intermountain peneplains . . . .''

Li (1936), in summarising his close study of ''The Physiographic Significance of the Occurrence of Red Earths in Nanning Basin,'' concludes that:—

> ''The occurrence of red earth has a remarkable physiographical significance: they occur exclusively on the terrace topography where drainage is perfect. Much of the red earth was undoubtedly developed before the present topography was shaped. It is supposed that by the time of late Pliocene when the basin was nearly filled up to a peneplain and when activities of erosion and deposition were reduced to their minimum, the red earth was in full development.''

VIII. CONCLUSIONS.

Evidence has been brought forward to show that there exists in South-Eastern Queensland a series of soils—namely, the Red Earths—that cannot be explained in terms of the existing soil-forming processes, but appear to have been inherited from an earlier wetter climate.

It has been shown, too, that the Red Earths have a restricted distribution and are associated with the dissected remnants of an old erosion surface.

The suggestion has been made that the Red Earth Residuals represent a definite epoch in the late Tertiary (probably Pliocene) history of South-Eastern Queensland and that they may conveniently be used as a datum to which earlier and later events may be referred.

Moreover, the combination of Red Earth soils with dissected plateau topography is so striking that it should be possible to use it as a basis of correlation.

Although no attempt has been made as yet at precise correlation, a number of occurrences have been cited from Australia and elsewhere that resemble more or less closely the Red Earth Residuals, and some of which may ultimately prove to be equivalent formations.

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EXPLANATION OF PLATES.

PLATE I.

FIG. 1.—Lateritic Red Earth, Sandgate.

FIG. 2.—Closer view of above profile, showing development of the Mottled Zone.

FIG. 3.—Red Earth, Eight-mile Plains.

FIG. 4.—Closer view of above profile, showing development of Nodular Zone.

PLATE II.

FIG. 1.—Podsolic soil of current development over shales of Ipswich Series, Nundah.

FIG. 2.—Immature Podsolic soil of current development over Brisbane Tuff.

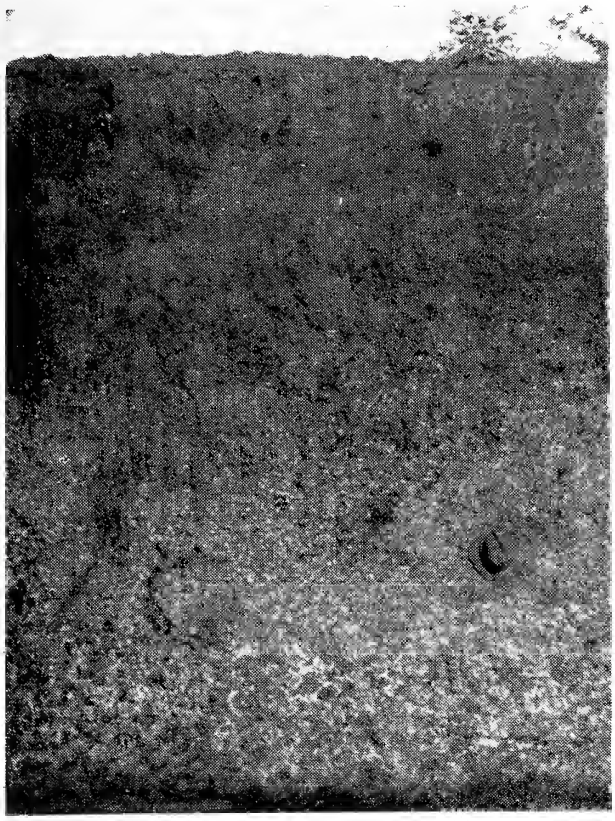
FIG. 3.—Lateritic Red Earth showing development of Cellular Zone, Scarborough.

FIG. 4.—Old River Gravel, the pebbles of which include masses of Lateritic Red Earth, Nudgee.

PLATE III.

FIG. 1.—Diagrammatic representation of some of the varieties found within the Red Earths. The variations are due in part to the presence of a Mottled Zone and/or a Nodular Zone; in part to incipient podsolisation; and in part to truncation of the profile.

FIG. 2.—Diagrammatic section to show the relationship of the geomorphology and pedology of the area. Red Earths are shown as occupying dissected plateaux, Redistributed Red Earths in old valleys, Podsolised Soils on steep slopes, erosion, hollows, and river terraces, and Alluvium on present flood plains



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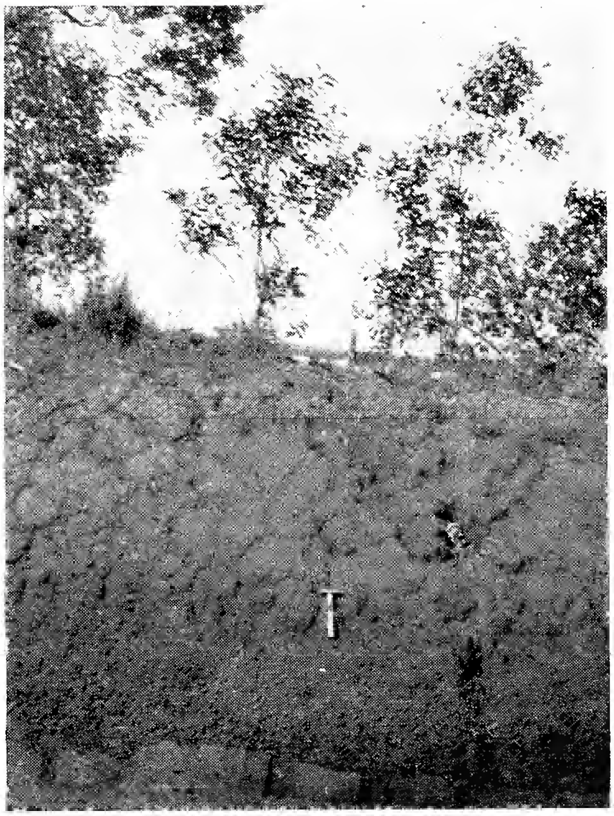

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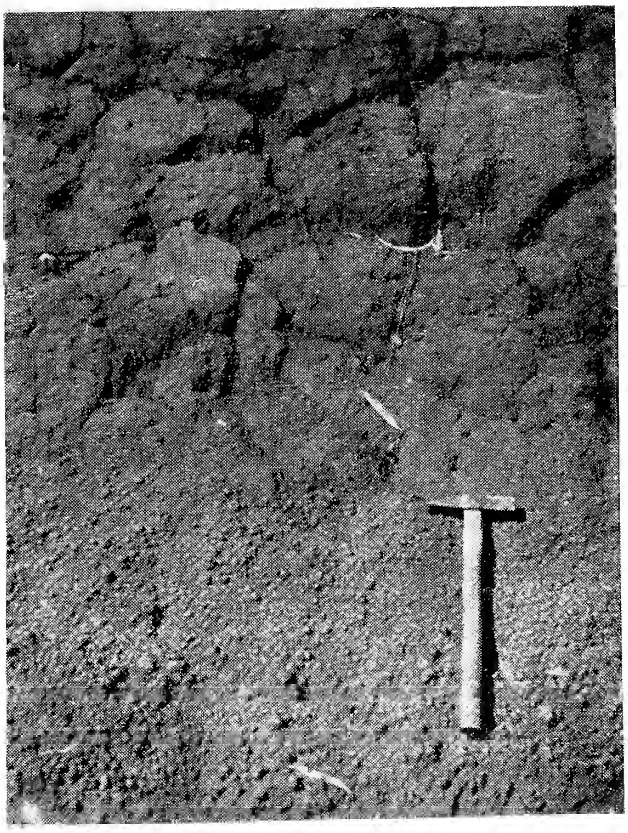

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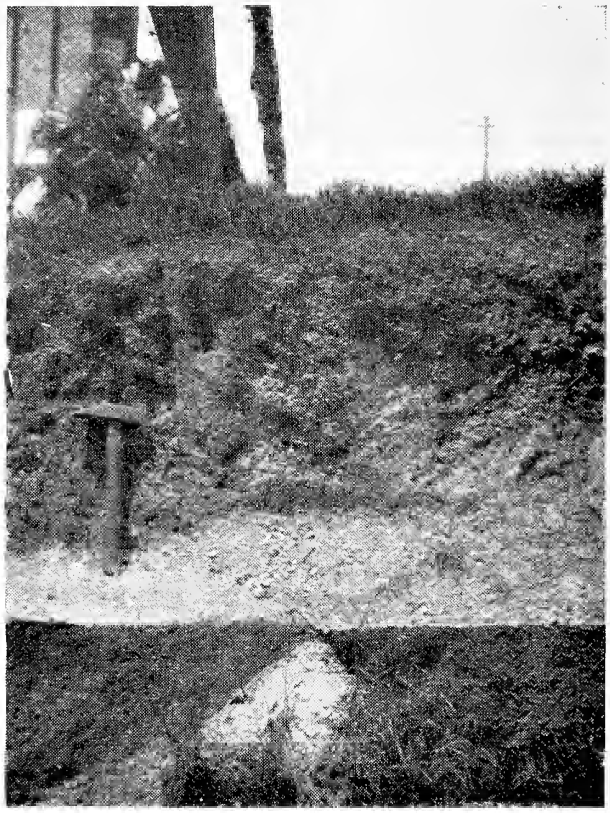

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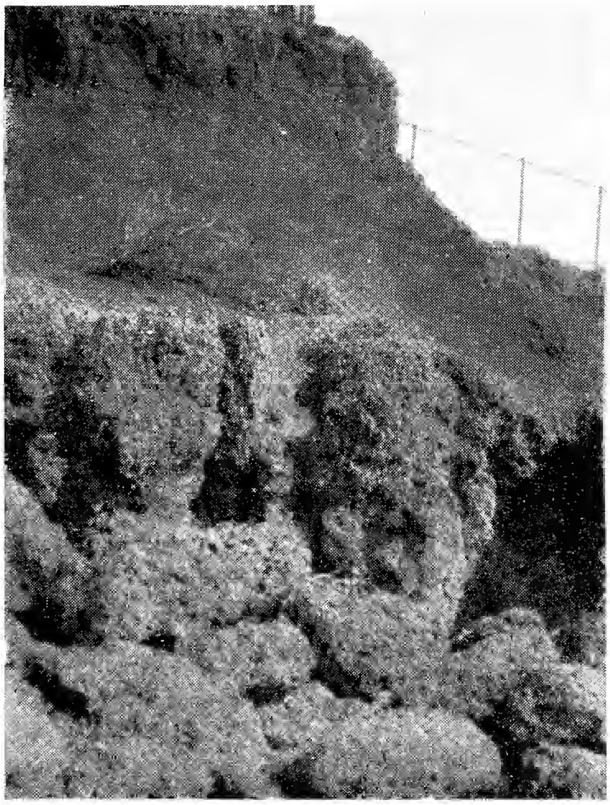

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Podsolised Surface.

Alluvial Soils.

FIGURE. 1.

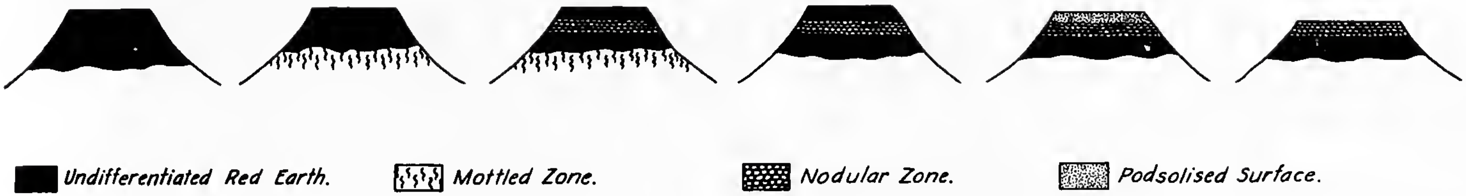
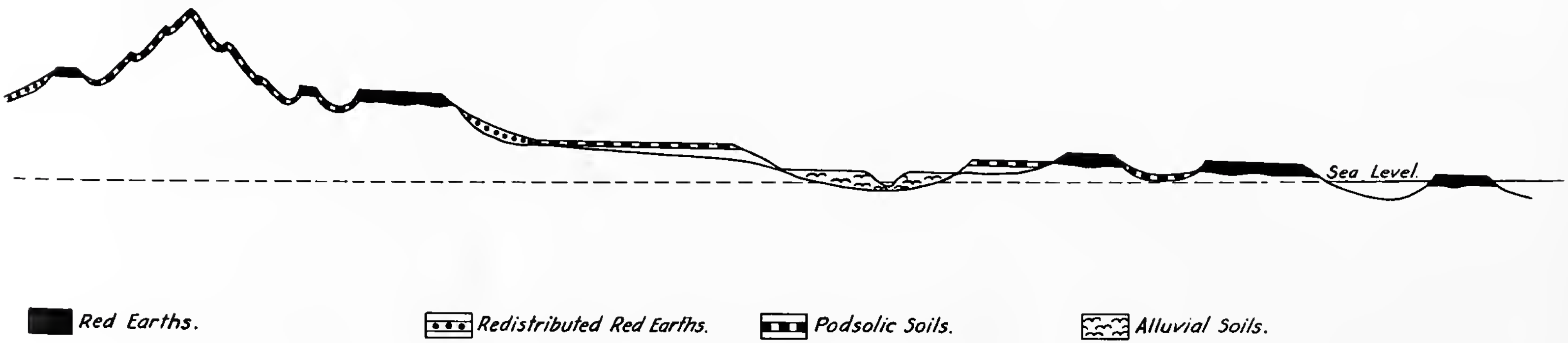


FIGURE. 2.



Notes on Australian Muscoidea IV.

The genus Microtropeza and some Phaoniinae.

By G. H. Hardy.

(*Read before the Royal Society of Queensland, 28th November,* 1938.)

Genus *Microtropeza* Macquart.

Microtropeza Macquart, Dipt. Exot. suppl. 1, 1846, 185.
Tasmaniomyia Townsend, Canad. Ent. XLVIII. 1916, 152.
Gerotachina Townsend, ibidem. 152.

The synonymy is new. The genus belongs to the second section of the Tachininae in which the forceps are fused along the median line. Its position within that section is undoubtedly with the *Echinomyia-Peleteria* group of genera which is the group 3, Eutachinae, in Lundbeck's Diptera Danica. Several characters of the genus tend to show this is the true relationship, as has been seen by several authors, but it was frequently confused with the Dexiinae (see Tillyard, Ins. Austra. N. Zeal. 1926, p. 376), and Malloch quite unnecessarily placed it in a tribe of its own.

In 1856, Walker placed a species in *Echinomyia* which is the earliest expression of the true relationship. Schiner is credited with the same view but I failed to find the reference. Engel in 1925 certainly indicated this position in his remarks—"*Microtropeza* Macq. zeigt im Bau der Genitalien eine sehr grosse Ähnlichkeit mit deren bei Echinomyia Duméril." I regard the genus as the most primitive of those placed by me in the second section of the Tachiniini.

In the several species, there is a tendency for the third antennal segment to grade from long to short; the character does not mark generic values as frequently happens, and the species vary widely in other ways, which seem to have led authors to misunderstand the genus. All the known species are highly ornamented or brightly coloured and therefore attractive, so it is not surprising to find the synonymy is involved. By determining which of the characters used by early authors are unique to the species, and aligning these with those used by recent authors, the identity of most forms is brought out with remarkable clearness. It is therefore expected that the synonymy given here is unlikely to need much amendment when the types are re-examined. There is one described species for which I can find no valid name and therefore I suggest a new name here, but leave unnamed those species hitherto not referred to in literature.

The life history of the species is unknown, but the relationships suggest that they may be parasitic on some large ground-frequenting Lepidopterous larva. The flies occur in swampy areas, where the adults are usually found on or near the ground, and are not uncommonly seen on flowering tea-tree (*Melaleuca* sp). Possibly the fly lays its eggs on reeds and grasses, to be swallowed later by the host, which habit is in conformity with related genera.

Key to species of *Microtropeza*.

1.	With a short transverse band on the second abdominal tergite, white in colour and complete across the median line. Face mostly white in ground colour, this contrasting with yellow around it. The third antennal segment is deep black	*nigricornis* Macq.
	With the transverse band on the second abdominal segment interrupted on the median line so as to form two white spots. Female with the anterior tarsi very broad and the thoracic markings are reduced	*sinuata* Don.
	With the white on the second tergite reduced to a single median spot or absent	2
2.	The markings of the thorax have mainly disappeared, leaving a scanty more or less uniform pulverulent white there. The blue-black abdomen has the white restricted to two apical tergites. Large species	*fallax* new name
	Smaller in average size than *fallax*, with thoracic markings highly developed, including a dense white median stripe interrupted at suture, the apical part rarely missing on inferior specimens. The abdominal markings variable in extent on a blue-black ground.	*intermedia* Mall.
	With the abdomen mainly brown, the restricted black median stripe is variable in extent. Medium to small species	*obtusa* Walker

All described forms fall into one or other of the species included in the above key with the exception of *viridiventris* Macq. that may be allied to a new species not included above. This new species has an entirely metallic abdomen with a slight trace of a pulverulent covering. The four white stripes of the thorax are complete. The antennae are less specialised in shape than that on any other species examined, but this structure varies widely and is of questionable value and on two species it takes an intermediate form.

Microtropeza sinuata Don.

M. sinuata Donovan, Epit, Nat. Hist. Ins. New Holland, Dipt. fig. (*Musca*).—Wiedemann, Auss. zweifl. Ins. ii. 1830, 384 (*Musca*). Guerin, Rev. Zool. vi. 1843, 270 (*Rutilia*). Macquart, Dipt. Exot. suppl. 1, 1846, 186; suppl. 4, 1849, 226. Schiner Novara Reise Dipt. 1868, 316. Brauer and Bergenstamm, Denk. Akad Wiss. Wien. lvi. 1889, 152; lx. 1893, 176 (possibly should be removed to stand under *fallax*). Townsend, Ann. Mag. Na. Hist. (10) ix. 1932, 40. nec Engel, nec Malloch.

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M. ignipennis Macquart MSS.—Brauer Sitz. Akad. Wiss. Wien. cviii. 1899, 510.

M. latimana Malloch, Proc. Lin. Soc. N. S. Wales, liv. 1929, 286; lv. 1930, 100.

The synonymy is new. I have not seen Donovan's illustration, but Wiedemann has given a detailed colour description of it, mentioning "hinterleib rothlichbraun, am zweiten Abschnitte zwei weissliche punkte . . . . . ," a very decisive character. These two white spots on the second abdominal segment, occur also in the description of *T. bura* Walk. whilst *M. skusei* Bergroth is said to have the white fascia interrupted on this segment, this amounting to the same character. There can be little doubt that *ignipennis* B. & B. and *latimana* Malloch are the same species because the flattened broad anterior metatarsus of the female is also a decisive character, unique to the species. This form of the metatarsus was used by Brauer to distinguish *ignipennis* from that form regarded by him as being the typical *sinuata* and he did not realise the character is limited to the sex. The species referred to as *sinuata* by Brauer and Bergenstamm, may be the same as a species so called by Engel and by Malloch, and re-named below as *fallax*. On *sinuata*, the abdomen is strongly marked with brown; the white marking on the second abdominal tergite is broad and no median marginal bristles occur there. The thoracic markings are only moderately developed, and without the white median line.

Hab.—The species is known to me only from southern Queensland and New South Wales, but doubtless it is widely distributed over southern areas of the mainland. It occurs also inland, at least as far as Chinchilla.

Microtropeza nigricornis Macq.

M. nigricornis Macquart, Dipt. Exot. suppl. 4, 1849, 226.

Macquart described this species as having a white face and a black third antennal segment, so there can be little doubt that he had before him a Tasmanian species; in this case his locality seems to be correct.* In addition there is a complete white fascia on the second abdominal segment and the anterior tarsi of the female are normal. In other respects the fly is very like *sinuata*.

Hab.—Tasmania. It is one of two species known to me only from this locality.

Microtropeza fallax, new name.

M. sinuata Engel, Zool. Jahrb. 1925, 344-6.—Malloch, Proc. Lin. Soc. N. S. Wales, liii. 1928, 614; liv. 1929, 287; lv. 1930, 100. nec Donovan.

The species that is placed under this name is not uncommonly met with in collections.

Malloch's description of *sinuata* conforms here but he may have confused another species with it. Perhaps Engel was following *sinuata* as identified by Brauer who gave no description so this too is somewhat uncertain.

This is the largest species of the genus known to me and together with *intermedia* has a blue-black abdomen with a restricted white design; it differs from the latter species by the lack of marginal bristles on the second abdominal tergite, and in having the thoracic markings reduced to a general powdery white, the white spots being absent.

Hab.—Only known to me from Queensland where it seems to be a widely distributed species, but it is also recorded from New South Wales. As far as can be judged it is limited to the coastal area of these two States. I have taken this species only once, Brisbane, January, 1928, a female which is the holotype. A female allotype from Mt. Cotton, Brisbane, captured in February, 1928, by Mr. J. Mann, is also in my collection. Others are in the Queensland Museum.

Microtropeza intermedia Malloch.

M. intermedia Malloch, Proc. Lin. Soc. N. S. Wales, lv. 1930, 100.

Malloch compares the present species with his *latimana* (i.e. *sinuata* Don.) using minor characters for distinguishing it, but its alliance is

* Hardy (Proc. Lin. Soc. N.S.W. liv. 1929, 61-4) questions validity of type locality "Tasmania," in Macquart's Fourth Supplement, for nearly all species so recorded.

with *fallax*. It differs by the presence of an intermediate pair of marginal bristles on the second abdominal tergite, by the highly developed thoracic markings, including a very conspicuous median white stripe, interrupted at the suture, and by its smaller average size.

Hab.—This species is known to me from Queensland, and found breeding around the swamps at Sunnybank; 5 males and 6 females, September, 1937, and another male without a label.

Microtropeza obtusa Walker.

Tachina obtusa Walker, Ins. Saund. Dipt. 1856, 274.—Townsend, Canad. Ent. xlviii. 1916, 152 (*Gerotachina*)—Townsend, Ann. Mag. Nat. Hist. (10) ix. 1932, 40 (*Gerotachina*).

Echinomyia stolida Walker, Trans. Ent. Soc. Lond. (2) iv. 1857, 196.—Austen, Ann. Mag. Nat. Hist. (7) xix. 1907, 330 (*Microtropeza*).

Microtropeza ochriventris Malloch, Proc. Lin. Soc. N. S. Wales, liv. 1929, 287; lv. 1930, 100.

M. flavitarsis Malloch, ibidem, liv. 1929, 288; lv. 1930, 100.

M. flaviventris Malloch, ibidem, lv. 1930, 101.

Synonymy.—The two names given by Walker are conspecific according to Austen, and Malloch seems to have described the sexes under two other names. The third description given by Malloch under the name *flaviventris*, makes it necessary for the types of Walker to be examined again, for if one of these has a pair of apical bristles on the second tergite, then it would conform to Malloch's third form. On my Tasmanian specimens there are weak bristles in the position on two specimens and none on the third, hence it becomes difficult to see how the character can have specific value. This variable form bears five names in literature and should there be more than one incorporated in the material described, then better characters will have to be discovered to elucidate them.

The species is subject to a variation in markings particularly on the abdomen where the black median stripe may be almost if not quite absent. The size also varies greatly, a common feature in parasitic flies. All species, therefore, that have an abdomen with a ground colour of brown need to be placed here and if one is distinct, some valid structural character must be selected to establish it as a species.

Hab.—Tasmania and the mountain areas of New South Wales form at present the known distribution of this species. The record for Western Australia needs confirmation.

Microtropeza viridiventris Macq.

Masicera viridiventris Macquart, Dipt. Exot. suppl. 2, 1847, 68; suppl. 4, 1849, 190.—Brauer Sitz. Akad. Wiss. Wien 1897, 336.—Townsend, Canad. Ent. xlviii. 1916, 152 (*Tasmaniomyia*).

There is an abnormal form of *Microtropeza* that is related apparently to Macquart's species, the type of which Brauer placed in his *Amphibolia* group, but differing from *Microtropeza* and he referred to its metallic colouration. Townsend gave this a new generic name without seeing the type, nor did he place specimens under his genus which will fall to synonymy if the interpretation given by me be correct. Macquart quotes the locality as Tasmania but my specimen is from the Blue Mountains, New South Wales, January 1922 (C. Deuquet).

Subfamily Phaoniinae.

Key to genera and species incorporated below.

1. Female with a pair of bristles directed towards and normally crossing each other, situated on the interfrontalia between the two rows of bristles	2
Female without such bristles on the frons	Other genera
2. First median vein with a strong bend over its apical section, and directed towards the lower radial vein. Femora largely brown over the apical half, and the antennae are red or reddish over the basal half (Introduced)	*Muscina stabulans* Fall.
The first median vein and the lower radial vein curving apically but very slightly towards each other. Antennae always black and the legs usually so	3
3. Anterior femora on male with a ventral notch containing a spine	*Hydrotaea australis* Mall.
Anterior femora on male without such spine ..	*Ophyra* 4
4. Species with the face silvery, and a silver spot on the frons, just at the base of the antennae. Highly polished black species	6
Species with head entirely black, no silvery markings. Abdomen blue, but the apical segment normally has a greyish pulverulent overlay	5
5. Frons of the male about the width of the ocellar tubercle, that of the female as wide as the distance between the anterior ocellus and the base of the antennae	*O. analis* Macq.
Frons of the male narrower, about two-thirds of the width of the ocellar tubercle, and that of the female correspondingly reduced	*O. rostrata* Desv.
6. Eyes on the posterior border with a concave section	*O. fuscocalyptrata* Macq.
Eyes on the posterior border without a concave section	*O. ? chalcogaster* Wied.

Under the name *nigra*, two species of *Ophyra* are standing in literature as one, and it is evidently due to this that Malloch has introduced into the Australian literature the name *chalcogaster* Wied., originally described from Java. This still leaves the relation with *Anthomyia nigra* Wied., 1830, from China, said to be widely distributed throughout the Orient, and reaching Australia, in a somewhat doubtful position. It is to be noted that *O. nigra* is supposed to have a white or yellowish squama whereas the form in Australia has this darkened at least on the majority of males. I give below a nomenclature that is perhaps less contentious and it is to be noted that in economic literature the names are frequently omitted due, apparently, to the general dissatisfaction felt with the naming of forms.

Genus *Hydrotaea* Desvoidy.

Hydrotaea Desvoidy, Easai Myodaires 1830, 509.

There are two specific names standing under this genus, but one is quite evidently misplaced, leaving a single recorded species acceptable in this position.

Hydrotaea australis Malloch.

H. australis Malloch, Ann. Mag. Nat. Hist. (9) xi. 1923, 667.—Malloch, Proc. Lin. Soc. N. S. Wales, 1. 1925, 40.

Hab.—Queensland and New South Wales.

Two specimens before me were reared from cow-dung (J. M. Bancroft 1920) a well known breeding habit for the genus, but apparently the species is not often met with under this condition in Australia.

Genus *Ophyra* Desvoidy.

Ophyra Desvoidy, Essai Myodaires 1830, 516.

Peronia Desvoidy, ibidem, 517.—Malloch, proc. Lin. Soc. N. S. Wales, li. 1926, 554.

Australophyra Malloch, ibidem, l. 1925, 40.—Malloch, Ann. Mag. Nat. Hist. (9) xi. 1923, 667.

Synonymy.—Hitherto this synonymy has been published only in part and I would point out that *Australophyra* was based upon *rostrata* Desvoidy, not on *analis* Macquart, as claimed, thus making the name an absolute synonym of *Peronia*. Both these names must fall to *Ophyra* as they were separated on minor characters. Malloch separated *Peronia* by the presence of some hairs on the hypopleura, adjacent to the spiracle, a character that is frequently absent in *analis*. Desvoidy separated it on the more prominent clypeus with which goes also the more prominent carina as this is part of the same general structure. This clypeus and its associated carina varies with the species and is valueless for generic distinction.

Ophyra rostrata Desvoidy.

Peronia rostrata Desvoidy, Essai Myodaires 1830, 517.

Hydrotea cyaneiventris Macquart, Dipt. Exot. suppl. 5, 1855, 118.—preoccupied Macquart 1849.

Ophyra analis of Authors in part (early authors record it under this name.)

Ophyra nigra of some early authors.

The synonymy is new.

Hab.—Queensland, New South Wales, Victoria and South Australia. There is also a female labelled "*Ophyra analis* N(ew) Z(ealand)" brought back from those islands by Professor T. Harvey Johnston, and is quite typical of *rostrata*, not *analis*, but possibly both species occur in those islands.

Ophyra analis Macquart.

O. analis Macquart, Dipt. Exot. suppl. 1, 1846, 202. nec other authors.

This specific determination is new and depends upon the fact that the present species is quite unknown to me outside the island from which it was originally described.

Hab.—Tasmania.

Ophyra fuscocalyptrata Macq.

Hydrotaea fuscocalyptrata Macquart, Dipt. Exot. suppl. 5, 1855, 119.

Ophyra nigra of authors, at least in part.

Wiedemann's *Anthomyia nigra* from China, in accordance with description does not agree with the present form. Macquart's description does agree except in so far as he quotes the presence of the spine typical of *Hydrotaca* and in which character he was probably mislead, and also he based his description on a specimen the legs of which had become brown, a not uncommon occurrence.

Hab.—Queensland and New South Wales, but probably widely distributed.

Ophyra chalcogaster Wied.

Malloch, Ann. Mag. Nat. Hist. (9) xi. 1923, 666.—which see for such characters as are quoted there but which may not all apply. The original description gives the abdomen as tinged with blue, which does not apply in the present case.

The species so-called by Malloch can be distinguished from *O. fuscocalyptrata* by the different posterior margin of the eye, and by the frons of the female being much narrower.

Hab.—Queensland, but the distribution is probably wide. It occurs throughout the year in Brisbane, and, so far, is the only one I have taken there in winter.

Muscina stabulans Fall.

Hab.—Queensland to South Australia, but probably more widely distributed. Introduced.

Specimens before me have been reared from rotted potatoes (J. M. Bancroft) and from carrion (O. W. Tiegs). The fly can be considered one of the so-called ''quaternary flies'' together with *Musca domestica* Lin., already recorded as such. The food in these two cases cannot consist wholly of animal matter, as their maggots thrive in dung, and the latter breeds in the daggs on sheep even in the early stages of myasis, and so it would appear that the house fly becomes associated with carrion, but not or hardly partaking of this food. Conversely cases of certain blowflies said to be breeding in decayed vegetation were subsequently found in this food contaminated with animal matter.

A New Derivative of Terpinen-4-ol.

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Department of Chemistry, University of Queensland.

(*Read before the Royal Society of Queensland*, *28th November*, 1938.)

Terpinen-4-ol is reported (Penfold, 1926) to form a crystalline nitrosochloride, m.p. 115-116°. In an attempt to prepare this compound by an alternative method, using the gases generated from sodium nitrite and hydrochloric acid, a crystalline product, very sparingly soluble in most solvents, was obtained; this was, however, not the nitrosochloride of Penfold. Preliminary investigation has led to the view that it may be regarded tentatively as a chloronitrosite, of formula $C_{10}H_{18}N_2O_3Cl$; should this prove to be so, it would be a compound of a type hitherto unreported. The substance is very easily prepared, although the yield is somewhat low, and it would appear to be eminently suitable for the characterisation of terpinen-4-ol.

There is also evidence that a similar compound may be prepared from α-terpineol; this is also being investigated.

EXPERIMENTAL.

A solution of terpinen-4-ol (10 ccs.) in an equal volume of dry ether was used; the gases generated by adding a saturated solution of sodium nitrite drop by drop to concentrated hydrochloric acid were passed through the solution, which was cooled in a freezing mixture. The terpinenol solution rapidly became green and later deposited a copious precipitate of the compound in question. It was isolated by filtration, and purified by repeated washing with ether, in which it is very sparingly soluble; after drying in the air, it melted at 105-106°. A suitable solvent for recrystallisation has not yet been found. The yield averages about 20 per cent. of the original material; this, as well as the time of formation of the compound, appears to be somewhat variable, and to depend in some way not yet understood on the experimental conditions. The compound is not formed if the hydrochloric acid is dropped into the sodium nitrite solution.

Estimation of nitrogen and chlorine gave the results:—

N = 11·1, 11·4 %; Cl = 14·0 %. (Theoretical for $C_{10}H_{18}N_2O_3Cl$, N = 11·2 %, Cl = 14·2 %).

The compound undergoes slow decomposition on keeping, with development of a brown colour, and lowering of the melting point.

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Essential Oils from the Queensland Flora—Part XV.

Backhousia Bancroftii and Daphnandra rapandula.

By F. N. Lahey, M.Sc., and T. G. H. Jones, D.Sc. A.A.C.I., Department of Chemistry, University of Queensland.

(*Read before the Royal Society of Queensland, 28th November,* 1938.)

As part of an extensive programme of research on Queensland plant products, made possible by a grant from the Commonwealth Council for Scientific and Industrial Research, the oils of *Backhousia Bancroftii* and *Daphnandra rapandula* were obtained for examination. The yield of oil in each case however, was too small to permit of a thorough investigation.

Both oils were found to contain sesquiterpenes as the principal constituents with pinene and esters as minor constituents.

Backhousia Bancroftii.

220 lb. of leaves yielded 35 cc. of oil with the following constants:—

$d_{15\cdot5}$	·926
n_D^{20}	1·4948
$[\alpha]_D$	+ 8
Ester value	29·4
Ester value after acetylation	66
Acid value	0

On distillation under reduced pressure (2 mm.) the following principal fractions were obtained.

(1). From liquid ammonia trap	$d_{15\cdot5}$	·8655
	$[\alpha]_D$	+37
	n_D^{20}	1·4634
(2). 50–65°C. (2cc.)	$d_{15\cdot5}$	·9034
	$[\alpha]_D$	0
(3). 65–72°C. (12cc.)	$d_{15\cdot5}$	·9154
	$[\alpha]_D$	+ 2·6
	n_D^{20}	1·4894
(4). 77–87°C. (2½cc.)	$d_{15\cdot5}$	·9441
	n_D^{20}	1·4968

Fraction (1) was shown to contain d-α-pinene by oxidation with permanganate to pinonic acid, identified by its semicarbazone m.p. 207°C.

Fraction (2) was principally an ester which on hydrolysis yielded a sweet-smelling alcohol which was not identified. The acid present was identified as acetic by silver salt estimation which yielded 64.4 per cent. Ag.

The physical constants of fractions (3) and (4) indicated the presence of a sesquiterpene and a sesquiterpene alcohol which was confirmed by the characteristic colour reaction with bromine and glacial acetic acid.

Daphnandra rapandula.

120 lb. of very dry leaves gave 140 cc. of oil with:

$d_{15\cdot5}$	..	·9260
$[\alpha]_D$	..	+26·4
n_D^{20}	..	1·4903
Ester value	..	4·6
Ester value after acetylation ..	..	53·6
Acid value	..	0

Fractionation of 100 cc. under reduced pressure (2 mm.) gave:—
(1) A fraction (10 cc.) collected in the liquid ammonia trap having

$d_{15\cdot5}$	..	·8454
$[\alpha]_D$	..	+37·4
n_D^{20}	..	1·464

Oxidation with permanganate gave a product whose semicarbazone melted at 207° C. and at the same temperature when mixed with pinonic acid semicarbazone. Hence the presence of d-α-pinene. The low density material of this fraction was not identified.

(2). A fraction (1cc.) ..	b.p.	..	42–46°C.
	$d_{15\cdot5}$	..	·8779

On hydrolysis with alcoholic KOH acetic acid was shown to be present by qualitative reactions. The alcohol liberated from the ester was not identified.

(3). A fraction	b.p.	..	73–79°C.
	$d_{15\cdot5}$	..	·9254
	$[\alpha]_D$	..	+ 5·7
	n_D^{20}	..	1·497

This was a sesquiterpene with constants closely resembling those of aromadendrene but on ozonolysis no aromadendrone was isolated.

(4). A fraction	b.p.	..	88–92°C.
	$d_{15\cdot5}$	..	·920
	$[\alpha]_D$	..	+35·8
	n_D^{20}	..	1·4970

A drop dissolved in glacial acetic acid yielded a violet colour on the addition of bromine vapour.

On dehydrogenation with sulphur under 40 mm. pressure, a small quantity of an azulene was formed (m.p. of picrate 120°C.)

(5). A viscous oil	b.p.	..	100–112°C.
	$d_{15\cdot5}$	..	·9559
	$[\alpha]_D$	..	+ 8·66

This was a sesquiterpene alcohol, for on treatment with formic acid a sesquiterpene $d_{15\cdot5}$ ·9145 was isolated which gave a deep blue colour with bromine in acetic acid.

Our thanks are due to the Queensland Forestry Department for the collection of the leaves and to the Council for Scientific and Industrial Research for a grant.

Essential Oils from the Queensland Flora—Part XVI.—Eucalyptus microcorys.

By T. G. H. Jones, D.Sc., A.A.C.I., and F. N. Lahey, M.Sc.

(*Read before the Royal Society of Queensland, 28th November, 1938.*)

Since the extensive investigations of Baker and Smith[1] on the essential oils of the Australian Eucalypts, very little work has been done on these important oils. Meanwhile great advance has been made in terpene chemistry and chemical technique and it was thought that oils from some of the more abundant species of Eucalypts could, with advantage, be subjected to a more thorough investigation.

The essential oil of *Eucalyptus microcorys* was chosen as it grows abundantly in southern Queensland, where it is cut for its timber known as Tallow wood.

The essential oil was a light-yellow mobile oil, smelling strongly of cineol.

Baker and Smith[2] recorded the presence of pinene, cineol, volatile aldehydes and sesquiterpenes. We have confirmed these observations and also have shown the presence of isoamyl isovalerate, borneol, bornyl acetate, and butyrate, and have proved the volatile aldehyde present to be isovaleric aldehyde. Also a small quantity of a carbonyl compound was isolated but not identified.

Experimental.

Two samples of leaves of *Eucalyptus microcorys*, one from Enoggera, Brisbane, and the other from Yandina, yielded ·71 and ·73 per cent. of oil respectively.

The physical constants of the two oils were very similar and also agreed very closely with those given by Baker and Smith (loc. cit.).

	Sample A.	Sample B.	Constants by Baker and Smith.
$d_{15\cdot5}^{15\cdot5}$	·9069	·8953	·895
$[\alpha]_D$	+17·9	+18·6	+18·3
n_D^{20}	1·4690	1·4671	1·4690
Ester value ..	23·8	22·5	19·6
Acetyl value ..	60·4	62·7	..
Cineol content ..	46 %	43·9 %	49 %

Sample B was extracted in turn with sodium carbonate and sodium hydroxide solutions. These extracts yielded very small amounts of an acid and a phenol which were not further examined.

The residual oil after drying was submitted to fractional distillation at two millimetres pressure when the following fractions were obtained:—

	$d_{15\cdot5}^{15\cdot5}$	n_D^{20}	$[\alpha]_D$
(1). Collected in liquid ammonia trap	·8772	1·4595	+32
(2). 30–40°C. ..	·894	1·4600	+16
(3). 40–44°C. ..	·8908	1·4400	− 2·5
(4). 44–56°C. ..	·9548	1·4720	−28
(5). 56–60°C. ..	·9739	1·4810	−17
(6). 60–80°C. ..	·9484	1·4926	+24

Fraction (1) was shaken with saturated sodium bisulphite solution. A solid compound separated which, on decomposing with caustic soda solution, gave a volatile aldehyde identified as isovaleric aldehyde by the preparation of its 2 : 4 dinitro-phenyl-hydrazone, m.p. and mixed m.p. 123°C.

The residual oil of this fraction mixed with fraction (2) was extracted three times with resorcin solution. The cineol recovered from the resorcin compound had

$d_{15\cdot5}^{15\cdot5}$	..	..	..	·9316
$[\alpha]_D$	..	..	..	·45
n_D^{20}	..	..	..	1·4554

It readily formed an o-cresol compound m.p. 55°C.

The oil freed from cineol had the following constants: —

$d_{15\cdot5}^{15\cdot5}$	..	..	..	·8638
$[\alpha]_D$	..	..	..	45·8
n_D^{20}	..	..	..	1·4648

This was d-α-pinene for on oxidation with permanganate a good yield of pinonic acid was obtained, identified by its semicarbazone m.p. 204°C.

Fraction (3) contained an ester and consequently was hydrolysed with alcoholic KOH. From the aqueous alkaline solution on acidification and steam distillation was obtained an acid which formed a silver salt giving 51·68 per cent. silver on ignition. Silver isovalerate contains 51.65 per cent. silver.

The alcohol from the ester was extracted by means of phthalic anhydride. It distilled at 130-140°C. and formed a naphthyl urethane m.p. 67°C. identical with the naphthyl urethane of isoamyl alcohol.

From a consideration of the constants of fractions (4) and (5) it was thought that these would contain the mixture of carbonyl compounds, cuminal, phellandral and cryptal, originally known as aromadendral. Consequently fractions (4) and (5) were combined and submitted to extraction by the method of Macbeth[3].

The extraction with normal sodium sulphite yielded one cc. of a carbonyl compound which, after purifying by a second extraction, had

b.p.	..	..		60°C. *at* 1mm.
$d_{15\cdot5}^{15\cdot5}$	..	..	..	·978
$[\alpha]_D$	..	..	..	—45
n_D^{20}	..	..	..	1·488

It yielded a 2 : 4 dinitro-phenyl-hydrazone m.p. 176°C. and so appeared to be different from any constituent of aromadendral. This carbonyl compound was not identified as very little was available for experiments. Extraction with sodium bisulphite failed to remove anything.

The oil remaining after these extractions had a strong camphoraceous odour. It failed to yield a positive test with 2 : 4 dinitro-phenyl-hydrazine. By careful fractionation, a fraction was obtained with:

b.p.	..	..	57–62°C. *at* 2 mm.
$d_{15\cdot5}^{15\cdot5}$	..	..	·9629
$[\alpha]_D$	..	..	—22
Ester value		..	=41

This fraction was heated with phthalic anhydride in dry benzene for 8 hours. The alcohol recovered from the acid-phthalate in the usual way partially solidified. The solid was filtered and dried on a porous plate. After recrystallising from petroleum ether it melted at 199°C. Lack of material prevented further purification but by mixed melting point determinations it was shown to be borneol.

The recovered oil was hydrolysed with alcoholic KOH. From the aqueous solution on acidification and steam distillation, a solution of acids was obtained. The silver salts of these acids were formed and analysed.

First crystals gave 55·39 per cent. Ag.

Silver butyrate requires 55.36 per cent. Ag.

Second crystals gave 59·28 per cent. Ag.

It appears as though both butyric and acetic acids are present as esters.

The oil containing the alcoholic portion of the ester was extracted with phthalic anhydride resulting in the isolation of borneol, and a mobile alcohol which was not identified.

The remainder of the oil consisted of sesquiterpenes which gave the usual colour reaction with bromine vapour and glacial acetic acid. These were not further examined.

The authors' thanks are due to the Queensland Forestry Department for the collection of leaves.

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The Gastro-Intestinal Helminths of Cattle in Queensland: Their Distribution and Pathogenic Importance.

By F. H. S. ROBERTS, D.Sc., Animal Health Station, Yeerongpilly.

(*Read before the Royal Society of Queensland, 28th November, 1938.*)

INTRODUCTION.

While the total number of species of helminths infecting the alimentary tract of cattle throughout the world is relatively large, there is comparatively little information on the pathogenic importance of the various species recorded.

McFadyean (1896), Daubney (1933), and Taylor (1934; 1937) have reported *Trichostrongylus axei* Cobbold as causing gastritis of cattle in England. Baker (1933) also records it as causing a chronic bloody diarrhoea in a nine-months-old calf in the United States.

Stiles (1901) considers the loss of 10,000 head in Texas, United States, in the wet years 1899-1900, to be due to heavy infections of *Haemonchus contortus* Rudolphi, associated with *Ostertagia ostertagi* Stiles, *Bunostomum phlebotomum* Railliet, and verminous bronchitis (*Dictyocaulus viviparus* Bloch). Powers (1909) refers to *H. contortus* as a serious obstacle to cattle raising in Southern California and describes a severe outbreak in 1904. The twisted stomach worm is also a serious parasite of cattle in Rhodesia (Bevan, 1929; Le Roux, 1932); in Kenya (Daubney, 1929); in British East Africa (Montgomery, 1916); in Natal (Le Roux, 1930); in Nyasaland (Turnbull, 1932) and in the West Indies (Van Volkenberg, 1934).

Ostertagia ostertagi is first mentioned as pathogenic by Gilruth (1899) when discussing the annually recurring mortalities among calves in the South Island of New Zealand, worm infestation being associated with malnutrition and exposure. Anaemia and diarrhoea were prominent symptoms. He also considers *O. ostertagi* responsible for an anaemia prevalent among grown cattle on the west coast of the North Island. Gastritis associated with this species has been also observed in England (Sheather, 1923) and in the United States (Barger, 1927; Dikmans, 1923; Baker, 1937.)

Bunostomum phlebotomum has been noted (Dawson, 1903, 1906) in association with "salt sick" disease of cattle in Florida, United States. This condition is manifested by a low fever, intermittent diarrhoea and constipation, progressive emaciation and anaemia. Mortalities are high. Conradi and Barnett (1908) record it as being serious also in California; Le Roux (1932) in Rhodesia; Van Volkenberg (1934) in the West Indies and Reisinger (1916) and Sigetwary (1931) in Central Europe.

Of the several species of Cooperia recorded from cattle, only *C. oncophora,* Railliet, is implicated as pathogenic. This species was present in large numbers in yearling cattle in Montana, United States, among which mortalities had occurred. *Nematodirus helvetianus* May, and coccidiosis, however, were also conspicuous (Tunnicliffe, 1932).

The nodule worm, *Oesophagostomum radiatum* Rudolphi, is said by Dikmans (1923) to be serious in Louisiana, United States. Le Roux (1932) considers the species harmful in Rhodesia, especially when associated with large numbers of other helminths. Losses have also been reported from the Philippine Islands (Farinas, 1930; Boynton and Wharton, 1916) where *H. contortus* and *B. phlebotomum* were also present in large numbers.

Other records of pathogenicity among the nematodes concern *Ascaris vitulorum* Goeze, (Turnbull, 1932) and an unidentified species from the abomasum of calves in India, which may be *Mecistocirrus digitatus* (Sheather, 1919).

Of the numerous trematodes recorded from the alimentary tract of cattle, only those of the Paramphistomidae appear to be harmful. *Cotylophoron cotylophorum* Fischoeder is very pathogenic to sheep in South Africa, and is also harmful to cattle (Le Roux, 1930, 1932), while Van Volkenberg (1934) mentions it as being serious in the West Indies. Pandi (1935) has recorded *Paramphistomum* sp. as pathogenic in Assam, India. Heavy infections cause a pronounced anaemia and emaciation, accompanied by a profuse and foetid diarrhoea.

PARASITIC GASTRO-ENTERITIS IN QUEENSLAND.

Parasitic gastro-enteritis is by no means uncommon among cattle in Australia. Gilruth and Sweet (1910) and Seddon* consider that *O. ostertagi* is of importance in the southern States, while Edgar (1938) has drawn attention to heavy infections of *Paramphistomum cervi* in calves in New South Wales. In Queensland, on the other hand, reports on the occurrence of the disease refer only to *H. contortus* (Dodd, 1908; Legg, 1923 and 1930).

Clinical cases in Queensland occur chiefly in the coastal and sub-coastal areas. The disease may, however, be present occasionally in the more western districts and an outbreak has been reported at Blackall, approximately 400 miles inland.

As has been reported in other countries, (Powers, 1909; Bevan, 1929; Daubney, 1929; Van Volkenberg, 1934), young cattle are chiefly affected, more especially from 4 months to 12 months of age. Rainfall, rate of stocking and nutrition appear to influence outbreaks.

The annual rainfalls of the areas in which the disease is most prevalent range from 25 to nearly 160 inches (see map). The type of country also varies considerably. The richer areas, namely, the south-east corner and the Atherton Tableland,† are most heavily stocked and are most affected. In the central and much of the northern coastal districts the country is poorer and the stocking correspondingly lighter. Here, outbreaks are less frequent.

The disease usually occurs during the dry season, i.e., in the winter and spring months. As little supplementary feeding is practised, cattle frequently lose condition and become susceptible to infection. In addition, the concentration of animals on permanent waterholes during the dry season creates conditions conducive to heavy and rapidly acquired infections. This factor applies chiefly to beef cattle country.

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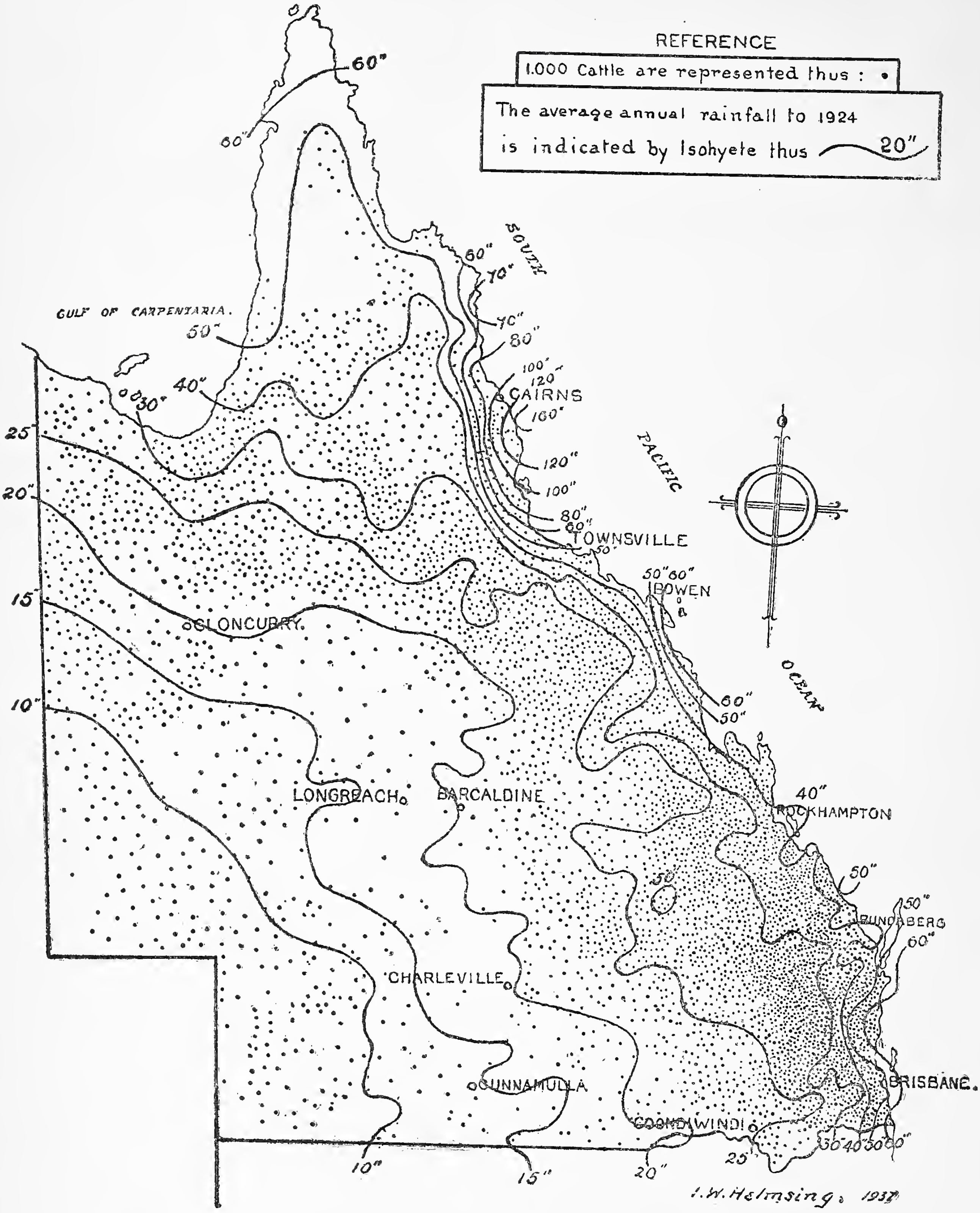
* Private communication.

† An area of high country in North Queensland, immediately south-west of Cairns.

During the past three years a number of affected animals have been examined. Counts of each species of helminth were made when possible, in order to ascertain their relative importance and pathogenicity.



The Distribution of Cattle in Queensland.

The infections always comprised a number of species, but, as a rule, one or sometimes two species so predominated as to leave little doubt as to the pathogenic agents. The lungworm, *Dictyocaulus viviparus*, was occasionally a contributing factor in outbreaks, a verminous pneumonia being then associated with heavy infections of worms in the alimentary tract.

HELMINTHS OBSERVED IN AFFECTED ANIMALS.

Genus PARAMPHISTOMUM Fischoeder, 1901.

P. cervi Schrank, and/or *P. explanatum* Creplin, are associated with a disease of cattle reported only from south-eastern Queensland and known locally as "black scours." This condition is manifested by a progressive emaciation and anaemia, accompanied by a dark, foetid and profuse diarrhoea. In the only two cases examined, large numbers of immature worms were recovered from the faeces.

The adult flukes in the rumen and reticulum must be only slightly pathogenic, if at all, as it is very common to see animals in excellent condition harbouring many hundreds of them.

Genus COTYLOPHORON Stiles and Goldberger, 1910.

C. cotylophorum Fischoeder has been seen on several occasions, but is regarded as uncommon and of little economic importance.

Genus MONIEZIA Blanchard, 1891.

As a rule, a few tapeworms appear of little consequence, but recently 17 well grown *M. benedeni* Moniez, were taken from a six-months-old calf which was stunted, "pot bellied," and suffering intermittently with diarrhoea. Very few other worms were present.

M. expansa Rud., which has also been seen in cattle, is of rare occurrence.

Genus HELICTOMETRA Baer, 1927.

Helictometra giardi Moniez is apparently rare in cattle, as it has been seen once only. It is, however, not uncommon in sheep.

Genus HAEMONCHUS Cobb, 1898.

The twisted stomach worm, *H. contortus* Rud., is undoubtedly the most widespread and most pathogenic helminth of calves and young cattle in Queensland. Estimations showed the numbers harboured by affected animals to be from 5,200 to 12,000. In several cases which yielded 5,200 to 6,000 *H. contortus*, 30,000 to 60,000 *Cooperia* spp. have also been present. One six-months-old animal harboured 5,200 *H. contortus* and 76,000 *T. axei*.

H. contortus has also been implicated in serious losses among three-year-old steers and in the death of an aged cow.

Genus OSTERTAGIA Ransom, 1907.

Three species of this genus have been seen, namely, *O. ostertagi* Stiles, *O. circumcincta* Stadelman, and *O. occidentalis* Ransom, but the only species to occur in any numbers is *O. ostertagi*. Calves suffering from gastro-enteritis, due principally to *H. contortus* or *O. radiatum*, have contained as many as 22,500 and 31,500 worms belonging to the genus *Ostertagia*. As Robertson (1933) considers that 8,000 or more *O. circumcincta* are pathogenic in lambs, it is possible that at times *O. ostertagi* may be of importance among young cattle in Queensland.

Genus TRICHOSTRONGYLUS Looss, 1905.

T. axei Cobbold, *T. colubriformis* Giles, *T. vitrinus* Looss, and *T. longispicularis* Gordon, have been observed but only *T. axei* appears to be of any importance.

Usually, the numbers of this species taken from affected animals have not exceeded 15,000, but in one instance a six-months-old animal harboured 76,000 in addition to 5,200 *H. contortus* and a small number of other species. Taylor (1934) records 140,000 *T. axei* as causing gastritis in a two-year-old heifer. It is possible, therefore, that the 76,000 specimens present in our case were pathogenic and contributed to the general ill effects observed.

Genus COOPERIA Ransom, 1907.

Only *C. pectinata* Ransom and *C. punctata* v. Linstow, appear important, both species usually occurring together. *Cooperia spp.* have frequently been observed as a contributing factor to gastro-enteritis in animals also harbouring large numbers of *H. contortus* or *O. radiatum.* In such cases 30,000 to 60,000 *Cooperia spp.* have been present. In two outbreaks, these small Trichostrongyles appeared to be the principal causal agents. Three young animals from such outbreaks harboured 72,200 *C. punctata* and 23,300 *C. pectinata,* 92,400 *C. pectinata* and 18,600 *C. punctata,* and 28,000 *C. pectinata,* and 110,000 *C. punctata,* respectively. In all three cases the number of other species present was small. The most prominent symptoms of a heavy infection of *Cooperia spp.* are emaciation and diarrhoea. Anaemia is apparently not conspicuous.

Macroscopic lesions are practically confined to the small intestine which shows scattered and extensive areas of inflammation, with deposits of a tough brownish exudate. Such changes may be visible with infections of 30,000 to 40,000 worms.

Four other species of this genus have been collected, namely *C. oncophora* Railliet, *C. mcmasteri* Gordon, *C. curticei* Railliet, and *C. spatulata* Baylis, all of which occur in only small numbers.

Genus NEMATODIRUS Ransom, 1907.

Both *N. filicollis* Rud., and *N. spathiger* Railliet, occur only in small numbers.

Genus BUNOSTOMUM Railliet, 1902.

In only one instance was *B. phlebotomum* Railliet definitely responsible for serious effects, a 15-months-old animal dying as a result of an infection of 2,250 worms. Although this species is a prevalent parasite of young cattle, it apparently becomes serious only under conditions of heavy stocking. The hookworm is very troublesome among young cattle employed for tick fever work at the Animal Health Station, Townsville, where the rate of stocking at times becomes very high. Attempts to control the infections by keeping the animals in bare yards and feeding from racks has met with little success and the heavy infections under these conditions suggest that the infective larvae can enter the body via the skin. Cameron (1927) with *B. trigonocephalum* and Schwartz (1924) with *B. phlebotomum,* however, failed to produce infection except by ingestion but, more recently Orrlepp (1937) working with *B. trigonocephalum,* has established infection in sheep simply by placing larvae on the skin behind the ears.

The disease occasioned by hookworm runs a well marked course with progressive anaemia, weakness, emaciation and diarrhoea which in the initial stages may be only intermittent. The anaemia is severe and the red cell count may be reduced by as much as 75 per cent. The worms cause small haemorrhagic punctures in the intestine, the wall of which in heavy infections is covered by a thick layer of slimy mucous.

Reports from Townsville indicate that animals over 18 months of age are little affected.

Genus STRONGYLOIDES Grassi, 1879.

S. papillosus Wedl., which is a common helminth in sheep and cattle usually posseses a low degree of pathogenicity. Recently, however, an infection of at least 54,000 worms in a three-months-old calf, which was weak, emaciated and affected with an intermittent diarrhoea was encountered. The duodenum and jejunum showed patchy inflammation and here the majority of the parasites occurred.

Genus OESOPHAGOSTOMUM Molin, 1861.

O. radiatum Rud. appeared to be primarily responsible for two outbreaks as animals from these herds yielded 4,260 and 6,510 worms respectively. The disease was characterised by an extreme anaemia, emaciation and weakness, accompanied by an acute diarrhoea.

As a result of infection the walls of the colon become thickened, the mucosa shows patchy inflammation, and is thrown into folds. The worms may be seen with their anterior ends buried into the swollen mucosa, causing a conspicuous pitting. The mucosa is covered with a thick layer of, blood-stained mucous and clots of blood may be present in the lumen, to appear later in the faeces. Thickening and pitting may be present with populations of 300 or more worms.

Genus TRICHURIS Roederer, 1761.

T. ovis Abildg. is not uncommon, but is of no importance.

EGG COUNTS IN RELATION TO AN INFECTION.

The egg output of an helminth infection as determined by the number of eggs present in a unit weight of faeces is frequently a useful though not always accurate indication of the degree of infection. Very few determinations have been recorded from cattle though Taylor (1934; 1937) considers egg counts of 400 (in grown cattle) and 500 to 1,000 (in yearlings) per gram weight of faeces symptomatic of parasitic gastritis caused by *T. axei*.

Egg counts were therefore made when possible from animals manifesting marked symptoms of helminthiasis, the animals being later autopsied and the numbers of worms present determined. In all cases a mixed infection was present, but one or another species usually predominated. From the data secured, it was determined:—

(1) In calves 6 to 12 months old, heavily infected with *H. contortus* and/or *O. radiatum*, the egg counts may vary from 3,400 to 7,800 eggs per gram of faeces. The smaller count was made from the mushy faeces of a six-months-old animal. The count of 7,800 came from diarrohoeal faeces of a 12-months-old animal.

(2) A serious infection with *Cooperia spp.* in calves 5 to 6 months old may give an egg count of only 800-1,200 eggs per gram, in mushy to diarrhoeal faeces.

(3) In a 15-months-old animal infected with 2,250 *B. phlebotomum* and suffering from diarrhoea, the egg count was only 400 to 800 eggs per gram.

(4) Two six-months-old animals, which manifested marked symptoms of parasitic disease, gave an egg count of only 200 to 400 eggs per gram of faeces. On post mortem, one animal yielded 6,500 *H. contortus*, 4,220 *T.axei*, 2,600 *C. spp* and 29 *O. radiatum*. Only a few *H. contortus* were, however, mature. The second animal was penned on concrete and at the end of three weeks the count had risen to 4,500 eggs per gram of faeces. This denotes that a massive infection may seriously affect the health of an animal before the worms are mature.

DISTRIBUTION.

The distribution in Queensland of many of the species recorded here has already been dealt with in so far as they occur in sheep (Roberts, 1936). *H. contortus* was noted as widespread, occurring in sheep as far west as Longreach and Cloncurry. It has since been found in cattle in the Cunnamulla area and in the far north-west. This stomach worm, therefore, is probably present throughout the State, except perhaps towards the extreme western and south-western borders.

Of the species of Ostertagia recorded, *O. ostertagi* reaches its greatest development in the south-east. Its numbers show a gradual decrease northwards and in the vicinity of Townsville only very small numbers are found. On the Atherton Tableland, however, the species appears to be slightly more prevalent than elsewhere in the north. In the south, it extends west at least as far as Goondiwindi. *O. occidentalis* has been seen in cattle only from the south-east. There is nothing to add to the distribution of *O. circumcincta* already given for sheep. (Roberts, 1936.)

Trichostrongylus axei has a distribution very similar to *O. ostertagi.* It reaches its greatest development in the south-east and becomes scarce in the north. It occurs in moderate numbers in cattle in the central west, at least as far out as Blackall. *T. longispicularis* was seen only in the south-eastern sheep districts.

The distribution of *T. colubriformis* and *T. vitrinus* was discussed in an earlier paper (Roberts, 1936).

Six species of Cooperia were recorded. Of these, *C. pectinata* and *C. punctata* are most widespread. The presence of these species in calves from the Cunnamulla district and in sheep from the Longreach and Cloncurry districts (Roberts, 1936) indicates very hardy preparasitic stages. *C. pectinata* appears slightly more capable of existing in the drier districts, whilst in the wet tropical areas it is more usual for *C. punctata* to form the bulk of the infections. Both species reach their highest development on the coast and are just as prevalent in the north as they are in the south. *C. oncophora, C. curticei* and *C. mcmasteri* have been seen in cattle only from the south-eastern sheep areas. Neither *C. oncophora* nor *C. curticei* are very prevalent in Queensland and appear to be confined to the south-east. As these three species have been seen only in small numbers, conditions in Queensland may not be very favourable to them. *Cooperia spatulata*, though taken only in small numbers, occurred along the coast from Brisbane to Cairns and in the south as far west as Clifton.

Nematodirus spp. have a distribution similar to that of *C. oncophora*, but are more prevalent towards the south-west where they occur frequently in sheep in the Charleville district (Roberts, 1936).

The hookworm, *B. phlebotomum*, is practically confined to the coastal and subcoastal districts and in the south has been seen as far west as Chinchilla. *S. papillosus* has a similar distribution, but extends further west.

O. radiatum is widespread, but its western limits are not so far inland as those of *H. contortus*. Calves from the Cunnamulla area are apparently free from this parasite. It occurs, however, in the central Gulf areas, but has not been seen in considerable numbers, except in coastal regions.

The distribution of *T. ovis* has already been considered (Roberts, 1936).

P. cervi and *P. explanatum* are confined to the coastal and subcoastal areas. Little is known of the distribution of *C. cotylophorum*, the few specimens seen coming from the coastal districts south of Rockhampton.

M. benedeni has been taken only from coastal cattle. There is also a single record of its presence in a sheep from Central Queensland. *M. expansa* is widespread in sheep, reaching its greatest development in the higher rainfall sheep country. It has been seen only twice in cattle, both animals coming from the south-eastern sheep districts.

SUMMARY.

1. Parasitic gastro-enteritis of cattle is not uncommon in Queensland. It is most prevalent among young cattle. Outbreaks are most numerous during the winter and spring and in the coastal and subcoastal districts.
2. *H. contortus, C. pectinata* and *C. punctata* and *O. radiatum* are the helminths chiefly concerned. Pathogenic infections of *P. cervi* and *P. explanatum, M. benedeni, B. phlebotomum*, and *S. papillosus* have also been seen.
3. While *T. axei* and *O. ostertagi* are not usually sufficiently numerous to be important, infections of such proportions as to be possibly pathogenic have been observed.
4. The symptoms and lesions in affected animals are discussed. The numbers of helminths present in affected animals are given.
5. Some information as to the significance of the number of eggs passed per gram of faeces as an aid to a diagnosis of parasitic gastro-enteritis is given.
6. The distribution of the various species throughout Queensland is discussed.

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The Middle Devonian Rugose Corals of Queensland, I. Douglas Creek and Drummond Creek, Clermont District.

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(*Read before the Royal Society of Queensland, 28th November, 1938.*)

Plates IV. and V.

Summary.—In this paper the Rugosa from the Clermont district, Queensland, are redescribed, and their age is deduced to be Middle Devonian, probably the upper part of the Lower Middle Devonian, i.e., Upper Couvinian. The paper includes a review of the Family Spongophyllidae, and supplementary remarks on the family Acanthophyllidae, and a new genus *Xystriphyllum* is founded.

Corals from the Clermont district were first recorded by Rands (1886, p. 4) from a bed of dark-coloured crystalline limestone outcropping close to Douglas Creek, about 3 miles below its junction with Drummond Creek, and about 4 miles south-east of Copperfield. Rands tentatively referred the limestone to the Devonian. Jack (1895, p. 10) mentioned an outcrop of limestone on Drummond Creek, about 3 miles south of Copperfield, containing *Heliolites* and other Devonian corals. Dunstan (1900, p. 3) and Morton (1931, MS map, Rockhampton Office, Geological Survey of Queensland) have since collected from the limestones, whose relation to the metalliferous mica and hornblende schists of the district is unproved. Dunstan gave their strike as N.N.E., S.S.W., and that of the schists as north-easterly, and (1901, pl. 1) regarded them as unconformable on the schists.

A study of Rands and Dunstan's texts and maps and the Lands Department map of the Parish of Copperfield, County of Clermont, in conjunction with Morton's MS map (by courtesy of Mr. J. H. Reid, District Geologist, Rockhampton), indicates that there are four limestone outcrops near Douglas Creek, as follows:—Portion 73, Parish Copperfield (Rands and Morton); Portion 85, Parish Copperfield (Rands and Dunstan), both on the left bank of the Douglas; Selection No. 75 (Dunstan, present portion number could not be traced by the Lands Department), on the right bank of the Douglas; and Portion 9, Parish Theresa (Morton). In addition there is Jack's locality on Drummond Creek, which appears not to have been visited subsequently.

Etheridge (1911) described the Rugosa collected by Rands and Dunstan, but did not determine the age of the limestones. Rands, Dunstan's, and Morton's material from Douglas Creek are used in the present work, with also one specimen from Drummond Creek, possibly collected by Jack. The three species, *Acanthophyllum clermontensis* (Etheridge), *Spongophyllum cyathophylloides* Etheridge, and *Xystriphyllum dunstani* (Etheridge), are common to the first three localities cited above from Douglas Creek, and *Spongophyllum cyathophylloides* occurs on Drummond Creek, so that these limestones might reasonably be considered to be of the same age. One indeterminable Rugose coral was collected from Portion 9, Parish Theresa, by Morton. The specimens are in the Collection of the Geological Survey of Queensland and in the Australian Museum.

Age of the Limestones.—*Spongophyllum* is known from the Upper Silurian and the Middle Devonian; *S. cyathophylloides* possesses no feature which could serve to ally it with Middle Devonian rather than Upper Silurian species, or *vice versa*. *Xystriphyllum* has so far been recognised only from the Lower and Middle Devonian, and *X. dunstani* is closest to the New South Wales Lower(?) Middle Devonian *X. mitchelli* (Etheridge). *Acanthophyllum* extends from Lower to Upper Devonian, but from Wedekind's figures of the Rugosa of the Eifel we see that *A. clermontensis* has a morphology characteristic of the Upper Couvinian. On this somewhat limited evidence it is deduced that the Douglas Creek and Drummond Creek limestones are Middle Devonian, and that they probably represent the upper part of the Lower Middle Devonian, i.e., the upper part of the Couvinian.

Family ACANTHOPHYLLIDAE.

Acanthophyllidæ Hill, 1939.

Range.—Devonian.

Remarks.—The arrangement of the axial ends of their septa suggests that these further forms from the Eifel district in Germany belong to the Acanthophyllidae:—*Keriophyllum* Wedekind (1924, p. 69, Couvinian, including *Cyathophyllum cylindricum* Schulz); *Leptoinophyllum* Wedekind (1925, p. 4, genotype *Leptoinophyllum multiseptatum* Amanshauser MS, Wedekind *id.* figs. 1, 2, Lower Givetian); and a group consisting of the following:—*Trematophyllum* Wedekind (1924, p. 75, Couvinian), *Dohmophyllum* Wedekind (1924, p. 76, Couvinian, including *Cyathophyllum helianthoides* Goldfuss, Quenstedt), *Stenophyllum intermedium* and *Stenophyllum implicatum* Wedekind (1925, figs. 5-7, both Lower Givetian), and *Sparganophyllum* Wedekind (1925, p. 13, genotype *Sparganophyllum difficile* Borchers MS, Wedekind *id.* fig. 9, Lower Givetian).

The possibility that the new genus *Xystriphyllum* is a cerioid Acanthophyllid is discussed on p. 62.

Genus Acanthophyllum Dybowski.

Acanthophyllum Dybowski, 1873, p. 339; 1874, p. 493.

Acanthophyllum Hill, 1939.

Ptenophyllum Wedekind, 1924, p. 36, Couvinian, Eifel.

Astrophyllum Wedekind, 1924, p. 46, Couvinian, Eifel.

Stenophyllum Amanshauser in Wedekind, 1925, p. 9, genotype *Stenophyllum diluvianum* Amanshauser in Wedekind *id.*, figs 3, 4, Lower Givetian, Eifel.

Genolectotype (chosen Schlüter, 1889, p. 38): *Cyathophyllum heterophyllum* Edwards and Haime.

Diagnosis.—Large, simple, or weakly compound Rugosa with a wide dissepimentarium of small, highly arched dissepiments, with shallowly concave, axially deepened tabulae, and with long but unequal major septa. The axial ends of the major septa are arranged in groups in the tabularium, and are straight, or curved vertically, the curvature differing in degree from group to group; the cardinal septum is typically short, and one septum, not a proto-septum, extends to the axis. The septa show different types of modification; they are frequently much dilated, either in the dissepimentarium, or more rarely in the tabularium, or in both; towards the periphery they may be thin and lined with lateral dissepiments; in the tabularium they are sometimes waved and carinate.

Range.—Fairly common in the Lower Devonian of Europe, and very common in the Middle Devonian of Europe. Lower and Middle Devonian of Australia.

Remarks.—The following is added to previous remarks (Hill, 1939). I consider that Wedekind's (1924) genera *Ptenophyllum* and *Astrophyllum* from the Couvinian of the Eifel are better regarded as each forming single variable species of *Acanthophyllum;* also that the following are *Acanthophyllum:*—*Cyathophyllum* sp. Wedekind (1921, pl. 1, fig. 1, Couvinian, Eifel); *Mesophylloides richteri* Wedekind (1921, pl. 1, fig. 2, Couvinian, Eifel), *Stenophyllum diluvianum* Amanshauser (Wedekind, 1925, pl. 1, figs. 3, 4, Lower Givetian, Eifel, genotype of *Stenophyllum* Amanshauser, Wedekind, 1925, p. 9), and *Neostringophyllum* spp. Wedekind (1925, pl. 11, Upper Givetian, Eifel).

Acanthophyllum clermontensis (Etheridge).

(Plate IV., figs. 1, 2.)

Cyathophyllum ? clermontensis Etheridge, 1911, p. 5, pl. B, figs. 1, 2, pl. D., fig. 3, Douglas Creek, 7 miles S.S.W. of Clermont. [Lower] Middle Devonian.

Lectotype (here chosen): 2C, Geological Survey of Queensland Collection, being specimen figured Etheridge *loc. cit.* pl. D., fig. 3; portion is F 9487 in the Australian Museum.

Diagnosis.—Sub-compound *Acanthophyllum.*

Description.—The lectotype consists of a number of unequal corallites in a limestone block, suggesting by their manner of aggregation that they are parts of a compound corallum, though none can be seen to arise from another. A topotype collected by Morton, however, shows an offset arising by lateral increase, its diameter being enlarged fairly rapidly. Etheridge (1911, p. 5) noted corallites in contact and subpolygonal, but I have not seen such a specimen. The calice is the "Krempenkelch" of Wedekind; that is, the dissepimentarium has an almost flat surface, descending steeply into the concave surface of the tabularium. The diameter varies between 25 and 60 mm. (*fide* Etheridge). The septa are numerous and very long; the major septa extend unequally towards the axis, their axial ends usually being slightly curved, waved and carinate, and arranged in the manner described as diagnostic for the genus. The minor septa are three-quarters or four-fifths as long as the major septa. Dilatation is usually apparent in the septa, less in the minor than in the major; an irregular zone may occur near the inner third of the dissepimentarium; the septa may sometimes be dilated like spindles, so that they are thickest in the middle parts, thinning towards both axis and periphery. The tabulae are fine, close, incomplete, and the floor of the tabularium is slightly concave with a median depression. The tabularium may have as little as one-quarter the diameter of the corallum. The dissepiments are rather elongate; in a narrow zone near the inner edge of the tabularium they are inclined vertically, but outside this zone the inclination decreases suddenly at first and then rather gradually, the dissepiments near the periphery being almost horizontal. Many dissepiments are geniculate in transverse section, while lateral dissepiments lining the sides of the septa are common.

Remarks.—Three individuals, illustrated on Plate IV., Figs 3-5, are placed, with some doubt, in this species. That figured 3a, b, has septa more openly spaced and a somewhat narrower tabularium than is typical, but it has the irregular zone of septal dilatation near the inner third of the dissepimentarium. The specimen figured 4 shows a different arrangement of the axial ends of the septa from that characteristic of *Acanthophyllum,* in that they are not all rotated in the same direction; that figured 5 may possibly be a young stage of *A. clermontensis;* the photograph falsely suggests that the ends of the septa in the tabularium are dilated (as in Wedekind's Lower Devonian *Ptenophyllum*).

I know of no other species of *Acanthophyllum* which has advanced from a solitary to a sub-compound habit. Wedekind's analysis (1924, 1925) of the *Cyathophyllum heterophyllum* group suggests that the "Krempenkelch" as possessed by *A. clermontensis* is characteristic of the lower part (Couvinian) of the Middle Devonian. The aspect of the Acanthophyllids from Clermont approaches very closely that of the Upper Couvinian forms from the Eifel, called by Wedekind (1924) *Astrophyllum* and *Rhopalophyllum.* According to Wedekind's observations, the Lower Couvinian Acanthophyllids (*Ptenophyllum* s.s. Wedekind) show, particularly in the young stages, great dilatation of the axial septal ends; the fact that such dilatation does not occur in the Clermont forms suggests that they are later than Lower Couvinian. Our species differs from the Givetian Acanthophyllids described by Wedekind in that the latter have a "Trichterkelch" rather than a "Krempenkelch" and have less dilated septa. In the absence of any evidence to the contrary, I consider that we may accept for the Clermont fauna the Upper Couvinian age suggested by *Acanthophyllum clermontensis.*

Family SPONGOPHYLLIDAE.

Type Genus. *Spongophyllum* Edwards and Haime.

Rugose corals in which the long major septa extend unequally towards the axis or the median plane; the minor septa are usually degenerate, and both orders may be discontinuous near the periphery where lonsdaleoid dissepiments may be developed; the tabularium is frequently bisymmetric, and the tabulae are close, parallel, and usually complete, concave without a median notch.

Range.—Upper Silurian of the Baltic States, Bohemia, and New South Wales, Lower Devonian of Styria and France, and Middle Devonian of Europe and Australia.

Remarks.—The boundaries of this family are not clearly defined. In *Spongophyllum* itself I include only those cerioid forms in which the tabularium is narrow and the tabulae close and but slightly concave, the minor septa degenerate, and in which lonsdaleoid dissepiments may be developed in an irregular peripheral zone when the major septa are discontinuous; that is, five Upper Silurian and six Middle Devonian species.

Three phaceloid species from the Middle Devonian of Germany have usually been regarded as *Spongophyllum.* These are *Spongophyllum torosum* Schlüter (1881, p. 211, pl. vi., figs. 1-5, Givetian) *S. elongatum*

Schlüter (1881, p. 213, pl. vii., figs. 1-5, Givetian) and *S. semiseptatum* Schlüter (1881, p. 215, pl. v., figs. 1-3). They have a wider tabularium than the cerioid genotype, and a peripheral border of very large lonsdaleoid dissepiments, and the septa are more noticeably arranged about a median plane. They should probably be regarded as a separate genus.

Four other groups have morphologies which make it reasonable to regard them as members of the Spongophyllidae. The first is of elongate, solitary or weakly fasciculate corals, like *S. sedgwicki* except that the minor septa may be well developed and lonsdaleoid dissepiments seldom appear. These were figured by Wedekind (1925) from the Givetian of Germany as *Grypophyllum gracile, G. normale, G. tenue, G. regressum, G.* sp., and *Leptoinophyllum* sp.

The second group is of solitary coralla, which have a less regular lonsdaleoid border than the phaceloid species of the *torosum* group, and in which traces of minor septa sometimes occur, and there is a tendency for the tabulae to be arranged in two series in the rather wide tabularium. They were described from the Lower Givetian of the Eifel by Wedekind (1925), e.g. *Loipophyllum kerpense* (genotype of *Loipophyllum* Wedekind (1925), *L. pilaeforme, L. sociale* (a compound form), *L. biradiatum, Neospongophyllum variabile* (genotype of *Neospongophyllum* Wedekind 1922), and *N. crassum*.

Another group of elongate, sometimes slightly branched, coralla has a rather marked bilateral symmetry; its major septa are but rarely broken by lonsdaleoid dissepiments, and the inner ends of the minor septa may be well developed. This group consists of the Givetian forms described by Wedekind (1925) as *Loipophyllum rotundum, L. acrophylloides, Grypophyllum isactis* (Frech) and *G. schwelmense*.

The fourth group is of large solitary forms from the Givetian of Germany, and has been regarded by Wedekind (1922, 1925) as constituting two new genera, *Schizophyllum* and *Stringophyllum*. These have a wide tabularium of very deeply concave tabulae, a wide lonsdaleoid border, and discontinuous septa in which, in some forms, the individual trabeculae may easily be distinguished.

From Jones' (1929) study of the tabularium of *Endophyllum* Edwards and Haime, it seems unlikely that this genus is a member of the Spongophyllidae, although Frech (1886, p. 87) merged *Spongophyllum* with *Endophyllum*. Stumm (1937, p. 435, pl. 55, figs. 5-6) has described two phaceloid species from the American Eifelian as *Spongophyllum*. These have well-developed, rather sinuous major septa, degenerate minor septa and a relatively wide tabularium, but there is a possibility that they may be members of the Disphyllidae.

A future, wider review of the Middle Palaeozoic Spongophyllidae should include a discussion of their possible relations to the Lower Palaeozoic Favistellidae (Columnariidae *auct.*) and the Upper Palaeozoic Lonsdaleiidae.

There are in the Devonian a number of cerioid corals which have the same type of tabularium as *S. sedgwicki*, but have perfectly developed minor septa, and only very rare lonsdaleoid dissepiments. They are discussed in this paper under the new genus *Xystriphyllum*, which is here doutbfully included in the Spongophyllidæ. But (see p. 62) they show certain resemblances to the group of *Cyathophyllum heterophyllum*, Edwards and Haime, and the possibility that they are related to the Acanthophyllidae rather than to the Spongophyllidae is regarded as quite a strong one.

Genus SPONGOPHYLLUM Edwards and Haime.

Spongophyllum Edwards and Haime, 1851, p. 425.

Spongophyllum; Jones, 1929, p. 88.

Genotype (by monotypy): *Spongophyllum sedgwicki* Edwards and Haime, 1851, p. 425; 1853, p. 242, pl. lvi., figs. 2, 2 a-e, Battersby Collection, Torquay. Devonian [Couvinian, Givetian, and Frasnian limestones occur at Torquay; the latest Geological Survey Memoir on the district (Explanation of Sheet 350) does not mention *Spongophyllum sedgwicki*, and so there is no evidence of its position in the limestones].

Diagnosis.—Cerioid rugose corals in which the tabularium is narrow and the tabulae close and slightly concave, the minor septa are degenerate, and lonsdaleoid dissepiments may be developed in an irregular peripheral zone when the major septa are discontinuous.

Remarks.—Frech (1886, pp. 89-90) considered Edwards and Haime's illustrations to represent two species, one with septa continuous to the epitheca, and the other with lonsdaleoid dissepiments. He equated a specimen from the *Stringocephalus* limestone (?) of Pelm with the figure 2d (with lonsdaleoid dissepiments) and others from Torquay and the *Stringocephalus* beds of Nismes with figures 2-2c. He placed the lonsdaleoid type in *Endophyllum*, and the other in *Cyathophyllum*.

Jones (1929, p. 89) considered these two morphologies to represent one species, and named as neotype British Museum Specimen R 4999, Beckles Collection, South Devonshire. He does not state, however, which morphology the neotype shows. Smith (*in litt.*) has examined several specimens, all of which fall between the extremes figured by Edwards and Haime, and he considers the figures to represent only one species.

I have before me Sedgwick Museum Slides H 138 from Mudstone Bay, Brixham (Couvinian, Givetian, or possibly Frasnian), and H 149 from Paignton. The former has a frequent development of irregular lonsdaleoid dissepiments correlated with vertical discontinuity in the septa, such as is illustrated in Edwards and Haime's fig. 2d. The vertical section of this specimen is quite similar to Edwards and Haime's figure 2e. The slide H 149 shows very few instances of discontinuity in the septa or irregular lonsdaleoid dissepiments, but the arrangement, length, and number of the septa and the irregular attitude of the dissepiments and their distance apart is the same as in H 138. It is unwise to argue on such scanty material either that there are two species or one only represented in *S. sedgwicki* Edwards and Haime, but in any case the resemblances between the two morphologies are so great that they must be of the same genus, and the generic diagnosis given above is based on both.

The species which appear to me to belong to *Spongophyllum* are the five Upper Silurian species *Spongophyllum rectiseptatum* Dybowski (1874, p. 479, pl. iv., figs. 3, 3a from Zone 3, Gotland), *Spongophyllum fritschi* Novak (Pocta, 1902, p. 152, pl. 102, figs. 6-8, Bohemia), *Spongophyllum spongophylloides* (Foerste; Jones, 1932, p. 52, pl. iii., figs. 3-4, New South Wales), *Spongophyllum inficetum* Pocta (1902, p. 153, pl. 102, fig. 1, Bohemia), and *Spongophyllum shearsbyi* Chapman (Jones, 1932, p. 51, pl. iii., figs. 1, 2, pl. iv., fig. 1, New South Wales), and six Middle Devonian species, *Spongophyllum ligeriense* Le Maitre (1934, pl. vi., fig. 14, Chalonnes, France), *Spongophyllum giganteum* Etheridge (1899, p. 158, pl. xx., figs. 1-3, pl. xxxviii., fig. 3, New South Wales), *Spongophyllum varians* Schlüter (1889, p. 56, pl. v., figs. 1-3, Eifel), *Spongophyllum kunthi* Schlüter (1881, p. 217, pl. vii., figs. 4, 5, pl. viii., figs. 1, 2, Givetian, Eifel), *Spongophyllum parvistella* Schlüter (1889, p. 65, Givetian, Eifel), and *Spongophyllum cyathophylloides* Etheridge described herein. I have not found that any special feature distinguishes the Upper Silurian forms from the Middle Devonian species.

Stumm (1938, p. 482, pl. 59, fig. 5) gives no vertical section of his *Spongophyllum prismatophylloides* from the Middle Devonian of Nevada, but the species appears to me to be a *Prismatophyllum*.

Other groups of forms with somewhat similar morphologies and which are possibly related to *Spongophyllum* are discussed in the remarks on the Family Spongophyllidae.

Spongophyllum cyathophylloides Etheridge.

(Plate V., figs. 3, 4.)

Spongophyllum cyathophylloides Etheridge, 1911, p. 7, pl. A, fig. 3 pl. C. [Douglas Creek], Clermont, Queensland. [Lower] Middle Devonian.

Spongophyllum cyathophylloides; Jones, 1932, p. 55.

Spongophyllum cyathophylloides; Stumm, 1938, p. 482.

Lectotype: (chosen Jones, *loc. cit.*) Australian Museum F 9494-7, figured Etheridge, 1911, pl. A, figs. 3; pl. C, fig. 2. Part of this specimen is 26C in the Geological Survey of Queensland's Collection.

Diagnosis—*Spongophyllum* in which the peripheral half of the dissepimentarium consists of lonsdaleoid dissepiments, and in which the minor septa are usually as perfectly developed as the major septa.

Description.—The corallum is cerioid and large—one specimen (incomplete) was 14 x 10 x 6 cm. The corallites are unequal, varying from 2 to 9 mm. in diameter, usually 6 to 8 mm. They are three to six sided, and the sides are usually curved. Increase is peripheral and possibly intermural also. The wall between corallites is formed of septal bases, which are expanded so as to be in contact laterally, giving the wall a scalloped appearance. The septal bases may be opposite or alternate in neighbouring corallites. The fifteen to eighteen major septa are long, unequal, and slightly waved and carinate, seldom curved at their axial ends; the two longest are opposite and almost meet at the axis. Usually they are separated from their bases by one to three series of irregular lonsdaleoid dissepiments, but in some parts of some corallites they may proceed to the wall, when they may or may not increase slightly in thickness from the axis to the wall. The minor septa vary in development. In some corallites they are regularly present between the major septa, and are, like their neighbours, sometimes continuous to the wall, but are more often discontinuous; in others they are suppressed almost entirely, only bases on the wall and crests on the dissepiments being found; the major septa of such corallites usually extend to the wall, but may be discontinuous. Like the major septa the minor septa may be waved, and may increase in thickness towards the wall; they are always thinner than the major septa, and extend about two-thirds of the way to the axis. The tabulae are thin, slightly concave, and very closely placed, complete or incomplete. The tabularium has only one-third the diameter of the corallum. The dissepiments are usually large, unequal, and lonsdaleoid, but rather irregularly arranged; when the septa are continuous to the wall of the corallite, however, the dissepiments are small and each is confined to one interseptal loculus, and has a concave upper surface. They are only slightly inclined at the periphery, but the inclination increases towards the axis.

Remarks.—The illustrations for this species were chosen to show its variability. Thus fig. 3a, from the lectotype, shows most corallites with the typical structure of the diagnosis; but one corallite shows both major and minor septa proceeding to the wall, unbroken by lonsdaleoid dissepiments. Figure 4 shows a portion of a corallum where most corallites have lost the minor septa, while in some cases the major septa are continuous to the wall so that the appearance of *S. sedgwicki* is obtained. The latter type of corallite sometimes arises in *Xystriphyllum dunstani,* described below, which occurs at the same locality, and leads to the supposition that *X. dunstani* is a member of the Spongophyllidae rather than the Acanthophyllidae, with which it has much in common.

The species occurs at Drummond Creek in addition to the type locality.

Genus *Xystriphyllum* nov.

ξυστρις = a rake; φυλλον = a leaf, hence septum.)

Genotype.—*Cyathophyllum dunstani* Etheridge, 1911, p. 3, pl. A, figs. 1, 2; [Douglas Creek] Clermont. [Lower] Middle Devonian.

Diagnosis.—Cerioid Rugose corals with long major septa and well-developed minor septa, with close, concave tabulae and globose dissepiments.

Remarks.—The following species are also considered to belong to this new genus:—*Cyathophyllum inequale* of Swartz (1913, p. 205, pl. xx., figs. 1-4, not necessarily of Hall; Keyser member, Helderberg formation, Lower Devonian, Maryland), *Cyathophyllum manipulatum* Pocta (1902, p. 103, pl. 104, figs. 6, 7, Lower Devonian, Bohemia), and *Cyathophyllum mitchelli* Etheridge (1892, p. 172, pl. xi., figs. 9, 10, pl. xii., fig. 4, Middle Devonian, New South Wales). A possible member is *Cyathophyllum hexagonum,* Frech (1886, pl. iii., figs. 20, from Refrath, near Cologne), not necessarily *C. hexagonum* Goldfuss, which (vide Lang and Smith 1935, p. 550) is a *Prismatophyllum.*

The genotype occurs with *Spongophyllum cyathophylloides* at Clermont in Queensland; some atypical corallites of *X. dunstani,* those from which the minor septa are absent, are indistinguishable from atypical corallites of *cyathophylloides,* in which the major septa are continuous to the wall, and minor septa are absent. The resemblance thus obtained may be homeomorphic only, but it supplies fair reason to place these two species provisionally in the same family. It is possible, however, that *Xystriphyllum* is a member of the family Acanthophyllidae, for the concave tabulae are usually incomplete, and especially in the older forms the concavity increases towards the axis. But the arrangement of the axial ends of the long major septa, so characteristic of *Acanthophyllum,* is not obvious in *Xystriphyllum.*

Xystriphyllum dunstani (Etheridge).

(Plate V., figs. 5-8.)

Cyathophyllum dunstani Etheridge, 1911, p. 3, pl. A, figs. 1, 2, [Douglas Creek] Clermont. [Lower] Middle Devonian.

? *Cyathophyllum dunstani;* Allan, 1935, p. 6, pl. v., figs. 4, 5, Middle Devonian, Lankey Gully Limestone, Reefton, New Zealand.

Lectotype (here chosen): Cl. 6, Geological Survey of Queensland Collection.

Diagnosis.—*Xystriphyllum* with long, unequal major septa interdigitating in the tabularium; in some corallites the minor septa may be lost and lonsdaleoid dissepiments may arise.

Description.—The corallum is cerioid and large, but fragments only are known. The corallites are unequal, varying in diameter between 2 mm. at origin, and a maximum of 11 mm., the average being 6 to 8 mm. They are three to six sided, and the sides may be curved or straight. Increase is peripheral, and possibly intermural also. The fairly thick wall between corallites is formed by the rapid wedge-like expansion of the septa, so that the inner margins of the wall appear zig-zag. The fifteen to eighteen long major septa extend from the wall to the axial region, where they interdigitate fairly deeply and without regularity, and may abut on one another. The minor septa are typically regularly developed, and are always thinner than and two-thirds to three-quarters as long as the major septa. Both orders have a slight and rather irregular sinuosity, and increase gradually in thickness from the axis until they suddenly expand to form the wall. In some corallites the minor septa may disappear except for their bases; sometimes also the major septa become discontinuous near the wall, and lonsdaleoid dissepiments may appear. Typically the dissepiments are globose and of moderate size; but when the minor septa are lost, larger, less globular dissepiments develop; and occasionally truly lonsdaleoid dissepiments occur when the major septa become discontinuous. The tabulae are incomplete, thin, and close, and arranged in floors that are slightly concave like saucers, or concave with the concavity increasing towards the axis. The tabularium is about one-third as wide as the corallite.

Remarks.—This species is very similar to *Xystriphyllum mitchelli* (*see* p. 62), differing only in the more persistent and deeper interdigitation of the septa in the axial region, the smaller number of the septa, and in the occasional appearance of corallites whose morphology is that of *Spongophyllum sedgwicki*.

See remarks on *Xystriphyllum* (p. 62) and on *Spongophyllum cyathophylloides*.

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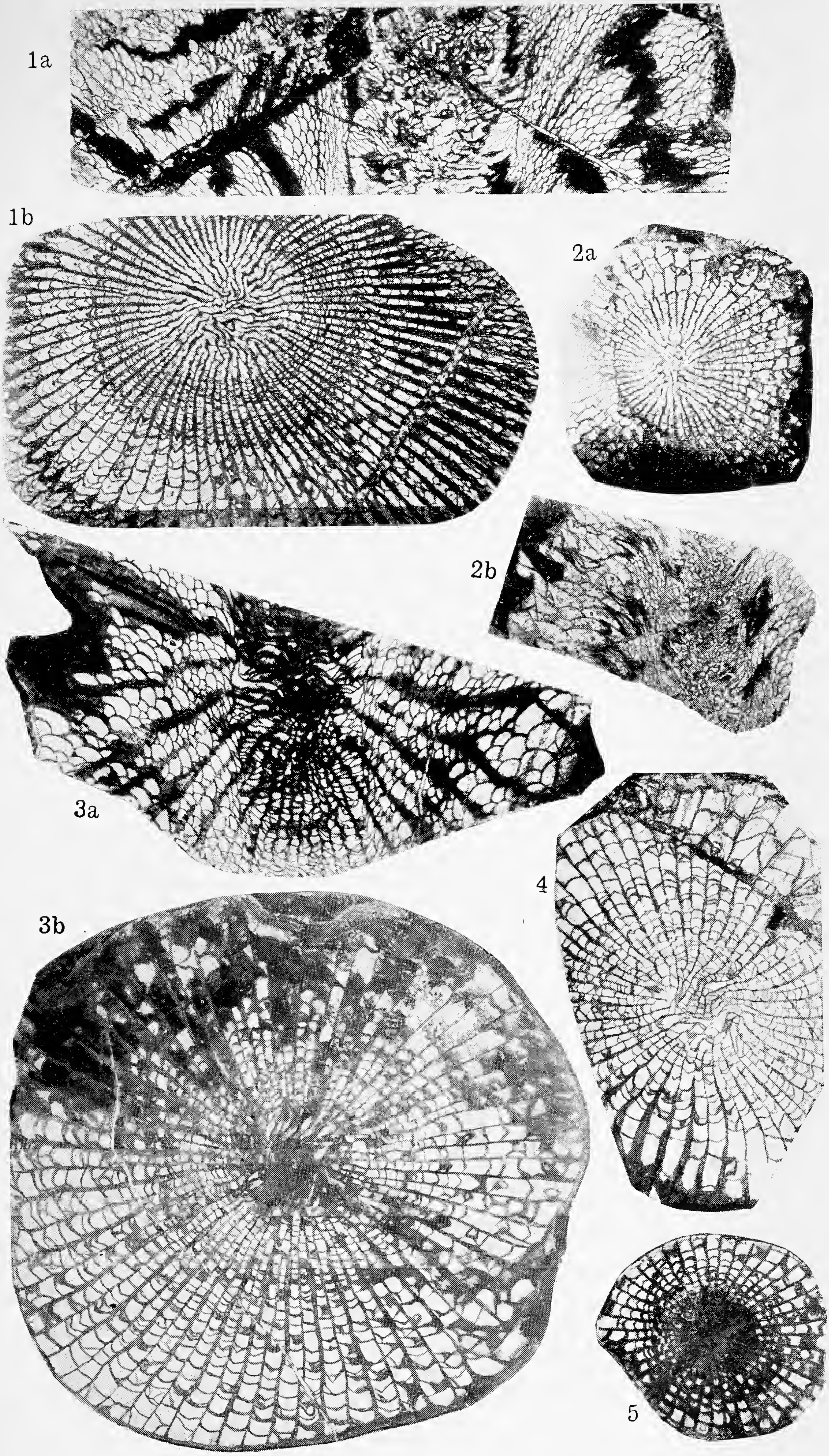
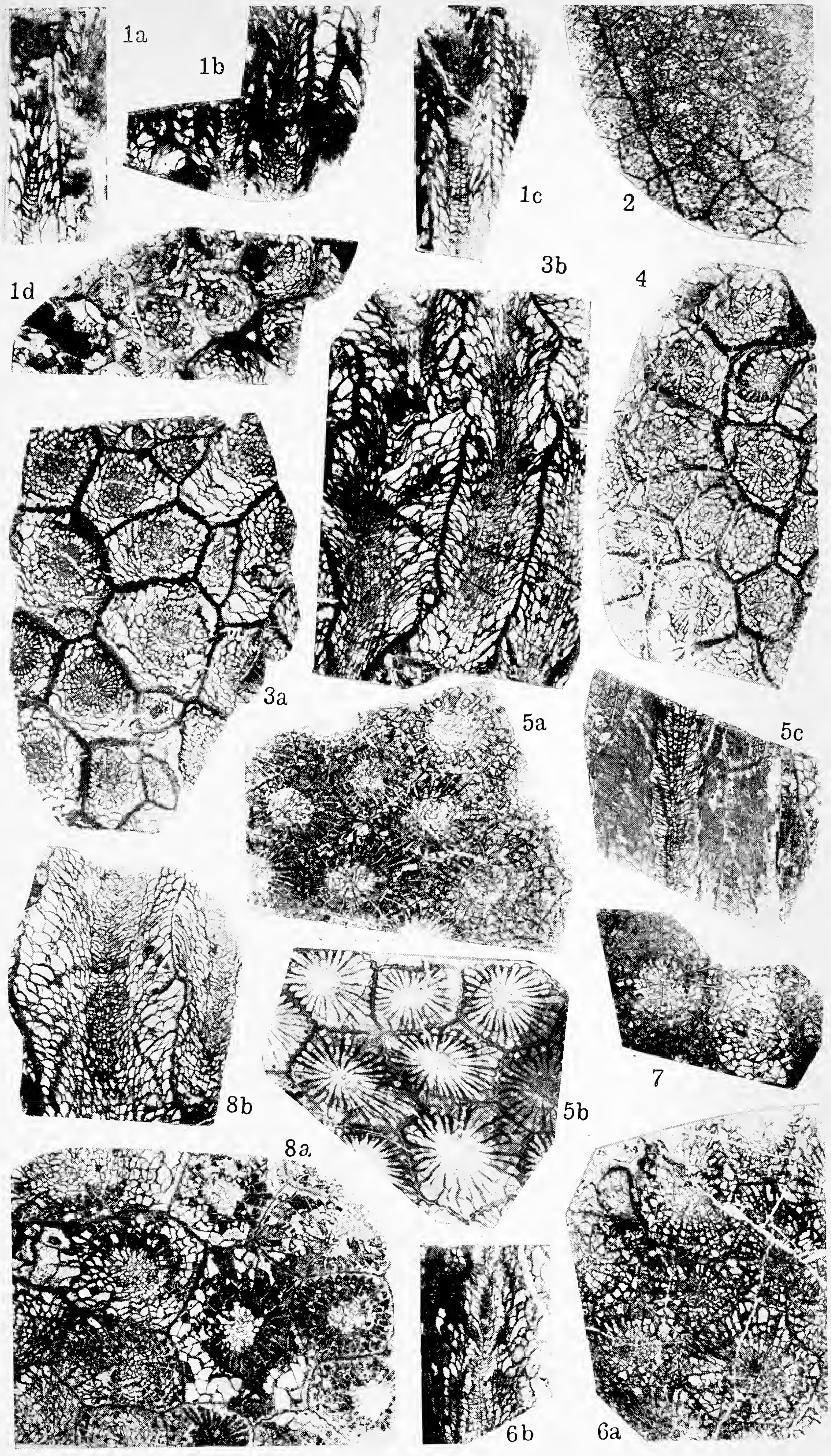


Middle Devonian Rugosa from Clermont. *Acanthophyllum.*



Middle Devonian Rugosa. Family Spongophyllidae.

WEDEKIND, R., 1921: Beiträge zur Kenntnis der Mesophyllen. Palaeont. Z. IV., Heft 1/2, pp. 48-63, pls. 1, 2.

———., 1922: Zur Kenntnis der Stringophyllen des oberen Mitteldevon. Sitz. Gesell. Förd. ges. Nat. Marburg, Jahrg. 1921, Heft 1, pp. 1-16.

———., 1924: Das Mitteldevon der Eifel. I. Teil. Die Tetrakorallen des unteren Mitteldevon. Schrift. Gesell. Beförd. ges. Nat. Marburg XIV., Heft 3, pp. vii. 93, 122 text-figs.

———., 1925: Das Mitteldevon der Eifel. II. Teil. Materialien zur Kenntnis des mittleren Mitteldevon. Id. Heft 4, pp. vii. 85, 106 text-figs.

EXPLANATION TO PLATES.

PLATE IV.

All specimens are from the Middle Devonian ((?)Upper Couvinian) of Douglas Creek, near Clermont, Queensland, and are now in the Collection of the Geological Survey of Queensland.

All figures approximately x 2 diameters.

Fig. 1. *Acanthophyllum clermontensis* (Etheridge). Syntype. 1A. Vertical section; 1B. Transverse section. Coll. B. Dunstan.

Fig. 2. The same. Syntype 4C. 2A. Transverse section; 2B. Vertical section.

Fig. 3. *Acanthophyllum clermontensis* (?) (Etheridge). 3A. Vertical section; 3B. Transverse section. Coll. W. H. Rands.

Fig. 4. (?) *Acanthophyllum clermontensis* (Etheridge). Transverse section. Coll. W. H. Rands.

Fig. 5. *Acanthophyllum clermontensis* (?) (Etheridge). Transverse section. Coll. W. H. Rands.

PLATE V.

All specimens except those figured 1 and 2 are from the Middle Devonian ((?) Upper Couvinian) of Douglas Creek, near Clermont, Queensland, and are now in the Collection of the Geological Survey of Queensland.

All figures approximately x 2 diameters.

Fig. 1. *Spongophyllum sedgwicki* Edwards and Haime. H.138, Sedgwick Museum, Cambridge; Mudstone Bay, Brixham (Couvinian, Givetian, or possibly Frasnian). 1A-C. Vertical sections; 1D. Transverse section.

Fig. 2. The same. H. 149, Sedgwick Museum, Cambridge; Paignton. Transverse section.

Fig. 3. *Spongophyllum cyathophylloides* Etheridge. Lectotype, 26C. 3A. Transverse section; 3B. Vertical section.

Fig. 4. The same. Syntype, 28C. Transverse section showing some corallites without minor septa and with continuous major septa.

Fig. 5. *Xystriphyllum dunstani* (Etheridge). Syntype, Cl.41. 5A. Transverse section; 5B. The same photographed by reflected light, the peripheral parts of the septa show well, but the axial parts are lost; 5C. Vertical section.

Fig. 6. The same. Lectotype, Cl.6. 6A. Transverse section; 6B. Vertical section.

Fig. 7. The same. Syntype, Cl.33. T.S. showing a spongophylloid corallite.

Fig. 8. The same. Syntype, Cl.5. 8A. Transverse section showing several spongophylloid corallites; 8B. Vertical section.

Contributions to the Queensland Flora, No. 6.

By C. T. White, Government Botanist.

(*Read before the Royal Society of Queensland, 28th November,* 1938.)

Plate VI.

The present paper contains additions to the flora of Queensland since the publication of the previous contribution (these Proceedings, Vol. 47, pp. 235). The determinations of some of the species new to the flora of Queensland have been made by different members of the staff of the Queensland Herbarium. An indication of the botanist responsible is given under the individual headings. A description of a previously undescribed *Calandrinia* by Miss D. A. Goy is included.

Family Pittosporaceae.

Citriobatus linearis sp. nov.

C. multiflorus A. Cunn. var. *intermedius* F. M. Bail. Queensl. Agr. Journ. XXX., 399, Plate 65 (1913).

C. multiflorus A. Cunn. var. *linearis* F. M. Bail. l.c. Pl. 66 (1913).

Frutex robustus 2–3 m. altus, ramulis abortivis brevibus spinosis armatus vel ramulis ordinariis in spinam pungentem terminantibus, ramulis junioribus pubescentibus mox glabris. Folio supra nitida linearia vel anguste obovata ad apicem acuta vel rotundata, ad basin valde angustata vel rarius subrotunda 1–3 cm. longa, 0·2–0·5 cm. lata, petiolo 0·5–1·5 mm. longo, costa media supra leviter impressa, subtus leviter elevata, venis obscuris vel in sicco subinde leviter impressa. Flores numerosi, solitarii, axillares, pedicello 2–5 mm. longo. Sepala 5 anguste ovata 1 mm. longa. Petala in tubum longum conniventia; tubus 3·5–4 mm. longus; lobi ovati, 1·5 mm. longi. Antherae leviter exsertae, filamentis ligulatis. Ovarium lageniforme, pilosum. Fructus globosus, pisiformis, ca. 1 cm. diam. Seminibus nitidis rubro-fuscis 3 mm. diam.

A very common shrub, especially as second growth in the drier rain-forest areas of south-east Queensland. The following is a selection of localities from the Queensland Herbarium, Brisbane:—

Moreton District.—Yarraman, M. A. Cameron, No. 754 (flowers), Oct., 1924. Allandale, near Boonah, Rev. N. Michael, No. 1997. Laidley, C. T. White (a very common shrub). Rosewood, C. T. White (fruits), May, 1913. Gold Creek, near Brisbane, C. T. White (young flower buds), 27th August, 1922.

Darling Downs.—Bunya Mountains, C. T. White. Main Range, F. M. Bailey (growing to the size of a small tree).

Burnett District.—Gayndah, Dr. F. H. Kenny (type). Childers, Dr. F. H. Kenny (shrub, flowers very sweet smelling). The Hummock, Bundaberg, Rev. N. Michael, No. 1776 (low shrub 3-6 ft.).

C. linearis was placed as a variety of *C. multiflorus* A. Cunn. by F. M. Bailey, but I think there is no doubt it is a very distinct species and that its affinities lie more with *C. pauciflorus* A. Cunn. rather than with *C. multiflorus* A. Cunn. All three species are very common in South-east Queensland. *C. multiflorus* is mostly found in the wetter rain-forest areas, particularly in mountain localities such as the Macpherson Range, Tambourine Mountain, &c. *C. linearis* and *C. pauciflorus* do not occur in the wetter zone. *C. linearis* grows in the eastern parts of the Darling Downs, the West Moreton, and the Burnett districts. *C. pauciflorus* is common in the Darling Downs and Burnett districts, and extends further west and north than *C. linearis,* being common in the Maranoa, Port Curtis, and Leichhardt districts. The northernmost locality for it in the Queensland Herbarium is Cannon Valley (North Kennedy district), Rev. N. Michael, No. 1035. I am not sure of F. M. Bailey's var. *intermedius* of *C. multiflorus.* The type of the variety consists of a leafy twig with detached fruits; the leaves approach those of *C. pauciflorus* A. Cunn., but the fruit *C. linearis,* and if the leaves and fruits are correctly matched it is probably only a growth form. I cannot see how F. M. Bailey's *C. pauciflorus* A. Cunn. var. *Kennyi* differs from the type. The only other species of the genus, *C. lancifolius,* grows in the rain-forests near Killarney and in the Lamington National Park. I have not seen it in fruit, and the measurements are taken from F. M. Bailey's original description. A characteristic feature in the field is that the leaves have a strong taste of carrots when chewed. A key to the species of the genus is given herewith:—

Leaves toothed or lobed in the upper part, rarely entire or nearly so, flowers sessile, fruit about 1 cm. diam.	*C. multiflorus*
Leaves linear, rarely obovate, 1-3 cm. long, 0·2-0·5 cm. broad, flowers pedicellate, fruit about 1 cm. diam.	*C. linearis*
Leaves all obovate, 1-1·5 cm. long, 0·5-0·8 cm. broad, flowers sessile, fruit 2 cm. diam.	*C. pauciflorus*
Leaves lanceolate, rarely elliptic, 2-6 cm. long, 0·8-2 cm. broad, flowers sessile, fruit about 1 cm. diam. (Bailey)	*C. lancifolius*

Family POLYGALACEAE.

Xanthophyllum fragrans sp. nov.

Arbor mediocris, partibus novellis tomentosis, ramulis lenticellatis, cortice atro-brunneo obtectis. Folia lanceolata utrinque nitida, lamina 17–20 cm. longa, 5–7·5 cm. lata, petiolo 1 cm. longo, costa media supra impressa subtus elevata, nervis secundariis validis, venis et venulis prominulis. Racemi terminales vel axillares 5–12 flori; rhachi 5–10 cm. longa, dense tomentosa; pedicellis 2 cm. longis, dense tomentosis, apicem versus incrassatis. Sepala inaequalia, puberula, margine ciliolata, majora 1·2 cm. longa, 6 mm. lata. Petala cremea, purpureo-maculata, 6·5 cm. longa, 1 cm. lata. Stamina 8; filamentis petalis adnatis, leviter applanatis, dense hirsutis, apicem versus exceptis; antheris glabris 2 mm. longis Pistillum 6 cm. longum, gynophoro pubescenti 1·5 cm. longo, ovario glabro applanato 5 mm. longo, stylo glabro applanato, stigmate capitato. Fructus oblongus, 9 cm. longus, 6 cm. diam.

Daintree River in rain-forest, on creek-banks, foothills of Thornton Peak, L. J. Brass and C. T. White, No. 264 (type: flowering specimens), 20th September, 1937 (tree 20 m., flowers very fragrant, cream, turning yellow with age, streaked and flecked with purple). Daintree River, common in rain-forest, S. F. Kajewski, No. 1430 (fruiting specimens), 2nd December, 1929 (large tree up to 20 m.; fruit oblong, coloured and shaped similar to a mango).

Family PORTULACACEAE.

Anacampseros australiana J. M. Black.

Moonie River, Nindigully, growing in hard red soil. R. Roe, February, 1938.

Determination by W. D. Francis—verified by comparison with the type by J. M. Black.

Calandrinia Morrisae D.A. Goy sp. nov.

Herba debilis carnosa; caulibus foliaceis ca. 30 cm. longis. Folia lineari-lanceolata basem versus in petiolum brevum angustata, 1·5–2 cm. longa; stipulis minutis, lanceolatis. Flores in racemos laxos longos dispositi, pedicellis crassis ca. 1 cm. longis, patentibus et recurvis; bracteis minutis, pallidus, costa media prominenti; sepalis subrotundis, apice acutis; petalis 6, lineari-lanceolatis, 7–8 mm. longis in parte superiore purpureis in parte inferiore albis; staminibus 8–14, 5 mm. longis, filamentis liberis, antheris breviter oblongis; stylis 4. Capsula ca. 8 mm. longa, anguste oblonga, obtusa; seminibus cochleatis numerosis nigris nitidis prominenter costatis.

Caiwarro, Eulo, S.W. Queensland, Katherine I. Morris, 31st August, 1936.

The closest affinity of the present species is *C. volubilis* Benth. The two may be differentiated as follows:—

Styles 4; capsule narrow oblong, obtuse; seeds cochleate, black, prominently costate, the costae very distinct and without any transverse raised markings .. .. *C. Morrisae*

Styles 3; capsule conical; seeds reniform, coppery, lightly costate the costae indistinct and with numerous transverse raised markings .. *C. volubilis*

Family TILIACEAE.

Corchorus tridens L.

Hughenden, W. D. Francis, May, 1934. Not previously recorded for Queensland (determination by L. Smith).

Family RUTACEAE.

Acronychia pubescens sp. nov.

A. melicopoides F. v. M. var. *lasiantha* F. v. Muell. Fragm. VII., 145 (1871).

Melicope pubescens F. M. Bail. Bull. IX.—Botany (Dept. Agric., Brisbane), 9 (1891); Comprehens. Cat. Q. Pl., fig. 59 (1912).

Melicope pubescens F. M. Bail. var. *superba,* Domin. Bibl. Bot. 89 (IV.), 843, 1927.

Sarcomelicope pubescens Domin.

Arbor mediocris, ramulis robustis, partibus novellis dense sericeo-hirsutis. Folio 1–3–foliolata, petiolo pubescenti vel deinde glabrescenti, 2–3·5 cm. longo. Foliola chartacea, lanceolata, sessilia, supra glabra vel pilis paucis vestita, subtus pubescentia, 6–18 cm. longa, 2–6 cm. lata, venis et venulis subtus valde elevatis. Cymae axillares, ramulis pedicellisque dense et molliter pubescentibus, penduculo communi 0·5–1 cm. longo, pedicellis 1–3 mm. longis. Calyx extus dense sericeo-pubescens, lobis 4, late ovatis, vix 2 mm. longis. Petala 4, extus dense sericeo-pubescentia, intus glabra, anguste ovata 6 mm. longa, ad basin 3 mm. lata. Stamina 8, filamentis applanatis, margine ciliatis. Ovarium glabrum. Discus pilis longis albis dense vestitus. Fructus subglobosus, carnosus, albus, acidulus, aromaticus, ca. 2 cm. diam.; carpella 4, ad margines laxe conjuncta. Semina atro-fusca vel nigra, tuberculata, 3 mm. diam.

New South Wales.—It is represented in the National Herbarium, Sydney, by a wide range of specimens; the following is a selection showing the range of the species in that State. Coff's Harbour, J. L. Boorman; Glenfernie Forest Reserve, J. H. Maiden; Acacia Creek, Killarney, W. Dunn, J. L. Boorman; Dorrigo, W. Heron; Tweed River district, E. Betche.

Queensland.—It is represented in the Queensland Herbarium by a wide range of specimens. The species extends from the Tweed River to the Blackall Range. The following is a selection:—Roberts Plateau, Lamington National Park, alt. 3,000 ft., C. T. White, 6026 (type: flowering specimens), 20th May, 1929 (small tree common in rain-forest and as secondary growth; leaves light green, flowers cream). Mudgeeraba, Dr. C. P. Ledward (fruits), Aug., 1937. Tambourine Mountain, J. H. Simmonds. Eumundi, Bailey and Simmonds, K. E. Kandler (fruits), Aug., 1931. Blackall Range, C. T. White (flowers), April, 1918, Bailey and Simmonds.

I think there is no doubt this plant is specifically distinct from *A. melicopoides* F.v.M., under which Mueller placed it as a variety. *A. melicopoides* (type) is a very common tree in the rain-forests of North Queensland from the Eungella Range (via Mackay) to Mount Spurgeon (north of Cairns). The chief distinctions are as follows:—

Leaves constantly 3-foliolate, glabrous except in the bud stage. Petals glabrous outside .. .. *A. melicopoides*

Leaves usually 3-foliolate, but sometimes 1 or 2-foliolate, glabrous above, pubescent beneath. Petals densely pubescent on the outer face .. .. *A. pubescens*

Phebalium gracile sp. nov.

Frutex gracilis, 1 m. altus, ramulis pubescentibus. Folio conferta, linearia vel ovato-linearia, subacuta, plana vel revoluta, utrinque glabra subtus punctis paucis elevatis signata petiolata; petiolus vix 1 mm. longus; lamina 7–8 mm. longa, 2 mm. lata. Flores albi in axillis supremis dispositi; pedicelli 4–5 mm. longi, angulati apicem versus gradatim incrassati, pilis paucis obsiti. Calyx 1·5 mm. diam., 5–lobati, lobis late triangularibus perbrevis. Petala glabra 4 mm. longa, 1 mm. lata. Stamina leviter exserta, filamentis subulatis glabris albis 4·25 mm. longis, antheris roseis vix 1 mm. longis. Pistillum glabrum. Cocci rostrati cum rostro 6 mm. longi.

Mount Greville, alt. 2,000 ft., common on rocky cliffs, C. T. White, No. 9947 (type; buds, flowers, and nearly ripe cocci), March, 1934 (slender-stemmed shrub 1 m. high, flowers white); E. J. Smith (flowers and flower buds), May, 1937. Rev. N. Michael, No. 2074 (sterile material), Oct., 1934.

Among previously described species *P. gracile* has most affinities with *P. diosmeum* A. Juss., which differs in having narrower, usually pubescent leaves with tightly revolute margins, flowers in a dense head with hairy larger calyces.

Phebalium squamulosum Vent. Jard. Malm. t. 102, var. *grandiflorum* var. nov.

Folio ad 6 cm. longa et 1 cm. lata. Flores speciosi, aurei; petala fere 1 cm. longa.

Wyberba, Mrs. N. Gunn (flowering specimens), Sept., 1932 (shrub, flowers bright yellow).

A very distinctive and showy variety, more robust in all parts than the type; the flowers are deeper yellow and twice the size of the normal form. Apart from these distinctions, however, the plant shows no fundamental differences from typical *P. squamulosum* Vent.

Type of the variety in the Queensland Herbarium, Brisbane; co-type material at Royal Botanic Gardens, Kew (Eng.), and Arnold Arboretum, Boston (U.S.A.).

Family CELASTRACEAE.

(W. D. Francis.)

Hedraianthera porphyropetala F.v.M. Frag. Phytog., v. 59.

The genus and species were described from Dallachy's specimens from Rockingham Bay. What appears to be the same species is very common in South Queensland rain-forests such as those at Kin Kin, Eumundi, Mount Cotton, Tambourine Mountain, and Currumbin. In these southern localities it is a shrub or a small tree attaining about 15 feet in height, and is remarkable for the fact that the dark red flowers are often borne in clusters on protuberances arising from the stem and branches. The peduncles and pedicels also are often deep red in colour. In his generic description Mueller describes the filaments as none. In the description of the species he refers to minute glands in the place of the filaments. In several of the specimens in the Queensland Herbarium from both Northern and Southern localities I found filaments to be present and distinct, in some instances attaining 1 mm. in length. The fruit are often ovate or oval, and, in the dry state, measure up to 2·5 cm. long and 1–1·3 cm. across. Northern localities represented in the Queensland Herbarium are Yarrabah, near Cairns, and mountains near Mossman.

Family RHAMNACEAE.

Alphitonia philippinensis Braid.

Cape York Peninsula, D. F. Thomson, No. 49. Sand Dunes, Barron Beach, H. Flecker, No. 1613, 26th April, 1936. This specimen matches those from the Philippine Islands remarkably well.

Cryptandra longistaminea F.v.M.

Moreton District.—Goodna, C. T. White; Beenleigh, J. Shirley; Fort Buchanan, common on cliff faces, altitude 2,300 ft., C. T. White, No. 9308 (flowering specimens), 7th October, 1933 (low shrub about 1 ft. high).

Darling Downs.—Gladfield, C. J. Gwyther; Condamine, C. H. Hartmann; Main Range, C. H. Hartmann; Crow's Nest, Dr. F. H. Kenny; between Dulacca and Miles, L. J. Brass and C. T. White, No. 5 (flowering specimens), 7th September, 1937; Silverwood, C. T. White, No. 1717 (flowering specimens), September, 1922.

From the above records in the Queensland Herbarium, Brisbane, it will be seen that this plant is a very abundant one in the Darling Downs and to a lesser extent in the Moreton district, South-east Queensland. Previously I had some doubt of the determination, as the specimens did not agree with the note in the "Flora Australiensis" and repeated in the "Queensland Flora"—"Disk glabrous or very minutely tomentose." The disk in all cases was very densely woolly tomentose. A portion of the type from Severn River, C. Stuart, No. 148, kindly loaned me by Mr. F. J. Rae, of the National Herbarium, Melbourne, showed it to have the same densely woolly, hairy disk. All the Queensland specimens quoted above match the type very closely.

Ventilago pubiflora sp. nov.

Frutex scandens, valde ramosus; ramulis novellis subangularibus pubescentibus mox glabris et teretibus; ramis ramulisque flexuosis. Folia petiolata, subcoriacea, glabra, elliptica, utrinque venulosa, margine pauci-dentata in sicco undulata; nervis praecipuis 7–9 in utroque latere; lamina 4·5–8 cm. longa, 2–4 cm. lata; petiolo 0·5–1 cm. longo. Flores in paniculas spiciformes dispositi; rhachi dense tomentosa ad 16 cm. longa; pedicellis 2–3 mm. longis, dense tomentosis. Calyx alte 5–fidus, dense tomentosus; lobis 1·5 mm. longis, intus glabris. Petala parva, glabra, truncata, subcucullata. Stamina petala haud excedentes; filamentis leviter applanatis. Ovarium dense hirsutum. Nux tomentosa, cum ala 2·5 cm. longa.

Wide Bay District.—Widgee, L. D. Pryor.

Burnett District.—Biggenden, C. T. White, No. 7333 (type: advanced flowers and young fruits), 11th October, 1930 (vine growing over trees, common in second growth rain-forest, on the Biggenden-Childers road). The Hummock, near Bundaberg, Rev. N. Michael, No. 1778 (fruiting specimens—a low undershrub). Wallaville, Dr. T. L. Bancroft.

The present species approaches *V. ecorollata* F.v.M. from North Queensland, which differs in its smaller leaves, very short panicles, glabrous or glabrescent flowers, and the absence of petals. It is very similar to *V. neo-caledonica* Schlechter and *V. vitiensis* Seem., both of which differ in having shorter panicles and in the more glabrous nature of inflorescence and flowers.

Family LEGUMINOSAE.

Acacia Cheelii, Blakely.

Between Miles and Chinchilla. L. J. Brass and C. T. White. No. 348 (flowering specimens), 1st October, 1937. As these specimens did not quite agree in all details with the author's description, I forwarded a sheet to Mr. Blakely for comparison with his type in the National Herbarium, Sydney, and he replied, "Not quite typical. The branchlets are non-glaucous, phyllodia straighter, and the spikes more slender than in the typical form. It would be interesting to see what the pods are like. It is the first record for Queensland to my knowledge."

Acacia linifolia Willd. and its allies in Queensland.

Acacia linifolia Willd. is a very common shrub in parts of New South Wales, particularly on the sandstone country about Sydney and the Blue Mountains. Bentham in the "Flora Australiensis" synonymises *Acacia fimbriata* A. Cunn. with *A. linifolia*. The two in their extreme forms, however, are very different; *A. linifolia* is a straggly shrub and *A. fimbriata* a tree with a dense spreading top and rather pendulous branches. It probably finds its greatest development in South-eastern Queensland and North-eastern New South Wales, where it is very common along fresh-water streams. Maiden in his "Forest Flora of New South Wales," Vol. V., p. 29, describes and illustrates both species. In its typical form *A. fimbriata* is characterised by pubescent branchlets, and more especially by the ciliate edge of the phyllodes. Glabrous and narrow-leaved forms of it occur, however, that connect it with *A. linifolia*. The following notes and key, I hope, will clear up some of the confusion concerning the two species. Domin in Bibliotheca Botanica reduces *A. fimbriata* to a variety of *A. prominens* A. Cunn., a fairly common species in New South Wales. I cannot follow him in this. He also names a variety *Whiteana* (?). I have seen what I take to be a co-type of this, and I cannot separate it from ordinary *A. fimbriata* A. Cunn., which is a very widely spread species; like most plants with a wide distribution, it shows considerable variation.

Acacia linifolia Willd. Sp. Pl. IV., 105 (1805).

New South Wales.—It is very common in the Port Jackson district and Blue Mountains. Maiden quotes Bargo (Picton district) as the most southerly locality in the National Herbarium, Sydney, north of Walgan Shale Mine (R. H. Cambage) as the most westerly, and Woodford, Lower Hunter River, as the northernmost.

Queensland.—Blackdown Tableland, Central Queensland (H. G. Simmons), is the only Queensland locality represented in the Queensland Herbarium. There is a very big gap in the known distribution from the Hunter River, New South Wales, to the Blackdown Tableland, Queensland. Domin (Bibl. Bot. 89 (III.), 808, 1926) records it from the Darling Downs (C. Moore).

Acacia fimbriata A. Cunn. in G. Don. Gen. Hist. of the Dichlamydeous Plants, Vol. II., p. 406 (1832).

Acacia prominens vars. *fimbriata* and ? *Whiteana* Domin. Bibl. Bot. 89 (III.), 810 (1926).

New South Wales.—Maiden records it from Barber's Creek and Nowra (Illawarra district) to the Queensland border, and says it finds its greatest development on the Northern Rivers and to a less extent the Northern Tableland.

Queensland.—It has a wide distribution in Queensland, and finds its greatest development in the south-eastern corner of the State. Our northernmost record in the Queensland Herbarium is Ravenshoe, Atherton Tableland (J. Tardent), and our westernmost records are Biggenden (C. T. White, 7304) and Kinleymore (Miss F. H. Beutel), both in the Burnett district.

It is a small tree mostly found along creek sides, but is sometimes frequent as undergrowth in Eucalyptus forests.

I have seen what I take to be the co-type of Domin's var. *Whiteana* and hardly think it worthy of a distinguishing name. *A. fimbriata* A. Cunn. as I recognise it is a species with a wide distribution and considerable variation.

Acacia fimbriata A. Cunn. var. *glabra* var. nov.

Tota planta glabra pilis paucis in partibus novellis excepta.

Differs from the type in being glabrous in all parts except for a few hairs on the shoots in the bud stage. Queensland: near Biggenden, Burnett district, W. R. Petrie, No. 18A (type of the variety); slopes of Bunya Mountain, C. T. White, October, 1919.

Acacia fimbriata A. Cunn. var. *perangusta* var. nov.

Tota planta glabra; phyllodia perangusta 4–9 cm. longa, 1–1·5 mm. lata; glandula marginali 0·5–1·8 cm. supra basin.

Differs from the type in its glabrous character, and longer, narrower phyllodes. In the type the marginal gland is usually near the base of the phyllode, in var. *perangusta* it is placed 0·5–1·8 cm. from the base on the upper edge; sometimes a second gland is present further up.

Queensland.—Slack's Creek, Rev. Norman Michael, Nos. 1936 and 2004. Wellington Point, J. Wedd (Oct., 1891). Castra, near Brisbane, very common along creek banks, C. T. White, No. 3554, 7th August, 1927 (type of the variety; flowers in late bud stage); Burrum River, C. T. White, No. 6286 (immature pods), 5th October, 1929 (tree 20 feet high, overhanging the river).

Acacia pubicosta sp. nov.

Arbor parva, 3–5 m. alta; partibus novellis pilis aureis sericeis vestitis (Goy, 319), ramulis junioribus subangularibus canescentibus. Phyllodia linearia, 4·5–8 cm. longa, 2–3·5 mm. lata, utrinque canescentia vel demum glabrescentia costa media excepta, ad apicem apiculo incrassato parvo rostrato superata, ad basin in petiolum brevum incrassata; glandulum marginale obsoletum vel nullum. Racemi in axillis superioribus dispositi, 3–5 cm. longi; rhachi et pedunculis pilis albis vel aureis (Goy, 319) brevibus dense vestitis, pedicellis 3 mm. longis, bractea ad basin pedicelli parva apiculata incrassata persistenti. Sepala ovata, distincta, 1 mm. longa, margine albociliata. Petala glabra sepalis duplo longiora. Legumen lineare 8–10 cm. longum, 0·8–1 cm. latum, undulatum; semina ca. 10, longitudinalia, funiculo leviter plicato ad apicem incrassato.

Burnett District.—Biggenden Bluff, C. T. White, No. 7722 (type: flowering specimens), 17th August, 1931 (small tree, 3–5 m. high, of slender upright growth, flowers white or pale cream); West Mount Morgan, Doris A. Goy, No. 319 (flowering specimens), 18th July, 1938 (small spreading tree, about 15 feet high, leaves silver, flowers pale lemon).

The Mount Morgan specimens possess shorter, more pubescent leaves than the type, the young shoots are markedly golden yellow, a character that persists for some time, and the flowers are a deeper colour. I think there is no doubt, however, that both collections represent the same species.

The affinities of the present species lie with *Acacia fimbriata* A. Cunn.

The following key gives the distinctions between *A. linifolia* Willd., *A. fimbriata* A. Cunn. and its varieties, and *A. pubicosta* C. T. White :—

Phyllodes glabrous	1
Phyllodes ciliate on the margins	2
Phyllodes clothed with grey or silvery hairs on both sides or glabrescent in age except the midrib ..	3
1A. Slender upright shrub of rather spindly growth, phyllodes glabrous 2-4 cm. long and 1-2 mm. broad, central nerve indistinct in the narrower phyllodes, marginal gland indistinct	*A. linifolia*
1B. Tree with dense spreading top and rather pendulous branches or shrub with ultimate branches drooping, phyllodes 3-4 cm. long, 2-4 mm. broad, midrib distinct, marginal gland prominent 0·5-1 cm. from the base ..	*A. fimbriata* var. *glabra*

1c. Tree with dense spreading top and drooping branches, phyllodes glabrous 4-9 cm. long, 1-1·5 mm. broad, midrib rather prominent, marginal gland prominent 0·5-1·8 cm. from the base, sometimes a second one present .. *A. fimbriata* var. *perangusta*

2. Tree with dense spreading top and rather pendulous branches or shrub with ultimate branches drooping, branchlets pubescent, phyllodes ciliate on the margin, 2-5 cm. long, 1·5-5 mm. broad, midrib rather prominent, marginal gland prominent, 1-7 mm. from the base .. *A. fimbriata*

3. Small tree of spreading habit or upright growth, young parts canescent or clothed with silky hairs of a golden colour, phyllodia 4·5-8 cm. long, 2-3·5 mm. broad, clothed on both sides with grey or silvery hairs, glabrescent when old except the midrib, marginal gland obsolete or none .. .. *A. pubicosta*

Cassia queenslandica sp. nov.

C. Brewsteri F.v.M. var. *sylvestris* F. M. Bailey. Bull. No. 9 (Bot. Bull. 3), Dept. Agric., Brisbane, p. 11 (1891).

Arbor elata, ramulis floriferis tomentosis, leviter, costatis. Folia 6– to 8–juga, ca. 18 cm. longa, rhachis puberula, subangulata, eglandulosa; foliola oblonga, 4–7 cm. longa, 2–2·5 cm. lata, apice obtusa, basi cuneata, utrinque prominule reticulata, supra glabra, subtus pilis albis inspersis vestita; petiolulus dense puberulus 3–4 mm. longus. Racemi 25–35 cm. longi, 50– to 60–flori; rhachis subangulata, dense puberula; bracteae lanceolatae 2 mm. longae mox deciduae; pedicelli graciles 2·5–3 cm. longi, sepala late ovata ca. 6 mm. longa, utrinque minute puberula. Petala flava ovali-oblonga 1·7 cm. longa, in unguem brevem contracta, in sicco valde nervosa. Stamina 3 infima majora, petala aequilonga, filamentis supra medium glandulo magno incrassata; stamina 7 inferiora 3–6 mm. longa; antherae basi leviter bifidae, loculi poris basilaribus dehiscentibus. Ovarium dense pubescens. Legumen pendulum, ca. 35 cm. longum ca. 1 cm. latum, subapplanatum, suturis laevibus continuis, inter suturas torulosum, intus transverse inter semina septatum. Semina transversa, horizontalia (septis parallela).

Kamerunga (now Redlynch), Barron River, E. Cowley. Bloomfield River, W. Poland (pods), Nov., 1902. Mount Molloy, E. Fryer (type: flowers and pods), Sept., 1936.

The above plant was named by F. M. Bailey l.c. and "Queensland Flora," II., 458, as *C. Brewsteri* F.v.M. var. *sylvestris*. He based this opinion on the similarity of his specimens to the plant figured by Rumphius in the "Herbarium Amboinense," 2, 88, t. 22, as *Cassia fistula silvestris*. Merrill in his interpretation of Rumphius' work refers this to *C. javanica* L., but the Australian plant shows marked differences.

Racemes 5-8 cm. long, 20-30 fld.; bracts ovate, subpersistent; flowers pink and white; pod terete .. .. *C. javanica*

Racemes 25-35 cm. long, 50-60 fld.; bracts lanceolate, very soon deciduous; fls. yellow; pod applanate, much constricted transversely between the seeds .. .. *C. queenslandica*

Pultenaea paleacea Willd. var. *pauciflora* var. nov.

Differt a forma typica foliis brevioribus, ad 1·2 cm. longis, in sicco supra subconcavis; capitulis multo minoribus, paucifloris; tubo calycis pilis strigosis paucis obsitis, bracteolis and basim affixis.

Wide Bay District.—Near Nikenbah, in damp places in open forest, S. T. Blake (type of the variety: flowering specimens), 5th June, 1932 (small, erect shrub, flowers yellow, keel more or less red). Goodwood, E. W. Bick (leaves only), June, 1915.

Port Curtis District.—Byfield, in damp places in "wallum country," comparatively rare, C. T. White, No. 8173 (nearly finished flowering), 25th September, 1931 (slender shrub, 1·5 m., flowers yellow).

P. paleacea Willd. as at present understood is a very polymorphic species with several named varieties. The present one is very different in appearance from the common Queensland form—var. *robusta* Williamson—and is much more like the typical form that grows in the Port Jackson area, New South Wales. When the group comes to be revised with more material I think it will have to be split up into several distinct species, of which the variety *pauciflora* C. T. White will be one. The Goodwood specimens were seen by H. B. Williamson when preparing his monograph of the genus, and he noted on them—"Flowers may show this to be a form of *P. paleacea* Willd."

Family MYRTACEAE.

Eucalyptus codonocarpa Blakely and McKie.

Lamington National Park, C. T. White, No. 11,119, 22nd October, 1934—common on trachytic hills, in more sheltered places; small gnarled tree up to 5 m. or more high and with a subfibrous bark at the base; in more exposed places a shrub of Mallee-like growth, numerous clean-barked stems from a common stock.

Mount Barney, altitude 3,500–4,000 feet, S. L. Everist, No. 1391, 13th October, 1935.—Small Mallee-like trees common on the upper slopes of the mountain on granophyre cliffs; bark grey, smooth; leaves stiff, coriaceous.

The determinations of these specimens have been kindly verified by Mr. W. F. Blakely, National Herbarium, Sydney, who adds: "The specimens of *Eucalyptus codonocarpa* vary to some extent from the type. The one from Lamington National Park has smaller and more numerous fruits than the typical form, which is usually confined to three in the umbel, while the specimen from Mount Barney has pedicellate fruits. The localities are interesting additions to the range of the species."

Leptospermum attenuatum J. Sm.

Darling Downs district, Q., Wyberba, C. T. White (flowering specimens), 13th October, 1933 (large shrub or small tree, very common; often forms dense thickets as second growth in paddocks).

Smith in his original description (Trans. Linn. Soc., London, Vol. III., p. 262) gave no locality record nor any indication as to where the specimen was obtained. I have not seen his type, but probably the common Port Jackson form represents it. The above specimens from Wyberba are a good match for this.

Leptospermum attenuatum J. Sm. forma.

Leichhardt District.—Ranges near Peak Downs, F.v.Mueller, Nov., 1858. Burnett District.—Biggenden, C. T. White, 7318 (flowering specimens), 13th October, 1930. (Shrub up to 2 m. high, moderately common on rocky places towards the top of Biggenden Bluff, alt. 2,000 feet, flowers white.) Eidsvold, Dr. T. L. Bancroft.

The Peak Downs specimens which I have been able to see through the courtesy of Mr. F. J. Rae have a label in addition to the official one of the National Herbarium (Melb.). This bears no heading, and the handwriting is unknown to me. They are named "*Leptospermum sericatum* Ldl. var. ? *pedunculatum*, ranges near Peak Downs, Dr. M., Nov., '58." The whole group is in need of revision with much more complete material. When better known *L. sericatum* Lindl. may be found a good species. Pieces of bark are included in Bancroft's specimens from Eidsvold, and these show the bark typical of *L. stellatum* Cav., under which Bentham included *L. sericatum* Lindl. I am not absolutely certain that all the specimens quoted above represent the same form.

Leptospermum attenuatum Sm. var. *subsessile* n. var.

Arbor parva, partibus novellis sericeis mox glabris. Flores singuli; pedicelli 1 mm. longi sericei. Calyx 3·5–4 mm. diam., tubo sericeo, lobis albidis, late triangularibus extus tenuiter sericeis, margine ciliolatis. Petala suborbicularia, 5 mm. longa, 4 mm. lata ad basem in unguem brevem contracta. Capsula parva, subsessilis.

Wide Bay District.—Moderately common in sandy soils in mixed xerophytic forest, Traverston, C. T. White, No. 6353 (flowering specimens), 6th October, 1929. (Tree up to 40 feet high and trunk 6 inches diam., with a close fibrous bark and very hard wood. Hervey Bay District.—Rosedale, common on sandy flats, estuarine sediments, L. G., Dovey, No. 988 (fruiting specimens), 26th May, 1937. (Small tree up to 25 feet.)

At first sight the above specimens seem quite distinct from *L. attenuatum* J. Sm., and when the *L. stellatum-attenuatum* series is revised may have to be raised to specific rank. The following are the chief differences:—

Young parts densely silky, the silkiness remaining for some time but gradually disappearing. Flowers single or in pairs. Pedicels 3-4 mm. Calyx tube and lobes both very densely sericeous, lobes triangular. Petals obovate, 4 mm. long, mostly about 2 mm. but sometimes up to 3 mm. diam. Fruiting pedicels 4-5 mm.	*L. attenuatum* (typical form)
Young parts sericeous, soon glabrous. Flowers single. Pedicels 1 mm. Calyx tube sericeous, lobes white, broadly triangular, outside thinly sericeous, margins ciliolate. Petals suborbicular, 5 mm. long, 4 mm. wide. Capsule small, subsessile ..	*L. attenuatum* var. *subsessile*

Myrtus dulcis sp. nov. (Plate VI.).

M. tenuifolia Sm. var. *latifolia* Maiden and Betche, Census N.S.W. Plants, p. 143, 1916.

Frutex 1–1·5 m. altus, ramulis junioribus pubescentibus angularibus, vetustioribus glabris, teretibus, cortice in filis deciduo. Folia ovata, ovato-elliptica vel ovato-lanceolata, supra glabra, subtus sericeis albis dense obsita vel glabra, margine leviter recurva; petiolus 1 mm. longus; lamina 1·5–2·5 cm. longa, 2·5–8 mm. lata. Pedicelli singulares, axillares, tenues, pilis sericeis obsiti, 3 mm.–1·1 cm. longi; bracteolae lineares, pilis sericeis paucis obsitae, 1 mm. longae. Calycis tubus dense sericeus, turbinatus, 2 mm. diam.; lobi 5, suborbiculares, extus glabrescentes, intus dense tomentosi. Petala suborbicullaria, 4 mm. diam., extus dense tomentosa, intus glabra. Stamina numerosa, filamentis glabris tenuibus leviter applanatis, ad 7 mm. longis. Ovarium ad apicem pubescens, stylo glabro. Bacca alba, nigro-punctata, dulcis; semina straminea nitida, sublenticularia 2 mm. diam.

This shrub is very common as undergrowth in the sandy forest lands of North-eastern New South Wales and South-eastern Queensland. Sometimes it grows in heavier forests a few miles inland, and most of the latter specimens seen by me have been of a more glabrescent character. The plant is characterised by its white berries marked with small blackish dots. It is familiarly known as Midgen Berry. It is represented in the Queensland Herbarium by a number of localities from Byron Bay in New South Wales to Fraser Island in Queensland. The following is a selection:—

New South Wales.—Byron Bay, E. Cheel; Cudgen, C. T. White, No. 9666 (very common on sandy hillsides, low shrub 1 m. high); Tweed Heads, Dr. F. H. Kenny.

Queensland.—Palm Beach, between Currumbin and Tallebudgera Creeks, C. T. White, No. 6506 (type, flowering specimens), Nov., 1929 (spreading shrub 1 m., leaves light green above, whitish beneath, flowers white); (fruiting specimens) sine number, April, 1928, shrub 1 m., common on sandy land, fruit white with small black dots, sickly sweet to taste); Pimpama, J. Shirley; Stradbroke Island, C. T. White; Moreton Island, C. T. White; Bribie Island, C. T. White; Mooloolah River, C. T. White; Eumundi. J. H. Simmonds; Cootharaba, W. D. Francis; Noosa Heads, C. T. White; Fraser Island, C. E. Hubbard, No. 4656 (shrub with spreading branches, leaves green above, grey-green below, young growth reddish, common in Eucalyptus forest on sandy slopes).

This plant is certainly very closely allied to *M. tenuifolia* Sm., but differs in its constantly broader, differently shaped leaves and somewhat larger flowers. In their original description Maiden and Betche state—"Bentham mentions the two forms of *M. tenuifolia* in the Flora Australiensis, but did not distinguish them as named varieties. The form common about Port Jackson and the Blue Mountains has from linear to very narrow-lanceolate leaves, and is a stiff, upright-growing, small shrub, generally found in the rocky beds of creeks; the variety *latifolia* has lanceolate to broad-lanceolate leaves, and is a spreading shrub generally found as undergrowth in the brush-forests of Northern New South Wales. Bentham knew the two forms only from herbarium specimens, and could not know their marked difference in habit."

Some time ago I sent specimens to the National Herbarium, Sydney, where they were examined by Mr. Cheel, who remarked that he thought the plant worthy of specific rank. Though it presents considerable variation in width of leaf and degree of pubescence, it can always be distinguished at a glance from typical *M. tenuifolia* Sm. It has also a different habitat and geographical range.

The accompanying plate shows *Myrtus dulcis* C. T. White from two localities compared with *M. tenuifolia* Sm. from the Port Jackson district, New South Wales.

Myrtus pubiflora sp. nov.

Frutex elatus, ramulis junioribus pubescentibus. Folia ovata vel ovato-lanceolata, apice acuminata, lamina 3–5 cm. longa, 1·5–2·5 cm. lata, petiolo 2 mm. longo, nervis lateralibus et vena intramarginali in sicco utrinque prominulis. Flores axillares singuli vel bini, pedicellis

2–4 mm. longis, pubescentibus. Calycis tubus dense hirsutus, subglobosus, 2–3 mm. diam., lobis 4, utrinque sericeo-hirsutis, angusto-triangularibus, 5 mm. longis. Petala 4, orbiculari-ovata, extus tomentosa intus glabra, 4 mm. diam. Stamina numerosa 4 mm. longa. Ovarium 2-loculare. Bacca 8 mm. diam.

Strathdickie, near Proserpine, Rev. N. Michael, No. 1476 (type: flowering specimens), 1497 (fruiting specimens). Strathdickie North, Ken Macpherson, No. 81 (flowering specimens), Aug., 1936. (Mr. Macpherson's specimens were received from the Herbarium, North Queensland Naturalists' Club, under No. 2742.)

Family Oenotheraceae.

Ludwigia prostrata Roxb.

Mossman, North Queensland, H. Flecker (flowering and fruiting specimens), 9th August, 1936, No. 2132. Erect herb, yellow flowers, growing in alluvial soil on bank of Mossman River. A plant with a wide range in the Indo-Malayan area, probably naturalised in North Queensland. Det. L. S. Smith.

Family Rubiaceae.

Plectronia odorata (Forst.) Hillebrand, Fl.

Hawaiian Island, 175 (1888), var. *reticulata* var. nov. Folia suborbicularia vel late obovata ad 9 cm. longa et 6·5 cm. lata, breviter petiolata, supra nitida, subtus pallidora et opaca, utrinque reticulata.

Thursday Island (E. Cowley, No. 10, type of the variety, flowering specimens); No. 29 (fruiting specimens; small tree, fruit black). A very distinctive-looking plant; unfortunately the flowers are too badly destroyed by insects to describe, but when better known may have to be raised to specific rank. The specimens were labelled by F. M. Bailey as a "form of P. odorata." They were seen by W. D. Francis when working at the Australian species of Plectronia at Kew, and he noted on the sheets "Canthium species aff. C. odoratum."

Spermacoce hispida L.

Cairns, Dr. H. Flecker, No. 1434, 21 February, 1936. Recumbent herb, growing near Esplanade, stems deep red, flowers white, pale mauve when faded.

Wendlandia connata sp. nov.

Arbor mediocris, ramulis junioribus saepe in sicco valde complanatis. Folia subcoriacea late lancelolatá apice obtuse acuminata, basi cuneata utrinque glabra costa et nervis primariis subtus excepta; nervi laterales subtus prominuli, in axillis foveolati; venae transversae immersae, sub lente vix manifestae; lamina 9–16 cm. longa, 3·5–6·5 cm. lata; petiolus 2-3 cm. longus; stipulae auguste triangulares in ramulis floriferis parviores, mox deciduae. Panicula terminalis, pedunculis ramulis pedicellisque pilis canescentibus obsitis, pedunculo communi 4-6 cm. longo. Flores primum albi deinde rosei; pedicelli 1·5-2 mm. pilis albis strigosis obsiti, bracteolis glabris 1-1·25 mm. longis. Calycis tubus subcylindricus, 3 mm. longus, pilis albis strigosis paucis obsitus; lobi 5, glabri, 2 mm. longi, in parte inferiore 2 mm. lati. Corolla glabra; tubus 3 mm. longus lobi oblongi, 3 mm. longi. Stamina exserta; filamenta in tubum connata, 4 mm. longa, ad basem tubi affixa, in parte superiore (apicem versus) pilis albis longis obsita; antherae basifixae, 3 mm. longae. Stylus 8·5 mm. longus; stigma capitata. Capsula subcylindrica, crustacea, 2-locularis, polysperma; sperma parva, testa rugoso-reticulata.

Mt. Spurgeon, in rain forest along creek bank, C. T. White No. 10663 (type: flowering specimens) Sept. 1936 (medium tree, flowers at first white, later pink, borne in great profusion). A. L. Merrotsy No. 35 (fruiting specimens) Feb. 1922 (shrub about 6 ft. high).

The specific name has reference to the stamens being united in a tube which is affixed to the corolla. On this account I had at first thought to make the species the type of a new genus, but the other characters are so much those of *Wendlandia* that I think it better to leave it in that genus.

Wendlandia urceolata sp. nov.

Arbor mediocris, ramulis novellis complanatis. Folia coriacea, late lanceolata vel elliptica, apice obtuse acuminata, basi cuneata, utrinque glabra, domatia in axillis nervorum subtus excepta; nervi praecipui subtus valde elevati; venae transversae sub lente prominulae; lamina 9-16 cm. longa, 5-7 cm. lata; petiolus 2·5-3 cm. longus. Panicula terminalis, pedunculis ramulisque roseis (Kajewski), subcomplanatis, in medio pubescentibus, lateribus leviter incrassatis, pedunculo communi 2-3 cm. longo. Flores sessiles, glabri, roseo-virides (Kajewski). Calyx: tubus 2·5 mm. longus; limbus 5-partitus, lobis late triangularibus vix 0·5 mm. longis. Corolla urceolata; tubus 1·5 cm. longus, lobi 5, parvi rotundi, apicem versus incrassati et intus infra apicem ipsum inflexi. Stamina 2 mm. longa, filamentis perbrevis, applanatis ad basem corollae affixis. Stylus cylindricus, 2 mm. longus, leviter striatus. Capsula subcylindrica, crustacea, 6 mm. longa.

Foothills of Mt. Bartle Frere, alt. 800 m., common in poor rain forest, S. F. Kajewski, No. 1349 (flowering specimens and a few old seed capsules) 1st October, 1936 (specimens gathered off small tree about 15 m. high, bark medium grey, light pink-brown when cut, no particular odour; young stems (branches of the panicle) bearing buds bright pink, buds pink-green.

Remarkable on account of its urceolate corolla, the lobes inflexed inside below the rounded apex. Though they have the appearance, as remarked by Mr. Kajewski, of being unopened, I think the flowers fully developed.

Family Compositae.

Centipeda thespidioides F. v. M.

Maranoa District.—St. George, J. Wedd. Nindigully, in red soil, R. H. Roe, July 1937.

Warrego District.—Murweh, R. Cameron, September 1916. Wedd's specimens were recorded by F. M. Bailey as *Coleocoma centaurea* F. v. M. This latter species should be deleted from the Queensland Flora until authentic specimens have been collected.

Cosmos caudatus L.

Kuranda, North Queensland. Dr. H. Flecker, No. 2046 (flowering and fruiting specimens, 19th July, 1936). Common weed 4 ft. high, pink flowers. Acclimatised in the Barron River Valley.

A native of Tropical America, but now widely spread over the tropics of the world.

Pterocaulon spheranthoides DC.

Received from Mr. T. H. Dowling, Oban Station, Mount Isa, 23rd December, 1935. (Determination by D. A. Goy.)

Helichrysum vagans sp. nov.

Frutex vagans virgatus, ramulis novellis albo-tomentosis, adultis glabris sulcato-striatis valde angulatis, angulis plerumque 5. Folia lineari-lanceolata supra glabra subtus albo-tomentosa vel rarius glabrescentia, 2·5-4 cm. longa, 4-5 mm. lata, trinervia, nervis lateralibus saepe indistinctis sed sub lente plerumque visibilibus. Capitula parva in paniculas compactas (1-2·5 cm. diam) terminales disposita. Involucra late campanulata 3 mm. longa 3 mm. lata, bracteis numerosis scariosis. Flosculi ca. 12. Achenia glabra cylindracea, pappi setis 2 mm. longis tenuiter barbellulatis ad basim coalitis.

Queensland.—Lamington National Park, Macpherson Range, alt. 1,000 m., C. T. White Feb. 1920 (type; scrambling scrub 2 m. high, common on edge of rain-forest). Springbrook C. T. White No. 8226, October 1931 (Shrub of straggling habit, 2 m. high, common on edge of rain-forest).

New South Wales.—Murwillumbah, W. Forsayth (ex Nat. Herb. Sydney). Mount Warning, L. J. Brass and C. T. White Jan. 1938 (straggling shrub common on edge of rain-forest).

This shrub is very common on the higher parts of the Macpherson Range and its offshoots in south-eastern Queensland. Some time ago I sent specimens to the National Herbarium, Botanic Gardens, Sydney, where they were reported on by Mr. W. F. Blakely who said that he recognised the plant at once as one that was in the *H. Beckleri* box in that Herbarium. He had put it aside meaning to work out the determination, but having greater interest in other plants he had not bothered to draw up a description of it as a new species. The species is most closely allied to *H. Beckleri* F. v.M. which is also a very common species in many of the mountain ranges of south-eastern Queensland and northern New South Wales. In their habits the two species are very distinct, *H. Beckleri* being an upright growing shrub and *H. vagans* a shrub of very straggling habit mostly growing on the edge of rain-forest. *H. Beckleri* is very common as secondary growth in rain-forest clearings in mountain localities. In this stage it is an intricately branched shrub with very small leaves green on the upper surface and clothed with white cottony wool on the under. *H. vagans* is not so common as secondary growth but is frequently seen on the edge of new clearings. It is a straggling shrub in its younger stages with leaves up to 6 cm. in length. The two species may be characterised as follows:—

Upright shrub. Juvenile leaves very small, 2-5 mm. long. Branchlets terete or nearly so, usually tomentose. Leaves mostly about 1·5 cm. long and 4 mm. wide .. .. *H. Beckleri*

Shrub of straggling habit. Juvenile leaves narrow-lanceolate, up to 6 cm. long. Branchlets very angular, usually quite glabrous or nearly so in the adult stage. Leaves somewhat variable, mostly 3-4 cm. long and 4-5 mm. broad .. .. *H. vagans*

Family Myrsinaceae.

Ardisia fasciculata sp. nov. (Subgenus Tinus.)

Arbor parva, ramulis robustis. Folia coriacea, late lanceolata vel anguste obovata, basi acuta, apice subobtusa, nervis lateralibus in sicco utrinque visibilibus vix sed prominulis; petiolus crassiusculos teres 1–2 cm. longus; lamina 7–10 cm. longa, 3–4 cm. lata. Inflorescentiae 3–6-florae, glabrae, in fasciculos axillares dispositae; pedicellis crassis angularibus ca. 7 mm. longis. Calyx late campanulatus, 3 mm. diam., lobis suborbicularibus atropunctatis. Corrollae lobi brevi, alte connati, crassi (in albastro modo visi). Stamina corolla aequilonga, antheris anguste ovatis, filamentis brevis applanatis, ovarium glabrum, conicum, stylo brevissimo.

Mt. Spurgeon, C. T. White No. 10673 (flowering specimens), Sept. 1936 (small tree in rain-forest).

A very distinctive species. Unfortunately I was able to get only very limited material. The flowers available are a few in the bud stage, and others with the corollas shed. From the appearance of the bud one gets the impression that they may fall off in a calyptrate fashion; this can only be proved, however, by observation in the field or by the collection of more material. Among Australian species it is most closely allied to *A. brevipedata* F. v. M. and *A. pachyrachis* F. v. M., which are both distinct in the pedunculate inflorescence with more slender pedicels and fewer flowers.

Family SAPOTACEAE.

Sideroxylon euphlebium F. v. M. var. *cryptophlebium* var. nov.

Folia coriacea, supra in sicco opaca, nervis secundariis et tertiariis in foliis novellis supra leviter impressis in foliis adultis paene invisibilibus, subtus visibilibus sed vix prominulis. Flores solitarii vel bini in axillis foliorum.

Mt. Spurgeon, C. T. White No. 10655 (flowering specimens) Sept. 1936. (Medium tree, on hillsides in rather dry rain-forest; very hard wood.)

I had drawn up a description of this tree as a new species, but the leaf-shape, the robust branchlets and the ferruginous tomentum of the young shoots are so much the characters typical of *S. euphlebium* F. v. M. that I felt that at most it could only be regarded as a variety. *S. euphlebium* is represented by several sheets in the Queensland Herbarium but only in fruit, and flowers were imperfectly known to Mueller. The flowers in this variety are solitary or in pairs not in clusters as described by Mueller, but this character may be variable.

Family SYMPLOCACEAE.

Symplocos ampulliformis sp. nov.

Arbor parva, ramulis junioribus subangularibus. Folia late lanceolata, in sicco subchartacea, apice acuminata, basi cuneata, margine leviter recurva undulata; costa media supra impressa, subtus elevata; nervi laterales distantes, utrinque 4–5, venis et venulis prominulis; petiolus 0·5–1 cm. longus; lamina 6–12 cm. longus, 2·5–5 cm. latus. Inflorescentiae (simplices vel ad basem ramosae ?), in axillis inferioribus vel in axillis defoliatis infra folia dispositae; *rhachis 0·5–1 cm. longa. Fructus ampulliformis, 1–1·2 cm. longus, in parte inferiore 5–6 mm. diam.

Mount Spurgeon, common in rain-forest, C. T. White, No. 10581 (fruiting specimens), September, 1936 (small tree, fruits green).

* The specimens are in fruit only, and it is difficult to say whether the racemes are simple or bear very short branches simulating pedicels. When a longer branch is borne this is situated at the very base, and has the appearance of a second slightly shorter raceme from the axil.

In the absence of flowers it is difficult to assign this species to its correct place in the genus. I should say it belongs to the Section Bobua (DC.) Brand, and its closest affinity among Australian species is with *S. Thwaitesii* F.v.M. It is still closer to *S. aneityensis* Brand, but differs from both. The racemes are only as long as or little longer than the petioles and are borne in the lower leaf-axils and usually below all the leaves, not crowded in the upper axils and often pseudo-terminal as in the two species mentioned.

Symplocos Stawelii F. v. Muell. Fragm. Phytogr. Austr. v. 60. (1865) var. *montana* var. nov.

Folia parva (3.5–6.5 cm. longa, 1–2 cm. lata). Inflorescentia valde reducta 3–7–flora, spicata, pseudo-spicata vel ad basem breviter ramosa.

Mount Bartle Frere, H. Flecker, No. 857 (flowers), 7th October, 1935.

At first glance one would take this to be a distinct species, but on closer examination I feel it is only a reduced mountain form of *S. Stawelii* F. v. M. Both leaves and flowers dry a deep yellow. The inflorescence is very much reduced and is either a simple spike or with one or two short branches at the base or with 1–2–flowered very short branches in the lower part. The branches in this case may easily be mistaken for pedicels like the very short secondary branches in the compound inflorescence of *S. Stawelii* F. v. M.

Family Oleaceae.

Linociera Sleumeri comb. nov.

L. coriacea C. T. White, Proc. Roy. Soc. Queens., Vol. 47, 20, 1936.

Dr. H. Sleumer, of the Botanic Gardens and Museum, Berlin, writes me that there is already a valid name, *L. coriacea* Vidal Rev. Pl. Vasc. Filip. (1886), 181. I have pleasure in naming the plant now after Dr. Sleumer, who has helped me considerably with Queensland and Pacific Islands Oleaceae and other plants.

Family Solanaceae.

Solanum dimorphispinum sp. nov.

Frutex 3–4 m. altus; rami pilis stellatis dense tomentosi, aculeis rectis vel recurvis 2–3 mm. longis a latere compressis armati; internodia 7–9 cm. longa. Folia plerumque ad nodos bina; petioli 2–2·5 cm. longi, sicut rami pilis stellatis tomentosi et aculeis muniti sed aculeis tenuioribus rectis et ad 4 mm. longis; lamina elliptica repanda vel raro subintegra, apice acuta 12–18 cm. longa, 5·5–7 cm. lata, supra glabra inermis vel aculeis rectis ad 8 mm. longis paucis armata, subtus breviter et dense albo-tomentosa, in costa media basem versus aculeis rectis 1–2 armata. Inflorescentia simpliciter racemosa, inermis ca. 7–flora; rhachis ad 2 cm. longa dense stellato-tomentosa; pedicelli apicem versus racemi conferta, ad 1·5 cm. longi, tenues, apicem versus incrassati sicut rachis dense stellato-pubescentes. Calyx campanulatus, extus dense stellato-tomentosus, 5-costatus, intus glaber, 1 cm. diam. Corolla violacea, campanulato-stellata, ca. 2 cm. diam., in lobos lanceolatos 5 divisa; lobi extus dense tomentosi intus in parte superiore pilis stellatis paucis obsiti; membranea inter petala glabra. Stamina glabra; filamenta brevia, applanata; antherae 6 mm. longae. Ovarium pilis stellatis crebis obsitum.

Mount Spurgeon, common along tracks and on the edge of clearings in rain-forest, C. T. White, No. 10619 (flowering specimens), September, 1936 (large straggling bushes, 3–4 m. high, flowers mauve).

Very close to *S. hamulosum* C. T. White, but can be distinguished as follows:—

Prickles all recurved and stout (except on the upper surface of the leaves); leaves 8-11 cm. long, 4-5 cm. broad, densely clothed with short stellate hairs above, paler and densely and loosely stellate-tomentose beneath .. .. .. *S. hamulosum.*

Prickles slender and straight on leaves and young stems, recurved on older stems. Leaves 12-18 cm. long, 5·5-7 cm. broad, glabrous above, white and densely and very shortly tomentose beneath .. .. *S. dimorphispinum*

Family SCROPHULARIACEAE.

Linaria Elatine Miller. Pointed Toad Flax.

Kangaroo Point, Brisbane. L. S. Smith, No. 372 (flowering specimens), 5th December, 1938.

A native of Europe, naturalised in the Southern States, but not previously recorded for Queensland.

Family ACANTHACEAE.

Graptophyllum Thorogoodii sp. nov.

Frutex intricate ramosus; ramulis spinosis, spinis tenuibus ca. 1 cm. longis; ramulis junioribus angulatis, breviter pubescentibus. Folia perbreviter petiolata, 1·5–2·5 cm. longa, 0·5–1 cm. lata, lanceolata vel elliptico-lanceolata, margine remote dentata. Flores 3–3·7 cm. longi, axillares, solitarii; pedicello tenui 6–10 mm. longo; calycis lobis linearibus, acutis, 6–8 mm. longis; corollae tubo 1·8–2·5 cm. longo; limbo bilabiato, lobis duobis superioribus (labio superiore) 10 mm. longis, lobis tribus inferioribus (labio inferiore) 12 mm. longis. Stamina exserta, stylo subaequalibus. Ovarium 5 mm. longo; stylo tenui, stigmata minute bilobo.

Kelsey Creek, near Proserpine, H. Thorogood (No. 1, received March, 1937), flowering specimens (shrub, grows in a thick mass almost impossible to penetrate; limbs often take root where they touch the ground; main flowering time seems to be May, June, and July.)

The present species has all the vegetative characters of *G. spinigerum* F. v. M., but the flowers in that species are several on very short pedicels in the axils of the leaves, not solitary on long, slender pedicils, and the flowers are at most only half the size of the new species. When better known *G. spinigerum* may be found to possess more than one type of inflorescence and flower, and the present species may have to be reduced to a synonym or at most to a variety.

Type at Brisbane.

Family PLANTAGINACEAE.

Plantago coronopus Linn.

Manly, Moreton Bay. C. T. White, No. 10740, June, 1936.

Common as a weed along the esplanade in made-up land.

These specimens have been determined for me at the Royal Botanic Gardens, Kew, and have been identified as the subspecies *commutata* (Guss.) Pilger.

Family Chenopodiaceae.

Atriplex elachophyllum F. v. M.

Gregory North District: Glenormiston. A. C. Boyle, 28th January, 1935.

New for Queensland. (Determination by S. L. Everist.)

Kochia ciliata F. v. Muell. Rep. Babb. Exped. 20.

Maranoa District.—Noondoo Station, via Dirranbandi, S. L. Everist, No. 767, 14th December, 1934; small herb from a woody base, not common. Between Warkon and Surat, B. A. Smith, No. 13; Nindigully, R. Roe, No. 13, July, 1937. In hard red soil. Det. W. D. Francis. Not previously recorded for Queensland.

The Noondoo specimens possessed a slight thickening of the upper rim of the perianth, and it was thought at first that it might be *K. coronata* J. M. Black. Specimens of both the Noondoo plant and the Surat plant were forwarded to Mr. J. M. Black, who replied that Mr. Smith's specimen was typical *K. ciliata,* and, though the Noondoo specimen showed a slight thickening of the upper rim of the perianth, he could find nothing like the conspicuous crown possessed by his *K. coronata,* and he would place it under *K. ciliata.* Both species are well figured by Mr. Black in his "Additions to the Flora of South Australia, No. 11," in Transactions and Proceedings of the Royal Society of South Australia, Vol. 41, 1917. Both illustrations are reproduced in his Handbook of the Flora of South Australia.

Kochia coronata J. M. Black in Trans. Roy. Soc. Sth. Aus. XLI., 43. Pl. IX. (1917).

Currawilla, J. Mann. Not previously recorded for Queensland. (Determination by W. D. Francis.)

Blackall.—S. L. Everist, February, 1938. Very common on edge of claypans. (Determination by S. L. Everist.))

Family Lauraceae.

Endiandra rubescens Blume ex Miq. Plantae Jungh. 176.

E. montana C. T. White Contr. Arn. Arb. IV. 36 (1933)).

Mount Alexander; alt. 1,300 m. Common in poor scrub on top of the mountain. S.F. Kajewski No. 1497 (flowering and fruiting specimens), 18th Dec., 1929. (Small, twisted, and gnarled tree up to 6 m. high; flowers cream; fruit yellow when ripe, slightly flattened on both sides.)

When looking through some non-Australian specimens of Lauraceae I was struck with the similarity of some specimens from Buitenzorg, labelled *Endiandra variabilis* Meissner (Winckel No. 1792B) and determined by Dr. Camerloher with my recently described *E. montana* from North Queensland. As I could not find the name *E. variabilis* in literature, I wrote to Buitenzorg and got a reply from Dr. Van Slooten as follows:—

"*Endiandra variabilis* Meissner was given (on the label only) by Dr. Camerloher (who studied only the genus Cinnamomum) for *Dictyodaphe variabilis* Meissner, and not published by him. In the Buitenzorg Herbarium this species is represented by one specimen only (from Java), a duplicate of which you possess."

The Queensland specimens seem to be an exact match for the Javanese, and I think there is no doubt about the identity of the two species. As most botanists regard *E. variabilis* as only a synonym of *E. rubescens* Blume, the Australian plant is now recorded as above.

Family PROTEACEAE.

Orites racemosa sp. nov.

Arbor elata, partibus novellis ferrugineo-pubescentibus mox glabris; ramulis robustis. Folia lanceolata, apice acuta, basin versus in petiolum gradatim angustata, coriacea, cum petiolo 8–15 cm. longa, 2–3 cm. lata; costa media supra leviter impressa, subtus leviter elevata, nervis secundariis plerumque indistinctis. Racemi axillares ca. 9-flori, 2·5–3 cm. longi; rhachibus pedicellis bracteisque pubescentibus; pedicellis 2·5–3 mm. longis; bracteis linearibus 2 mm. longis. Petala linearia, tenuiter pubescentia, 4 mm. longa, 1·75 mm. lata (vix matura in alabastro modo visa). Stamina libera vel ad basin petalorum affixa; filamentis applanatis 1·75 mm. longis, in connectivum latum inter antherae loculos productis; antheris 1·75 mm. longis. Ovarium in parte inferiori pilis longis obsitum. Folliculus sublignosus, applanatus, margine incrassatus, 4·5–5·5 cm. longus, apice rostratus, basin versus in stipitem angustatus; seminibus 2, compressis, ala membranacea alba cincta; ala ipsa ad apicem profunde emarginata; placenta compressa lignoso-spongiosa.

Mount Spurgeon, C. T. White, 10621 (nearly mature flowers and seed capsules—mostly open), Sept., 1936 (large tree in rain-forest).

Distinguished from all previously described species by its flowers single in the axils and on distinct pedicels. The flowers, though only collected in the bud stage, were nearly mature. Type in Queensland Herbarium, Brisbane. Co-type specimens at Arnold Arboretum, U.S.A., and Royal Botanic Gardens, Kew (Eng.).

Family EUPHORBIACEAE.

Actephila Mearsii sp. nov.

Arbor ad 20 m. alta, ramulis robustis. Folia supra atroviridia, subtus pallidiora, margine subremote crenato-dentata, petiolo 2 cm. longo, apicem versus incrassato; lamina 7–14 cm. longa, 2·5–5 cm. lata; nervis lateralibus tenuibus in utroque latere 7–8, in sicco utrinque visibilibus sed subtus prominentioribus. Pedicelli (in fructu modo visi) 2·5–5 cm. longi, apicem versus gradatim incrassati, recti vel curvati saepe valde recurvati. Sepala non-visa. Petala (vel glandula petaloidea) 5, persistentes crassa dura 1·5 mm. longa. Capsula globosa vel ovoidea 4 cm. diam., pericarpio lignoso, 1·5 mm. crasso, extus griseo, leviter ruguloso, intus stramineo; endocarpi cartilagineo; semina ovoidea arillo spongioso-pulposo rubro involuta cum arillo ca. 2·5 cm. longa, 2 cm. lata; sine arillo ca. 2 cm. longa, 1·5 cm. lata; testa cartilaginea, straminea.

Millaa Millaa, J. E. Mears (leaves and unripe fruits), Dec., 1937 (type: ripe fruits and seeds), Feb., 1938. Gadgarra, alt. 800 m., common in rain-forest, S. F. Kajewski, No. 1139 (empty seed capsules), 24th July, 1929 (medium-sized tree, up to 20 m. high, leaves dark green).

Mr. Mears wrote under date 18th December, 1937, as follows:—"I am sending you some unripe nuts, and will send on some more as soon as they are ripe (early February). They are soft-shelled, very sweet and palatable, but of course I should be afraid to eat them, but the opossums get them very quickly; very prolific, it's the only patch I know of on the Tableland.'' And later, under date 11th February, 1938: ''Herewith please find nuts as you desired—the best I could get. The birds eat them as fast as they ripen.''

It is very distinct from previously described Queensland species, and is a notable plant. It is most closely allied to *A. grandifolia* Baill., which differs in its entire or nearly entire leaves on shorter petioles, and much smaller seed capsules on shorter pedicels. I have not seen an arillus developed in the seed of *Actephila* before, but it is a feature that would be hard to observe on a dried seed.

Beyeria viscosa Miq. var. *obovata* var. nov.

Frutex 2 m. altus; partibus novellis viscosis; ramulis junioribus angulatis, complanatis. Folia plana, obovata vel spathulato-linearia, apice obtusa vel leviter emarginata, basi cuneata in petiolum gradatim angustata; lamina 3–4 cm. longa 1–2 cm. lata.

Torrens Creek, C. T. White, 8731 (female flowers and capsules), 19th March, 1933 (shrub 2 m., growing on rocky sandstone hills).

I had at first drawn up a description of this as a distinct species, for the general appearance is different from that of typical *B. viscosa* and its described varieties. Apart from the broader leaves, however, and the total lack of viscosity except in the very young leaf-buds, it shows no essential differences.

Type of the variety at Queensland Herbarium, Brisbane. Co-type material at Royal Botanic Gardens, Kew (Eng.), and Arnold Arboretum, Boston (U.S.A.).

Bertya oleifolia Planch. in Hook. Lond. Journ. Bot., IV., 473, tab. XVI., fig. 1, 1845, var. *glabrescens* var. nov.

Folia demum supra glabra, lineari-lanceolata 4–7·5 cm. longa, 2–4 mm. lata. Bracteae stellato-tomentosae. Flores glabri. Ovarium glabrum.

Eidsvold, Dr. T. L. Bancroft (type of the variety); Copperfield, G. Smith.

A rather distinctive plant which, when better known, may have to be raised to specific rank. There are two very small specimens from Copperfield; one is an exact match for the Eidsvold plant, the other is the typical form with densely hairy ovary.

Euphorbia hypericifolia L.

Trinity Beach, in sandy soil.

H. Flecker, 26th March, 1937 (North Queensland Naturalists' Club, No. 2942).

A common tropical species, not previously recorded for Queensland.

Family LILIACEAE.

Rhipogonum papuanum C. T. White, Proc. Roy. Soc. Queens., Vol. 34, p. 19, 1923.

R. album, R.Br. var. leptostachya Benth. Fl. Austr., Vol. VII., p. 9, 1878.

Papua Bet. Kubunah and Fofofofo, C. T. White, No. 687, August, 1918.

Left Bay, N. S. Wales. 3. *M.*
tenuifolia S

Myrtus dulcis C. T. White and *M. tenuifolia* Sm.

Left to Right.—1. *M. dulcis* C. T. W., Eumundi, Q., 2. *M. dulcis* C. T. W., Byron Bay, N. S. Wales. 3. *M. tenuifolia* Sm., Mossman, Port Jackson, N. S. Wales.

Queensland.—Rockingham Bay, J. Dallachy. Whelanian Pools, Bellenden Ker Range, F. M. Bailey. Atherton, C. T. White. Tarzali, C. T. White. Malanda, C. T. White.

Family GRAMINEAE.

Hierochloe rariflora Hook.

Lamington National Park, common in heavy Eucalyptus and Casuarina forest, C. T. White, No. 11,163, 22nd October, 1934.

Lagurus ovatus L., Hare's Tail. Farm School, St. Lucia, Brisbane River. C. T. White, 11160, 30th November, 1934, subspontaneous.

A native of Southern Europe, cultivated as an ornamental grass. It is completely naturalised in the Southern States.

Neurachne Muelleri Hackel.

Frazerborough, Jundah, E. M. Bowman.

Neurachne Munroi, F. v. Muell.

Wittenburra Station, 36 miles south of Eulo. S. L. Everist and L. S. Smith, No. 64, 7th January, 1937. Fairly common on hillside.

I am indebted to the Director and Government Botanist (Mr. F. J. Rae), Botanic Gardens and National Herbarium, Melbourne, for the determination of the above species of Neurachne. Mr. Bowman describes *N. Muelleri* as an excellent fodder.

Themeda quadrivalvis O. Ktze.

A native of India, naturalised in Fiji and not previously recorded for Australia. Collected at Habana, 14 miles north-east of Mackay, September, 1935, by J. P. Kahler, who makes the following remarks:—

"Grows in dense patches, not very common. In paddocks cattle keep it down. Tall, up to 5 ft."
(Determination by S. L. Everist.)

A Monograph of the Genus Eleocharis in Australia and New Zealand.

By S. T. BLAKE, M.Sc., Walter and Eliza Hall Fellow in Economic Biology, University of Queensland.

(*Read before the Royal Society of Queensland, 28th November, 1938.*)

PLATES VII. TO X.

The Australasian, and more particularly the Australian, species of *Eleocharis*, in common with many other genera of *Cyperaceae*, seem never to have been properly understood, and for a long time the genus has been in a state of hopeless confusion. As the result of a prolonged examination of a very large series of specimens, both in the field and in the herbarium, a clarification of the situation has been possible, and the results are presented in this paper. Not only have I been fortunate in being able to study all but one of the Australian species in the field, but also in that nearly every collection in Australia has been made available to me, and for this I wish to express my sincere thanks to the following:—Mr. C. T. White (Queensland Herbarium, Brisbane), Mr. R. H. Anderson (National Herbarium of New South Wales, Sydney), Mr. F. J. Rae (National Herbarium of Victoria, Melbourne), Mr. J. M. Black (Adelaide), Miss C. M. Eardley (Tate Herbarium, University of Adelaide), Professor J. B. Cleland (University of Adelaide), Mr. C. A. Gardner (National Herbarium of Western Australia, Perth), while Dr. H. H. Allan (Plant Research Bureau, Wellington) has donated a collection of New Zealand specimens. I am further indebted to Dr. J. Mattfeld, of the Botanischer Garten und Botanisches Museum, Berlin-Dahlem, for the donation of portions of type material, to Sir Arthur W. Hill, Director of the Royal Botanic Gardens, Kew, for copies of descriptions in works unavailable to me and for advice on nomenclature, and to Dr. A. B. Walkom, secretary to the Linnean Society of New South Wales, for a copy of a description.

Finally I wish to express my very deep gratitude to Dr. H. K. Svenson, of the Brooklyn Botanic Gardens, New York, who for some time past has been engaged in monographing the entire genus. His ready and kindly criticism, his assistance in determination and donation of specimens and in placing at my disposal copies of sketches and notes of specimens in the herbaria at Kew and the British Museum have very materially assisted in the preparation of this paper.

THE REVISION.

Eleocharis R. Br. Prodr. 224 (1810) (Cyperaceae-Scirpoideae-Scirpeae).—Spikelet solitary, terminal, erect, ebracteate, few- to many-flowered; glumes spirally imbricate, rarely more or less distichous; flowers hermaphrodite: perianth of 0–10 hypogynous bristles, style 3–2-fid, stamens 3–2–1, nut crowned by the persistent enlarged base of the style.

Annual or perennial leafless herbs frequently producing slender stolons sometimes bearing tubers, or descending or creeping rhizomes. Culms tufted or in a linear series, straight or arcuate or rarely flexuose, commonly trigonous to terete, sometimes fluted or angular-striate, often acutely 3–4–5-angled, occasionally compressed or more rarely flattened (often spuriously so in the dried state), frequently pitted, sometimes prominently transversely septate; leaf-sheaths 1 or more, herbaceous, membranous, or scarious, the appressed or dilated orifice horizontally truncate to very oblique when viewed from the side, often thickened at or immediately below the margin and frequently bearing a short, erect mucro or more rarely a lanceolate point (rudimentary lamina), or scarious and then often marcescent; spikelet very variable in size and shape from globular to linear-cylindrical, from somewhat narrower to very much wider than the culm, sometimes flattened when laxly-flowered, sometimes appearing spirally angular when dry or over-mature; glumes appressed or spreading in fruit, sometimes relatively persistent, often readily deciduous with the spikelet continuing to grow out after the lower ones have fallen, usually membranous, often with hyaline more or less scarious margins, 1-nerved and more or less distinctly keeled or else the back broad, flattened, cartilaginous to coriaceous or herbaceous, and closely striate with fine nerves on each side of the mid-vein, 1–2 lowermost often sterile, more rigid in texture, often rather different in size and shape and usually more persistent than the others; style short or long, flattened to filiform in the upper part, usually quite glabrous below the filiform, usually fimbriate stigmatic branches, the lower part (style-base) thickened, and persistent on the fruit; anthers ovate or oblong to narrow-linear, the connective frequently produced beyond the cells into an oblong, triangular, or setaceous appendage; nut most frequently obovate to nearly orbicular in outline, less commonly pyriform or narrow, often contracted immediately below the apex into a distinct neck, lenticular (plano– or biconvex) to triquetrous in transverse section, the margins or angles often prominently costiform and then usually paler in colour than the sides, which may be smooth, pitted, wrinkled, reticulated, cancellate, or longitudinally striate or ribbed and transversely trabeculate, depending on the size, shape, arrangement, and prominence of the margins or corners, of the external cells, which themselves may be hexagonal, rounded, transversely oblong to linear or vertically oblong or almost square, and are usually arranged in more or less regular vertical series, often also in regular horizontal series, rarely without any definite arrangement: sometimes also longitudinal furrows may be present on one or more faces, chiefly the adaxial, often due to the pressure of the hypogynous bristles; style-base variable in size, shape, and colour, sometimes very small and continuous with apex of nut and not readily distinguishable from it, usually very distinct and often with a horizontally straight or variously curved thickened annulus at the line of junction often paler in colour than the remainder, which may be more or less spongy and is sometimes minutely hispid; hypogynous bristles stout or slender, more or less strongly flattened or filiform, free to the base or connate in the lower part, smooth or scabrous or barbellate or rarely subplumose with retrorsely or rarely antrorsely directed small teeth, sometimes caducous as the flowering advances, frequently absent from the first and in this respect sometimes variable in the same species.

The name has been very frequently spelt *Heleocharis,* and this is the spelling which has been most used in Australia. It is not proposed to discuss the subject here. It has been thoroughly treated by Sprague[1] and by Svenson[2], and besides Sir Arthur Hill has informed me in a recent letter that the legally correct spelling, *Eleocharis,* is to be conserved against the emended spelling of Lestiboudois. In the present paper the example of most authors has been followed in treating the two spellings as trivial variations of the same name.

Subdivisions of the genus have generally been based on the relative width of spikelet and culm and then on the number of style-branches (2 or 3) with an accompanying flattened or trigonous nut. Such an arrangement was employed in the Flora Australiensis, and by more recent Australasian authors, but it is very artificial. The width of culm relative to the spikelet is often an illusory character, and if strictly applied would at times separate closely related species. Then very many species with trifid styles have lenticular nuts. This occurs in nearly half of our species. Many other characters vary considerably within small groups of closely related species, and sometimes even within a species itself. While the following remarks apply chiefly to the Australasian species, they are in general applicable throughout the genus.

The culms often vary considerably in diameter, and this variation may have no correlation with the length. Very often a second growth following a burn, severe grazing, or other such catastrophe, produces unusually slender culms. Generally speaking the outline in cross section is fairly constant, though occasionally an extra, usually ill-defined angle may be produced on unusually robust culms. The degree of pitting or wrinkling may vary considerably, but is often due to irregularities in drying. During drying also the sharpness of angles is often accentuated, while pressure may tend to obliterate others. The presence or absence of transverse septae appears to be quite constant, at least within a species. The nature of the uppermost leaf-sheath is relatively constant, sometimes throughout entire groups, though at times closely similar species may be quite different in this character. In species where the sheath is commonly horizontally truncate at the orifice a slight obliquity may occur in some specimens, while the mucro present in all such Australasian species may vary in development. Where the orifice is constantly oblique it may be somewhat lanceolate when flattened, often with a short obtuse point or mucro. Variations may occur on the same plant. The spikelet within a species is often fairly constant in shape and size, but usually varies within more or less well-defined limits. When in fruit, irregularities in pressure, &c., during drying often produce quite different configurations in spikelets of the same species, due chiefly to the degree to which the glumes may spread. The glume may also tend to become somewhat incurved along its length, and to this is due the spirally angular spikelet mentioned above. In the living state such spikelets are terete or nearly so. The glumes may vary considerably in size and shape, even in the same spikelet. A common tendency is for the upper glumes to become narrower and more acute as the apex is approached, while concurrently the keel tends to disappear at a greater distance from the tip. The number of style-branches is in general constant for each species, though accidental states occur in which a reduced number is to be found, as in *E. pallens.* The number of stamens is usually constant in each species. The anthers often vary considerably in length, but the shape, nature, and size of the appendage

[1] Kew Bull. 1928, 352.
[2] Rhodora xxxi., 122-3 (1929).

is nearly constant. It should be pointed out, however, that the anthers are readily damaged, particularly the often delicate appendage, and in fruiting specimens are often difficult to find intact. In most specimens in the older collections they have disappeared. Where flowering material only is available, the anthers, and particularly the appendage, sometimes offer the readiest means of distinguishing certain species. The hypogynous bristles, upon which much emphasis has at times been placed, are often quite variable either in number or degree of development, or both. In many species they are regularly absent. In *E. nuda* they are present in flower, but fall away before the fruit matures. In *E. pusilla* and some extra-Australasian species they may be present or absent in the same species. When constantly present they are usually 6 in number, but due to branching of the one on the adaxial face of the ovary and nut the number may be as great as 10 (*E. sphacelata*). Likewise reduction may occur, and, in some species with normally well-developed perianth, specimens are occasionally seen in which the bristles are few, unusually slender, and then short and irregular in length. The mature nut is usually the most characteristic feature of a species. Variations in shape, colour, lustre, and degree of surface marking sometimes occur, but usually within very narrow limits. The presence or absence of costiform margins or angles is a well-defined and important feature in the Australasian species. Such slight variations in surface markings as occur are usually due to the extent of a slight thickening which sometimes takes place at the line of junction of the external cells, particularly at the corners. In a few species the shape of the actual cells varies somewhat, due to a tendency towards a slight lengthening or shortening of the prevailing form. The most pronounced variations are in the absolute dimensions, and in the degree of turgidity of lenticular nuts. The style-base in its general characteristics is relatively constant, often through whole groups, although in detail it may vary widely within a species. Variations in shape are connected with two quite independent features. In the first place, the length, whether relative to the nut or absolute, sometimes varies considerably; and in the second place the degree of rounding at the base may greatly affect the form of the style-base. When the latter is carried to extremes the style-base may appear more or less stipitate on the nut, whether the latter has an expanded apex or not. Generally speaking the style-base on a trigonous nut is distinctly pyramidal at the base, though it may be dorso-ventrally compressed in the upper part, while that on a lenticular nut is strongly compressed. Occasionally, however, in those species with a trifid style and a lenticular nut, the style-base shows a median line or a more or less distinct ridge on the abaxial side.

Svenson's distribution of the species in Rhodora xxxi., pp. 127-129 (1929), is without doubt the most natural arrangement yet proposed. The old genus or subgenus *Eleogenus* (*Heleogenus*) becomes his first series *Mutatae*, while he has distributed the remainder among ten series relying on combinations of characters drawn from the number of styles, the colour, surface markings (and therefore the shape of the external cells), and shape in transverse section of the nut, the style-base, and the nature of the orifice of the leaf-sheath.

Since this paper was published, however, it has been found necessary to modify this arrangement somewhat, and an increase in the number of series is to be expected. One such new series is proposed in the present paper to receive *E. acuta* and its allies. Otherwise, except for a slight rearrangement in the order of the series, that arrangement is followed here.*

Throughout the work a binocular dissecting microscope was employed. For general examination and for drawing up the greater part of the descriptions a magnification of 20x–25x was used. This was supplemented by a study under a magnification of 40x–45x of the small species, details of the anthers in all species, of the external cells of the nuts, or to verify any other character which may be obscure under the lower magnification. The shape of the glumes given is that shown when the glume is flattened as much as possible without splitting it. The dimensions in the descriptions apply to the great majority of specimens, exceptional cases being noted in the discussion following these. I have differed from Svenson's method of giving the length of the nut together with style-base, by giving each separately, as the latter seems to give greater accuracy.

The Australasian species are mostly fairly well defined, and specimens should be readily determinable if good material is to hand. Fruiting material is preferable, and if such is available a magnification of 15x–20x should suffice when using the key. In most cases flowering material should be determinable, particularly if the base of the plant is present. Great care is required in measuring anther-tips. A magnification of about 40x is usually necessary, and care must be taken that the tips are not damaged.†

All the specimens cited have been actually examined unless expressly stated to the contrary. In the citation of specimens attention has been paid to geographical distribution. Generally speaking, the localities have been arranged in a general west-east and north-south direction.

The characteristic habitats of most species are wet, muddy places along stream banks or in swamps, often in water up to 2 ft. in depth. The annual species are frequently found on the edges or dried-out beds of lagoons, streams, &c. While the greatest concentration of species occurs in the regions of higher rainfall, one, *E. pallens,* is restricted to the more arid regions.

The perennial species have some fodder value, while pigs thrive on the tubers of *E. dulcis*. The latter are also edible to man, are collected by the Australian aborigines, and are largely cultivated in the Orient.

The bibliographical references are mostly confined to the original publications of the name-combinations (including synonyms) and references to be found in Australasian literature.

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* When Dr. Svenson published this arrangement he had seen very little of the Australian species, and it was his suggestion that this account be published before he treated these parts of the genus.

While this paper was in press I received from Dr. Svenson papers embodying his final opinions on the genus. Through the courtesy of the editors and the printer I have been able to make some changes in nomenclature made necessary by these papers, but I cannot agree with Dr. Svenson's broadened circumscriptions of certain species. These involve the union of pairs of species which to me seem quite distinct.

† Anther-tips considerably less than 0·1 mm. long are described as minute.

The herbaria, in which the specimens cited are laid, are indicated as follows:—

Queensland Herbarium, Brisbane	(B)
National Herbarium of New South Wales, Sydney	(S)
National Herbarium of Victoria, Melbourne ..	(M)
Tate Herbarium, University of Adelaide	(T)
Herbarium of J. M. Black, Adelaide	(Bl)
Herbarium of J. B. Cleland, Adelaide	(Cl)
State Herbarium of Western Australia, Perth ..	(P)

When no letter is used the specimens are in the Queensland Herbarium. All my collections are represented here, and no special mention is made of them.

KEY TO THE SPECIES OF ELEOCHARIS IN AUSTRALIA AND NEW ZEALAND.

Glumes hardened on back, finely many-nerved with a distinct mid-vein, not at all or only obscurely keeled, the spikelet not much wider than the culm; style 2-fid or 3-fid; nut lenticular (Species 1–9).

Culms not transversely septate; external cells of nut hexagonal or transversely oblong to linear in 10-20 vertical rows on each face.

External cells of nut oblong or linear, or if somewhat hexagonal then the culm stout and acutely triquetrous.

Culms exceeding 2 mm. in width.

Nut constricted below apex into a distinct neck; glumes more than 4 mm. long, not cuneate .. .. .. (1) *E. fistulosa*

Nut not constricted, the style-base almost confluent over shoulders; glumes less than 4 mm. long, cuneate .. (2) *E. spiralis*

Culms less than 1 mm. wide .. (4) *E. difformis*

External cells of nut more or less regularly hexagonal; culms never both stout and acutely triquetrous.

Culms usually less than 3 mm. wide; nut more or less attenuate below, with a distinct neck under the expanded apex and the annulus curved upwards.

Culms acutely, unequally, and re-entrantly 4–5-angled, soft and compressible; bristles always present .. (3) *E. philippinensis*

Culms terete or indistinctly trigonous, bristles absent at maturity .. .. .. (6) *E. nuda*

Culms 3 mm. or more wide, not prominently angled, nut not attenuate below and only very slightly expanded at apex, the annulus straight or nearly so .. .. .. (5) *E. Brassii*

Culms transversely septate; external cells of nut very small, very numerous, more or less rounded-hexagonal or elongated vertically.

Glumes about 8 mm. long, nut 2·2–2·5 mm. long; culms in a close linear series on a stout horizontal rhizome .. .. (7) *E. sphacelata*

Glumes 5–6·5 mm. long, nut 1·3–2·1 mm. long; culms tufted, rhizome short and oblique or stoloniform.

Glumes rounded at apex, flattened when dry, dull; hypogynous bristles strongly connate at base; plant often bearing tubers .. .. (8) *E. dulcis*

Glumes subtruncate, more or less shining, somewhat concave when dry; bristles free from each other at the base; stolons never tuberiferous .. .. (9) *E. equisetina*

Glumes membranous, with a distinct midvein, usually distinctly keeled, sides nerveless, the spikelet much wider than the culm unless the latter be flat. (Species 10–25.)

Style 3-fid, or if 2-fid then the upper leaf-sheath truncate and prominently mucronate at the summit. (Species 10–21.)

Nuts obscurely trigonous or terete, vertically ribbed and transversely trabeculate, the external cells transversely linear or oblong. (Species 10–11.)

Plants neither proliferous nor tuberiferous; spikelets ovate to linear, often setting fruit; glumes 2–2·2 mm. long .. (10) *E. pusilla*

Plants producing tubers, often proliferous; spikelets lanceolate to linear, rarely maturing; glumes 3 mm. long or more .. .. (11) *E. atricha*

Nuts triquetrous to lenticular, finely reticulate, alveolate, wrinkled, or smooth, the external cells very small and often very faint, mostly shortly vertically oblong, in very numerous series. (Species 12–21.)

Dwarf tufted plants with capillary culms and thin summits to the leaf-sheaths; nuts less than 1 mm. long, 3-ribbed. (Species 12–13.)

Glumes numerous, spirally imbricate; nut 0·45 mm. long, bristles absent .. (12) *E. nigrescens*

Glumes 4–5, subdistichous; nut 0·9 mm. long, bristles 6, comparatively stout .. (13) *E. caespitosissima*

Larger plants, the culms usually at least 0·5 mm. wide; orifice of leaf-sheath firm, often mucronate; nuts at least 1 mm. long. (Species 14–21.)

Nut trigonous, the dorsal angle prominently ribbed; style-base narrow-pyramidal, $\frac{1}{3}$–$\frac{1}{2}$ as wide as nut.

Rhizome at length creeping; culms tufted or approximate compressedly ± tetraquetrous, leaf-sheath oblique at orifice .. (16) *E. gracilis*

Rhizome short, culms densely tufted, soft, 6–9-fluted; leaf-sheath truncate and mucronate .. .. (17) *E. Dietrichiana*

Nut trigonous or lenticular, the dorsal angle if present not ribbed; style-base sometimes nearly as wide as nut.

Leaf-sheath oblique at orifice, not or only minutely mucronate; bristles filiform, not flattened at base; style-base pyramidal decurrent over the shoulders of the trigonous nut .. .. .. (14) *E. pachycarpa*

Leaf-sheath truncate and mucronate at orifice; bristles stout, flattened at base, or if slender then nut and style-base different from above.

Culms prominently 4-angled; nut trigonous .. .. (15) *E. tetraquetra*

Culms terete, angular-striate, or flattened; nut lenticular.

Rhizome creeping, nuts not strongly costate on the margins, anthers with a setaceous appendage 0·2 mm. long; glumes tardily deciduous.

Culms terete or nearly so; spikelet much wider than culm .. (18) *E. acuta*

Culms strongly flattened; spikelet scarcely wider than culm .. .. (19) *E. plana*

Rhizome very short; culms densely tufted; nuts with prominently costate margins; appendage to anther not exceeding 0·15 mm. in length; glumes readily deciduous.

Glumes triangular-acute at apex; spikelet more or less acute; anther-tip 0·15 mm. long .. .. (20) *E. pallens*

Glumes rounded at apex; spikelet ± obtuse; anther-tip minute .. (21) *E. cylindrostachys*

Style 2-fid, orifice of leaf-sheath never mucronate (Species 22–25).

Nut more or less golden brown, 1·75 mm. long, bristles absent .. (22) *E. neozelandica*

Nut black or reddish brown or greenish brown, not exceeding 1 mm. long; bristles usually present.

Nut 0·9–1 mm. long.

Leaf-sheath scarious or marcescent at apex; nut greenish when immature .. .. (25) *E. minuta*

Leaf-sheath firm at apex; nut shining black at maturity, not greenish when immature .. .. .. (23) *E. geniculata*

Nut 0·6–0·65 mm. long .. .. (24) *E. atropurpurea*

ENUMERATION OF THE SPECIES.

Series Mutatae.—Mostly coarse plants with swollen culms as wide or nearly as wide as the spikelets. Glumes not at all or only obscurely keeled, the very broad back thickened and often hardened, closely striate, the margins hyaline; nut lenticular; style elongated, flat, 2-fid or 3-fid. (Species 1–9.)

1. **E. fistulosa** (*Poir.*) *Link* in Spreng. Jahrb. iii. 78 (1820); C. B. Clarke Ill. Cyp. t. xxxv. fig. 1-4 (1908); Svenson in Rhodora xxxi. 152 (1929), not of F. Muell., Benth., F. M. Bail., nor Domin. *Scirpus fistulosus* Poir. Encyc. vi. 749 (1804) not of Forsk. *S. acutangulus* and *S. medius* Roxb. Fl. Ind. i. 216 (1820). *E. acutangula* (Roxb.) Schult. Mant. ii. 91 (1824). *Limnochloa acutangula* (Roxb.) Nees and *L. media* (Roxb.) Nees in Wight, Contrib. Bot. Ind. 114 (1834). *L. fistulosa* (Poir.) Nees in Linnaea ix. 294 (1835). *E. planiculmis* Steud. Cyp. 80 (1855).

Stolons ca. 2 mm. diam. Culms tufted, erect, 3–6 dm. high, acutely triquetrous, somewhat spongy and finely reticulate, not septate, 3–4 mm. wide. Sheaths very thin, orifice oblique, marcescent. Spikelets cylindrical, acute, rather pallid, 20–35 mm. long, 3–4 mm. diam.; glumes dense, closely appressed, ovate or oblong-ovate, obtuse, 1-nerved and closely many-striate, rather densely glandular-spotted within, margins narrowly hyaline and ± erose, 4·25–4·5 mm. long; style 2–3-fid; stamens 2–3, anthers linear, ca. 1·5 mm. long, shortly apiculate. Nut obovate, turgidly biconvex, the margins scarcely ribbed, 1·5–1·7 mm. long, 1·4 mm. broad, constricted below the apex into a neck $\frac{2}{5}$ as wide, the expanded apex $\frac{1}{2}$ as wide; sides glistening straw-coloured, the external cells transversely linear-oblong in ca. 15 vertical rows, the pitting very shallow; style-base triangular-ovate, flat, dark brown, ca. $\frac{1}{3}$ as long as nut; bristles 6–7, pale brown, rather stout, mostly smooth in the lower part, weakly barbellate above, one very short, the others subequal, usually as long as the nut together with style-base.—Plate VII., figs. 1–3.

Queensland.—Cook District: Cairns, in water in wet forest country ca. sea-level, June, 1935, *Blake* 9371.

And in Tropical Asia, Africa, South America, and the West Indies.

All previous references to the occurrence of this species in Australia belong to *E. philippinensis*.

2. **E. spiralis** (*Rottb.*) *R* & *S*. Syst. ii. 155 (1817); C. B. Clarke Ill. Cyp. t. xxxv. figs. 5–7 (1908); Svenson, Rhodora, xxxi. 135 (1929). *Scirpus spiralis* Rottb. Desc. & Ic. 45, t. xv. fig. 1 (1773). *Limnochloa spiralis* (Rottb.) Nees in Wight Contrib. Bot. Ind. 114 (1834). *E. compacta* R. Br. Prodr. 224 (1810); F. Muell. Fragm. viii. 239 (1874); Domin in Bibl. Bot. xx. Heft 85, 446 (1915) in part. *S. compactus* (R.Br.) Spreng. Syst. i. 202 (1825). *E. variegata* Benth. Fl. Austr. vii. 293 (1878) partly; F. M. Bail. Syn. Queensl. Fl. 594 (1883); Catal. Plants Queensl. 52 (1890); Queensl. Fl. vi. 1754 (1902) partly; Ewart & Davies Fl. North. Territ. 57 (1917) partly.

Stolons soft, 3–4 mm. diam. with rather distant short ovate membranous scales. Culms rather densely tufted, erect, 3–5 dm. high, 2–3·5 mm. wide, obtusely trigonous, or acutely triquetrous under the spikelet when dry and in that state somewhat rugose, not septate, rather shining. Sheaths firm, pallid or green or with purplish apices, orifice oblique, firm, with a fine setaceous point up to 4 mm. long. Spikelet cylindrical, subacute in flower, very obtuse in fruit, 1·5–3·5 cm. long, 4–6 mm. wide; glumes densely packed, shortly and broadly cuneate and scarcely narrowed at the subtruncate apex, pallid, somewhat coriaceous and faintly many-striate with a rather prominent mid-vein and usually a narrow brown zone within the broad hyaline margin, finally somewhat incurved, 3·3–3·8 mm. long; style 3-fid; stamens 3, anthers linear, yellow, and with the 0·2 mm. long triangular or ovate reddish appendage 2·2–2·3 mm. long. Nut broadly elliptic or somewhat obovate, margins not costate, sides glassy, pale straw-coloured, not pitted, external cells transversely linear in about 20 vertical rows, 1·5–1·7 mm. long, 1·2–1·4 mm. wide, the apical annulus indistinct; style base somewhat triangular, stout, almost confluent over shoulders of nut and about $\frac{1}{3}$ as long and $\frac{1}{2}$ as wide; bristles 5–6, very slender, usually about as long as nut, sometimes shorter or longer, white to pale brown with small weak antrorse and extrorse teeth, or some nearly smooth.—Plate VII., figs. 4–6.

North Australia.—Arnhem Bay, *Brown* 5934.*

Queensland.—North Kennedy District: Rockingham Bay, edge of waterhole, March, 1868, *Dallachy* (M., S.). Port Curtis district: Gladstone, brackish marshy ground at sea-level, March, 1937, *Blake* 12790.

Also in Malaya, Ceylon, Southern India, Mauritius, and Madagascar (probably introduced into the latter island).

The description of *E. variegata* given by Bentham and Bailey refers partly to the present species, partly to the plants cited which are *E. plana* (No. 19 below).

3. **E. philippinensis** *Svenson* Rhodora xxxi. 155 (1929). *E. fistulosa* F. Muell. Fragm. vi. 93 (1867); First Census 125 (1882); Sec. Census 211 (1889); Boeck. in Linnaea, xxxvi. 472 (1869-70); Benth. Fl. Austr. vii. 293 (1878); F. M. Bail. Syn. Queensl. Fl. 594 (1883); Catal. Plants Queensl. 52 (1890); Queensl. Fl. vi. 1754 (1902); Compreh. Catal. 591 fig. 574 (1913); Domin Biblioth. Bot. xx. Heft 85, 445 (1915) not of (Poir.) Link. *E. variegata* W. V. Fitzgerald in Proc. Roy. Soc. West. Austr. iii. 118 (1918) not of Kunth. *E. variegata* var. *laxiflora* Merrill, Enum. Phil. Pl. 121 (1922) not of C. B. Clarke.

Stolons 1–1·5 mm. diam.; culms tufted, more or less erect but usually very lax, up to 10 dm. long (usually 3–5 dm.) and up to 3 mm. wide, acutely and unequally 4–5-angled, not septate; sheaths thin, rather lax, deep purple, marcescent. Spikelet linear acute, up to 6 cm. long and 3 mm. wide; glumes usually green, rather remote, ovate-elliptic or obovate-elliptic, obtuse but when dry convolute upwards and subsquarrose, herbaceous, rather prominently keeled and strongly striate, more or less distinctly brown-zonate within the narrowly hyaline margins, 4·1–4·8 mm. long; style 2–3-fid; stamens 3, anthers linear obtuse, 1·4–1·6 mm. long. Nut obovate, somewhat clavate, slightly narrowed into a distinct neck below the apex, strongly biconvex, the margins indistinctly ribbed, the sides dark brown, deeply pitted with the hexagonal external cells in 15–20 regular vertical series, 1·5–1·7 mm. long, 1·5–1·6 mm. wide; style-base flattened, deltoid, about $\frac{1}{2}$ as long and $\frac{2}{3}$–$\frac{3}{4}$ as wide as nut, the annulus prominent outwardly curved upwards; bristles 6–7, the inner series somewhat the longer from less than $\frac{1}{2}$ the nut to as long as nut together with style base, usually firmly toothed. Plate VII., figs. 7–10.

Western Australia.—Kimberley Division: Isdell River near Mount Barnett Homestead, June, 1905, *Fitzgerald* 1038 (ex P.).

Queensland.—Cook District: Mareeba, edge of lagoon ca. 1,400 ft., March, 1938, *Blake* 13410; Cairns, in *Melaleuca* swamp ca. sea-level, June, 1935, *Blake* 9361. Port Curtis District: Rockhampton, common in wet places, November, 1867, *O'Shanesy* 46 (M.); wet places in railway

* I have not seen these specimens, the type of *E. compacta* R. Br., but Dr. Svenson has sent me sketches and notes on the specimens at Kew and at the British Museum.

enclosure ca. 25 ft., March, 1935, *Blake* 7820; Gracemere, in wet places, April, 1874, *O'Shanesy* 1821 (M.); Herbert Creek, *Bowman* in 1870 (M.). Wide Bay District: Near Bundaberg, near water, April, 1936, *Blake* 11271. Moreton District: Near Buderim Mt. on marshy ground in water, Feb., 1934, *Blake* 5226, 5227; Durundur, round lagoon, Nov., 1843, *Leichhardt* (M.); Petrie, near Brisbane, on muddy edge of water-hole in open forest, April, 1932, *Blake* 1220; Lawnton, near Brisbane, in dried-out swamp, March, 1932, *Blake* 1146; near The Blunder, near Brisbane, in ditch by the roadside, May, 1932, *Blake and Greenham in Herb. Blake* 1270; near Brisbane in swamp, Feb., 1875, *Bailey;* Brisbane, *Dietrich* 564 (M.); *Bailey* 21, 95 (M.); on mud near Bulimba Creek, June, 1933, *Blake* 4863; damp places at bottom of railway embankment, May, 1932, *Blake* 1296, and in Nov., 1932, *Blake* 1421; on dry mud in railway drain, May, 1937, *Blake* 12968; Pimpama, alongside road in shallow waterhole and around margin, Jan., 1933, *Cribb*. Darling Downs District: Palardo, between Miles and Roma, in fresh-water swamp, ca. 1,100 ft., Feb., 1935, *Blake* 7616.

Also in the Philippine Islands, whence it was originally described.

This species is readily distinguished from all other Australasian species by its soft, acutely and unequally 4-angled culms, the broadest side of which sometimes bears an incipient fifth angle. The nut approaches that of *E. nuda* but is less attenuate below, is more deeply pitted, the annulus is much less curved, and the hypogynous bristles are invariably present . The latter are usually well-developed, but when short they are often nearly smooth. A complete gradation is to be seen within some of the collections cited above. Occasionally the external cells show a tendency to lengthen transversely, but not to such an extent as to alter the typical character of the nut. *Blake* 9361 consists of small, exceptionally slender plants resembling at first sight those of *E. nuda*, among which they were growing.

It differs from *E. fistulosa*, with which it has been freely confused, by the more slender differently shaped culms, the spreading, upwardly inrolled glumes, and the hexagonal external cells.

4. **E. difformis** *S. T. Blake* sp. nov. aff. *E. laxiflorae* (Thw.) H. Pfeiff. sed culmis tenuissimis haud rigidis, nucis minoris cellulis extimis oblongis differt.

Rhizoma tenuissimum repens; culmi caespitosi, virides, haud septati, saepe filiformes (steriles), sed fertiles usque ad 0·7 mm. diam., subteretes, levissime 4-goni, nunc patentes vel erecti usque ad 30 cm. longi, nunc laxi in aqua submersi partim natantes, usque ad 100 cm. longi; vaginae tenuissime membranaceae, arctae, superior apice obliqua vel lanceolata haud ampliata, scariosa vel marcescens. Spicula viridis, erecta, linearis vel linearo-lanceolata, acuta, 5–12 mm. longa, 1·3–1·5 mm. lata, pauciflora; glumae appressae, obovato-oblongae, obtusae, 4·5 mm. longae, 2–2·2 mm. latae, ecarinatae, dorso virides, 1-nerves sed tenuiter pluristriatae, marginibus late hyalinae; stylus trifidus; stamina 3, antherae lineares minute apiculatae, 1·5 mm. longae. Nux pallida, obovata, turgide sed inaequaliter biconvexa, bicostata, 1·3–1·5 mm. longa, 0·8–1·0 mm. lata, apice $\frac{1}{4}$–$\frac{2}{5}$ angustior sub annulo toroso recto vel fere recto vix constricta, verticaliter striata, cellulis extimis transversim oblongis 15–20-seriatim verticaliter vix recte dispositis; stylobasis triangularis applanata sessilis (i.e. $\frac{3}{5}$–$\frac{3}{4}$ nucis lata), $\frac{1}{4}$–$\frac{1}{3}$ nucis longa; setae hypogynae 5–6 basibus vix vel haud connatae, firmae, pallidae vel brunnescens, retrorsim firmule dentatae, inaequales sed plurimae nucem cum stylobasi adaequantes vel superantes. Plate VII., figs. 11–15.

Queensland.—Moreton District: Stradbroke Island, in Lake Karboorah, submerged to 2 ft., or on marshy ground at the brink, alt. 120 ft., Jan., 1938, *Blake* 13203. (TYPE in B.)

Readily distinguished by its habit, its exceedingly slender culms, the very tumid bicostate nut not constricted below the apex, and the transversely oblong prominent external cells in slightly irregular vertical rows. A large number of the culms are sterile, and these are even more slender than the fertile. There is a greater diversity in the terrestrial individuals than in the aquatic ones in this respect.

5. **E. Brassii** *S. T. Blake* Proc. Roy. Soc. Queensl. xlix. 154 (1938).

Tufted, stoloniferous, the stolons ca. 1·5 mm. diam. Culms erect or suberect, 40–50 cm. high, rigid, subterete, scarcely trigonous under the spikelet, 3·5–4 mm. diam., dried specimens often flattened and up to 5 mm. wide, striate and more or less rugulose but not at all septate. Upper leaf sheath membranous, purplish below, rather firm and oblique at the orifice, shortly mucronate or acuminate. Spikelet 3–5 cm. long, 4–5 mm. wide, linear, acute, dense-flowered, spirally angular when dry; glumes ovate, obtuse, concave, rigid, many-striate, straw-coloured or greenish but with a narrow brown zone within the narrowly hyaline margins and the entire upper part brown-dotted, at least within, 4·8–5·2 mm. long; style 2-fid; stamens 3, anthers linear, minutely apiculate, 1·5–2·5 mm. long. Nut tawny to brown, shining, broadly obovate or suborbicular, 1·8–2·3 mm. long, 1·6–2·1 mm. broad, equally and turgidly biconvex, faintly ribbed on the margins, not at all or only slightly constricted immediately below the apex, the sides striate or reticulate, rather deeply pitted, the hexagonal external cells in about 20 vertical rows on each face; style-base pallid to brownish, spongy, flattened, triangular-ovate, $\frac{2}{3}$–$\frac{4}{5}$ nut in length and $\frac{3}{5}$–$\frac{3}{4}$ nut in width, the annulus nearly straight; hypogynous bristles 6–4, of which 4 are about as long as the nut with firm retrorse teeth and 2 very slender, very small, or absent.—Plate VII., figs. 16–19.

North Australia.—Baines Creek, in swamps, March, 1856, *Mueller* (M.); Darwin, *Holtze* 412 (M.); *Giles* 62; without definite locality, *Tenison-Woods and Holtze* in 1886 (M.); *Tenison-Woods*.

Queensland.—Cook District: On Wrotham Park, ca. 50 miles northwest of Mungana, in swamps, April, 1938, *Blake* 13693; Forest Home Station, Gilbert River, in swamps, April, 1931, *Brass* 1864 (Type). North Kennedy District: Rockingham Bay, *Dallachy* (M.).

Mueller's and Dallachy's specimens were referred by Bentham and the latter by Bailey to *E. variegata* Kunth. These, as are the other North Australian specimens, are in young flower only. The original description was based on *Brass* 1864, and it is only since then that I have seen the plant growing. My specimens differ in minor points, and the above description has been slightly modified accordingly. In these specimens the nut is somewhat larger, rather darker in colour, the style-base is also darker, relatively smaller, and less regular in outline. The over-maturity of some of the material is responsible for most of these differences.

The species bears a superficial resemblance to *E. spiralis* due largely to the spirally angular appearance of the spikelet, but in the shape of the glumes and structure of the nut it is much closer to *E. nuda* and *E. philippinensis.* From these it differs in the complete or almost complete absence of any constriction below the apex of the nut, the straight annulus, and in the details of the style-base and the bristles. Of the latter 4 are regularly present and well developed; the remaining 2, when present, are very fine and small. The culms are very much stouter than those of either species, and differ also from the latter in their shape.

6. **E. nuda** *C. B. Clarke* in Kew Bull. Add. Ser. viii. 21 (1908); Ill. Cyp. t. xxxv. figs. 9–11 (1909); Domin in Biblioth. Bot. xx. Heft 85, 446 (1915); Maiden & Betche Cens. N. S. Wales Pl. 28 (1916); Svenson in Rhodora xxxi. 162 (1929). *H. atricha* F. Muell. Fragm. viii. 252 (1874); Benth. Fl. Austr. vii. 295 (1878) excluding the citation of Brown's plants; F. M. Bail. Syn. Queensl. Fl. 594 (1883); Catal. Pl. Queensl. 52 (1890); Queensl. Fl. vi. 1756 (1902) chiefly, Compreh. Catal. 594 (1913) chiefly, not of R. Br.

Stoloniferous, stolons very slender. Culms tufted, erect or nearly so, up to 3 dm. long, terete or trigonous, longitudinally striate, not septate, not exceeding 2 mm. diam.; sheaths very thin, purplish, striate, orifice of uppermost firm, very oblique. Spikelet greenish, linear-cylindric, acute, 15–30 mm. long, slightly wider than the culm; glumes rather remote, appressed, ovate-elliptic, rounded at apex, 3–3·5 mm. long, herbaceous and finely striate on the back with one prominent nerve but not keeled and sometimes finely glandular dotted inside, margins broadly hyaline usually with an intramarginal brown zone; style 2-fid; stamens 2, anthers linear, acute, 0·7–0·9 mm. long. Nut broadly obovate-pyriform constricted into a distinct neck below the apex, biconvex, prominently ribbed on the margins, sides glistening brown, shallowly pitted, the external cells rounded-hexagonal in about 12–15 vertical rows, 1·2–1·3 mm. long, 1–1·1 mm. wide; style-base shortly ovate-triangular to nearly truncate, $\frac{1}{6}$–$\frac{1}{3}$ as long and about $\frac{2}{3}$ as wide as nut, the prominent annulus strongly concave upwards; bristles usually deciduous from the maturing nut, but apparently always present in the flower, and then usually 3–4, irregular, very slender, weakly barbellate, usually small.—Plate VII., figs. 20–22.

Queensland.—Cook District: Mareeba, in somewhat open swampy places in dwarf *Melaleuca* forest ca. 1,400 ft., March, 1938, *Blake* 13431; Cairns, in *Melaleuca* swamp about sea-level, June, 1935, *Blake* 9360. Burke District: Carron Creek between Gilbert and Norman Rivers *Gulliver* 10 and 17 (M. Co-type).

New South Wales.—Northern Tablelands: Timbarra, *Stuart* (M., S.).

Allied to *E. philippinensis,* differing in the more rigid differently shaped culms, the relatively broader appressed glumes, the distinctly pyriform nut with shallower pitting, the strongly upcurved annulus, and the caducous bristles. The New South Wales locality, if genuine and not due to a mixture of labels, presents a peculiar problem in geographical and climatic distribution. The material in Herb. Sydney consists of the basal parts of two culms and a packet of mature nuts bearing the words "H. atricha N. Eng." in Mueller's writing. The label carries the note "One unripe spike on original."

7. **E. sphacelata** *R. Br.* Prodr. 224 (1810); Hook. f. Fl. Tas. ii. 85 (1860), Fl. Nov. Zel. 300 (1864); F. Muell. First Census 125 (1882) and Sec. Census 211 (1889) partly; Boeck. in Flora lviii. 108 (1875); Benth. Fl. Austr. vii. 292 (1878) partly; F. M. Bail. Syn. Queensl. Fl. 593 (1883) partly, Catal. Plants Queensl. 52 (1890) partly, Queensl. Fl. vi. 1754 (1902) partly, Weeds & Pois. Pl. Queensl. 214 (1906) partly, Compreh. Catal. 591 (1913) partly; J. H. Maiden Useful Pl. Austr. 35 (1889) partly; Maiden & Betche Census N. S. Wales Pl. 28 (1916); Tate Handb. Fl. Extratr. S. Austr. 183, 264 (1890); Moore Handb. Fl. N. S. Wales 450 (1893); Turner in Proc. Linn. Soc. N. S. Wales xxviii. 306 (1903), xxx. 84 (1904); Cheesem. Man. N. Zeal. Fl. 767 (1906); Domin Biblioth. Bot. xx. Heft 85, 445 (1915); Ewart & Davies Fl. North. Territ. 57 (1917); Cleland & Black, Trans. Roy. Soc. S. Austr. li. 29 (1927); Ewart Fl. Vict. 223 (1930); Black Fl. S. Austr. 91 (1922); Svenson in Rhodora xxxi. 160 (1929). *Scirpus sphacelatus* (R. Br.) Poir. Encycl. Suppl. 102 (1817).

Rhizome stout, woody, 5–6 mm. diam.; culms in a close linear series, erect, up to 2 m. high, terete, 4-12 mm. diam., transversely septate and with a tumid ring close under the spikelet; sheaths very thin, oblique at the orifice. Spikelet cylindric acute, 3–5 cm. long, 8–9 mm. wide; glumes numerous, densely packed, elliptic or oblong-ovate, obtuse, mostly 8–8·5 mm. long (rarely up to 9 mm.), firm, streaked, dotted, or stained with brown, finely striate with a fairly prominent midrib, margins narrowly hyaline with an internal brown zone; style 3-fid, fimbriate in the upper part below the trifurcation; stamens 3, anthers linear apiculate, 3·5–4 mm. long including the acute 0·1–0·15 mm. long appendage. Nut light yellowish to tawny or pale brown, broadly obovate to orbicular, very turgidly biconvex with a definite furrow on the anticous face, margins somewhat costulate, 2·2–2·5 mm. long, 1·8–2·2 mm. wide, sides finely reticulate, the external cells irregularly hexagonal, often elongated vertically, without any definite vertical or horizontal arrangement; style-base flat, the base thickened, about $\frac{2}{3}$ as wide as nut and sometimes slightly wider than its apex, triangular, more or less acuminate, from $\frac{1}{2}$ to as long as nut, the long style usually persistent; bristles 8–10, not quite regular, at least as long as the top of style-base, sparsely toothed, strongly united at the base above the prominent receptacle.—Plate VIII., figs. 1–5.

North Australia.—Daly River Settlement, *Mair* 70.

Queensland.—Port Curtis District: Rockhampton, *Dietrich* 561 (M.): common in every lagoon, Nov., 1867, *O'Shanesy* 52 ser. 7 (M.). Wide Bay District: Bundaberg, *Keys* 350. Moreton District: Wilson's Lagoon, March, 1844, *Leichhardt* (M.); Nudgee Waterhole, near Brisbane, on mud or in water, March, 1933, *Blake* 4618; Pimpama, in creek, Jan., 1933, *Cribb*. Darling Downs District: Chinchilla, in water a foot deep in lagoon periodically flooded, April, 1934, *Beasley* 237; Wyberba, near Wallangarra, on creek bank in mud, 2,500-3,000 ft., Jan., 1933, *Blake* 4618.

New South Wales.—Northern Tablelands: Timbarra, *Stuart* (M.). North Coast: Clarence River District, in 1875, *Wilcox* (M.); Gloucester Buckets, Sept., 1897, *Maiden* (S.). Central Tablelands: Blackheath, Jan., 1905, *Maiden* (S.); Mittagong, *Travers* (M.); Mossvale, Dec., 1920, *comm. Town Clerk* (S.); Jenolan Caves, April, 1900, *Blakely* (S.). Central Coast: The Clyde, Nov., 1884, *Bäuerlen* 80 (S.M.); Kangaroo

River, National Park, Sept., 1893, *Betche* (S.); Camden, *Atkinson* (M.), *Jephcott* in 1883, (M.). South Coast: Near Milton, *Bäuerlen* in 1883 (S.M.).

Victoria.—Wimmera: Wimmera River, Shire of Dimboola, Nov., 1893, *Reader* (M.). Western District: River Wannon, Dec., 1873, *Sullivan* 28 (M.); Hawkesdale, Dec., 1901, *Williamson* (B., S., M.); Mount Emu Creek, *Whan* (M.); Australia felix, *Mueller* (M.). Central District: Ballarat, *Spence* in 1882 (M.). North-east District: Beriambra Creek, morass on alluvium overlying porphyry, *Fl. Australian Alps* 97A, (M.).

South Australia.—Flinders Range: Wilpena (T.); Wilpena Creek, Nov., 1928, *Cleland* (Cl.). Southern Districts: Barossa, in water, Jan., 1849, *Mueller* (M.); Reedbeds, Nov., 1879, (T.); Upper Willow Creek, Waitpinga, Jan., 1933, *Cleland* (Cl.); Myponga, Jan., 1909, *Griffith* (Bl.); Kangaroo Island—Cygnet River, (T), Feb., 1926, *Cleland* (Cl.), Rocky River and between Vivonne Bay and Rocky River, Nov., 1924, *Cleland* (Cl.).

Tasmania.—South Esk River, *Stuart* 556 (M.); *Oakden* in 1887 (M.); Swanport, *Story* (M.); Elizabeth River, Dec., 1892, (S., no collector's name); (locality illegible) *Archer* 56 (S.); without definite locality, *Rodway* (S.).

New Zealand.—North Island, Auckland Province: Tauroa, in swamp, Jan., 1913, *Carse*.

Apparently restricted to Australia and New Zealand, and readily distinguished by its stout horizontal rhizome and its large size. The strongly fimbriate margins of the upper part of the style, reminiscent of so many species of *Fimbristylis*, is also noteworthy. So far as my observations go, it never produces tubers, and all the Australian references to tuber-producing plants belong to the next species. Svenson refers to E. *sphacelata E. esculenta* Vieillard from New Caledonia, but as it bears tubers it is probably *E. dulcis* also.

8. **E. dulcis** (*Burm. f.*) *Trin.* ex Henschel, Vita Rumph. 186 (1883); Svenson in Rhodora xxxi. 158 (1929). *Andropogon dulce* Burm. f. Fl. Ind. 219 (1768). *Hippuris indica* Lour. Fl. Cochinch. 16 (1790). *Scirpus plantaginoides* Rottb. Desc. et Ic. 45, t. xv. fig. 2 (1773). *E. plantaginoidea* (Rottb.) W. F. Wight, Contrib. U.S. Nat. Herb. ix. 267 (1905) not *E. plantaginoides* (Rottb.) Domin. *S. plantagineus* Retz. Obs. 14 (1789). *E. plantaginea* (Retz.) R. & S. Syst. ii. 150 (1817); C. B. Clarke Ill. Cyp. t. xxxiii. figs. 1–5 (1908). *S. tuberosus* Roxb. Fl. Ind. i. 213 and *S. tumidus* Roxb. loc. cit. 215 (1820). *E. tuberosa* (Roxb.) R. & S. Mant. ii. 86 (1824); Domin Biblioth. Bot. xx. Heft 85, 445 (1915). *E. tumida* (Roxb.) R. & S. loc. cit. *E. esculenta* Vieillard, Ann. Sci. Nat. sér. 4 xvi. 37 (1862). *E. sphacelata* F. Muell. Fragm. viii. 238 (1874) partly, xii. 25 (1882); Benth. Fl. Austr. vii. 292 (1878) partly; F. M. Bail. Syn. Queensl. Fl. 593 (1883) partly, Catal. Pl. Queensl. 52 (1890) partly, Queensl. Fl. vi. 1754 (1902) partly, Weeds and Pois. Pl. Queensl. 214 (1906) partly, Compreh. Catal. 591 (1913) partly, not of R. Br.

Stolons rather slender, sometimes bearing zonate tubers about 7 mm. diam. or more. Culms tufted, erect, up to ca. 1 m. high, cylindrical in the living state, usually quite flat when dry and in that state mostly 3–8 mm. wide, transversely septate, finally longitudinally striate; leaf-sheaths very thin, oblique at orifice. Spikelet cylindrical, rather obtuse, 25–50 mm. long, usually somewhat wider than the culm, or occasionally narrower if the latter be very wide, pallid; glumes numerous, rather dense, oblong to oblong-obovate, finely closely striate on the broad back with a more distinct midvein, sometimes spotted with brown, with a narrow hyaline margin and a faint brown zone within it in the upper part, mostly 6–6·5 mm. long and about $\frac{1}{3}$ as wide; style 3-fid, glabrous and smooth or nearly so in the upper part; stamens 3, anthers linear, 2·5–3 mm. long, the 0·2 mm. long apex acute. Nut tawny to greyish brown, shining, obovate-orbicular, truncate at the apex, biconvex, the margins not costate, 1·5–2 mm. long, 1·2–1·8 mm. wide, the sides smooth or minutely reticulate, the anticous usually with a shallow longitudinal furrow, the external cells very small, vertically irregularly hexagonal or oblong-hexagonal though nearly quadrate at the base, in no regular series; style-base sessile, flat, triangular, about $\frac{2}{3}$ as wide and $\frac{1}{2}$ as long as nut, the remainder of style often persistent; bristles 6–8, about twice as long as nut, rather stout, retrorsely barbellate, flattened towards the base and there strongly united, the external series a little lower down than the others, the receptacle stout and prominent.—Plate VIII., figs. 6–9.

North Australia.—Darwin, in swamps, *Faelsche* in 1882 (M.).

Queensland.—Cook District: Cape York Peninsula, *Thomson* 20; Embley, May, 1901, *Roth* 397; Cairns, in swamp about sea-level, July, 1935, *Blake* 9663. Burke District: Burketown, edge of lagoons, June, 1935, *Blake* 9232. North Kennedy District: Cromarty, near Townsville, dominant in wettest places in open swamps, alt. 7 ft., March, 1935, *Blake* 8296. Port Curtis District: 80 miles north of Rockhampton, April, 1917, *Berney;* Rockhampton, lagoon, *Thozet* 6, 457, 811 (M.). Wide Bay District: Near Bundaberg in brackish swamp, April, 1936, *Blake* 11315. Moreton District: Petrie, near Brisbane, in small quiet stream, May, 1933, *Blake* 4781. Without precise locality: North Queensland, *Roth* 213, *Pollock*.

Extends through Malaya and south-eastern Asia to Madagascar, to Fiji, and is apparently in New Caledonia.

Very variable in stature and width of culms; occasionally specimens are to be found with culms up to 10 mm. diam., while several of the plants from Petrie bear barren culms not exceeding 1 mm. in width. The external cells of the nut also vary somewhat in shape and arrangement. Most Australian authors have confused the species with *E. sphacelata*, to which it is certainly very closely allied, but it never produces the characteristic stout horizontal rhizome of that species, the culms are usually more slender, the glumes and nuts are smaller, while the upper part of the style is never so prominently fimbriate and is nearly always quite smooth or entire at the margins. The tubers are not always present, though it seems probable that all plants would produce them under suitable conditions. As noted above these tubers are edible, and Roxburgh describes their cultivation by the Chinese. In Queensland it is stated that pigs thrive on them. The species is also an important member of the unusual but rich swampy pastures in the neighbourhood of Rockhampton.

9. **E. equisetina** *Presl.* Rel. Haenk i. 195 (1828); Svenson in Rhodora xxxi. 161 (1929); *E. plantaginea* F. Muell. Fragm. viii. 238 (1874) not of R. & S.; *E. sphacelata* Benth. Fl. Austr. vii. 292 (1878) and F. M. Bail. Queensl. Fl. vi. 1754 (1902) as to Bailey's specimens

only; not to R. Br. *E. plantaginoides* (Rottb.) Domin Biblioth. Bot. xx. Heft 85, 445 (1915), not *Scirpus plantaginoides* Rottb. (*E. plantaginoidea* W. F. Wight).

Stolons slender, sometimes hardening into rhizomes. Culms tufted, erect, rather rigid and somewhat shining, terete, usually not much compressed when dry, transversely septate and longitudinally striate, up to 10 dm. high, 1–3 mm. diam.; sheaths brownish or purplish, the uppermost firm and oblique at the orifice, rather lax. Spikelet cylindrical, rather acute, 2–4 cm. long, slightly wider than culm, pallid; glumes rather dense, appressed but somewhat incurved from the mid-vein when dry, broadly elliptic or somewhat obovate, very obtuse, 4·2–5 mm. long and about $\frac{3}{4}$ as wide, very rigid, pallid, very finely striate with a green mid-vein, margin very narrowly hyaline with a very narrow internal brown zone; style 3-fid, glabrous; stamens 3, anthers linear with a 0·3–0·4 mm. long setaceous appendage, and including it ca. 2·5 mm. long. Nut golden brown to light chestnut, rather turgidly biconvex with rather prominent acutely costate margins, 1·8–2·1 mm. long, 1·3–1·4 mm. wide, rounded or subtruncate at the apex, the annulus not prominent, the sides vertically finely and closely striate and pitted between the striations from the small hexagonal to squarish external cells arranged in numerous vertical series, the anticous side sometimes furrowed; style-base triangular, flattened, brown, closely sessile, about $\frac{1}{2}$ as long and $\frac{1}{2}$–$\frac{2}{3}$ as wide as nut, remainder of style usually persistent; hypogynous bristles 6–7, quite free at the base, rather slender, closely but shortly retrorsely barbellate, from about as long to twice as long as the nut, receptacle not prominent.—Plate VIII., figs. 10–13.

Queensland.—Cook District: Cairns, in water in wet forest country about sea-level, June, 1935, *Blake* 9372; Yarrabah, near Cairns, in swamp forest about sea-level, June, 1935, *Blake* 9647; Lake Barrine, near Yungaburra, ca. 2,500 ft., June, 1935, *Blake* 9581. Moreton District: Coolum, in swampy creek, April, 1938, *Blake* 13762; Palmwoods, in *Rhynchospora* swamp in cleared Eucalyptus forest country, soil a reddish brown loam, ca. 150 ft., May, 1930, *Hubbard* 2815; Brisbane River, *Bailey* 15, 50 (M.); New Farm road (Brisbane), in swamp, Feb., 1875, *Bailey;* Ekibin Creek (Brisbane), Feb., 1913, *White;* edge of Rocklea Creek (Brisbane), on mud or in water, forming fairly large stands, May, 1932, *Blake and Greenham in Herb. Blake* 1303; Indooroopilly, Brisbane, in waterhole, March 1932, *Blake and Everist in Herb. Blake* 1167; Kalinga Park, Brisbane, in swamp, March, 1932, *Blake* 1101, and at edge of waterhole, Dec., 1932, *Blake* 1440; between Nudgee and Virginia (Brisbane), on muddy creek bank or more frequently in water, Nov., 1932, *Blake* 1419; Gold Creek Reservoir, near Brisbane, in wet boggy places, 300 ft., April, 1937, *Blake* 12930.

New South Wales.—North Coast: Byron Bay, April, 1896, *Betche* (S.); Wyong River, in brackish water, Dec., 1893, *Betche* (S.); Wyong, April, 1899, *Hamilton* (S.).

The species also occurs in New Caledonia, Malaya, Ceylon, and Madagascar.

Bailey's specimens were referred by Bentham and later by Bailey to *E. sphacelata*, and by Mueller and Domin to *E. plantaginea* (*E. plantaginoides*). The specimens in Herb. Sydney have been referred by Kükenthal to *E. sphacelata*.

Though closely allied to both *E. sphacelata* and *E. dulcis, E. equisetina* is readily enough distinguished from both by the harder, often shining culms usually less flattened in herbarium specimens, the broader, shorter, more or less shining glumes somewhat incurved when dry, the long-apiculate anthers, the golden brown to light chestnut nut with acutely costulate margins and the sides finely vertically striate and seriate-pitted from the more evenly arranged, more regular external cells, and by the weaker usually much shorter bristles which are quite free from one another at the base. The only definite rhizomes I have seen are in my 9647; these are about 3 mm. diam., descending or curved, on which are borne tufts of culms, quite different from the closely linear series characteristic of *E. sphacelata*. In my 9372 the external cells of the nut show a tendency to become shortly vertically oblong, but they are otherwise very regular.

Series ACICULARES.—Nuts obscurely trigonous or terete, elongated, longitudinally ribbed and transversely closely trabeculate; style 3-fid; lowest glume fertile. Species 10–11.

10. **E. pusilla** *R. Br.* Prodr. 225 (1810); Benth. Fl. Austr. vii. 297 (1878); Tate Handb. Fl. Extratr. S. Austr. 264 (1890); Domin Biblioth. Bot. xx. Heft 85, 447 (1915); Maiden & Betche Census Pl. N. S. Wales 29 (1916). *Scirpus pusillus* (R. Br.) Poir. Encycl. Suppl. v. 103 (1817). *S. pumilio* Spreng. Syst. i. 204 (1825). *E. acicularis* F. Muell. Fragm. viii. 240 (1874); First Census 125 (1882), Sec. Census 211 (1888); Benth. Fl. Austr. vii. 297 (1878); Moore Handb. Fl. N. S. Wales 451 (1893); Cheeseman Man. Fl. N. Zeal. 768 (1906); Black Fl. S. Austr. 92 (1922); Ewart Fl. Vict. 223 (1930); not of R. & S. *E. acicularis* var. *elongata* Benth. Fl. Austr. vii. 297 (1878). *E. striatula* C. B. Clarke ex Domin loc. cit. not of Desv.

Rhizome slender or capillary, more or less hardened; culms tufted, more or less erect or somewhat arcuate, up to 25 cm. but usually 2–15 cm. long, capillary or rarely up to 0·5 mm. wide, somewhat thickened at base; sheaths loose, scarious, and often rigidly so, more or less inflated below the oblique orifice. Spikelet ovate to lanceolate, acute, 2–7 mm. long, 1·5–1·7 mm. wide; glumes ovate to obovate, obtuse or subobtuse, membranous, narrowly keeled, sides pallid or stained deep brown, 1·7–2·2 mm. long; style 3-fid; stamens 3, anthers linear obtuse, minutely apiculate, mostly 1–1·2 mm. long. Nut pale straw-coloured, rather glistening, narrowly obovoid, 0·7–1·1 mm. long, 0·45–0·55 mm. wide, obscurely trigonous, each face with 3–4 vertical ribs and finely trabeculate between them, the external cells transversely narrow-linear; style base very small, depressed ovoid, constricted at base to sometimes as much as $\frac{1}{2}$ its breadth, $\frac{1}{3}$–$\frac{1}{2}$ as wide as nut, and mostly $\frac{1}{5}$–$\frac{1}{4}$ as long; bristles few, very slender, small or absent.—Plate VIII., figs. 14–19.

Queensland.—Warrego District: Charleville, on wet mud in Eucalyptus parkland at 950 ft., April, 1936, *Blake* 11041. Maranoa District: Roma, depressions in Eucalyptus forest on mud, ca. 1,000 ft., March, 1936, *Blake* 10892. Darling Downs District: Jondaryan, damp depressions in grassland on dark grey clay, 1,250 ft., Feb., 1935, *Blake* 7756. Moreton District: Gatton Agricultural College (Lawes, near Gatton), dried-out depressions in grassland, deep black soil, forming small mats, September, 1933, *Blake* 4943.

New South Wales.—Northern Tablelands: Glen Innes, Jan., 1914, *Rupp* (S.). Rosehill, Guyra, Jan., 1932, *McKie* 223 (S.); Armidale, October, 1875, *Perrott* (M.). Western Plains: Euabalong, May, 1906, *Boorman* (S.); Lachlan River, Sept., 1878, *Mueller* (M.); Edwards River, October, 1875, *Mueller* (M.). Central Coast: Hawkesbury Agricultural College, Nov., 1906, coll. ? (S.). Southern Tablelands: Near Tharwa, Federal Capital Territory, in open swampy ground ca. 2,000 ft., Feb., 1935, *Blake* 7358.

Victoria.—Wimmera: Near Dimboola, in swamps, Dec., 1893, *Reader* 9 (M.); Lowan, in swamps, Dec., 1892, *Reader* (M., B.); and without definite locality, *Reader* in 1895, (M.). Western District: Hawkesdale, Feb., 1904, *Williamson* (M.); Mount Emu Creek, Nov., 1853, *Mueller* (M.). Central District: Bacchus Marsh, around ponds, Jan., 1853, *Mueller* (M.).

South Australia.—Murray River, Jan., 1884, (T.); *Griffith* (Bl.).

Tasmania.—Perth, South Esk River, *Stuart* 234 (M.); and without definite locality, *Mueller* (M.).

New Zealand.—North Island: Auckland Province: Lake Taupo, water's edge, April, 1924, *Allison*. Wellington Province: Himatangi, near Foxton, damp hollow in sand-dunes, March, 1930, *Zotov*. South Island: Canterbury Province: Lake Tekapo, water's edge, Jan., 1936, *Allan*.

Apparently confined to extra-tropical eastern Australia and New Zealand.

The species is very variable in stature, and different collections are often very unlike one another in general aspect. Perrott's specimens (*E. acicularis* var. *elongata* Benth., and identified with the South American *E. striatula* Desv. i.e. *E. bonariensis* Nees, by Clarke), the Richmond specimens, and *Blake* 7358, 7756, and 10892, possess tall soft culms, but seem rather to be ecological states than distinct varieties. The species was first identified by Svenson (Rhodora xxxi. 186) with *E. acicularis* from the Northern Hemisphere, but he has latterly come to the conclusion that it is quite distinct and is more closely related to the South American species. The combined result of our observations on the two species is that *E. pusilla* produces stouter rhizomes than does *E. acicularis*, the culms are more or less distinctly thickened at the base, often more rigid (though in this approaching *E. acicularis* var. *occidentalis* Svenson of the Western United States), the glumes are more obtuse, the nut is somewhat broader, and much more prominently ribbed. Svenson considers the Australasian plant to be closest to *E. costulata* Nees & Meyen from the South American Andes (Chile and Bolivia). I have seen no specimens of this species, but from Svenson's description and figure, the Australasian plant differs in that the anthers are much larger and less prominently apiculate, the nut not at all greenish and perhaps less distinctly trigonous, in the depressed style-base, and in the glumes being of a rather different shape. The whole group is, however, a very difficult one.

11. **E. atricha** *R. Br.* Prodr. 295 (1810); F. Muell. Fragm. ix. 100 (1875); First Census 125 (1882) and Sec. Census 211 (1889) partly; Benth. Fl. Austr. vii. 295 (1878) excl. descr. and as to the citation of Brown's specimens only; Moore Handb. Fl. N. S. Wales 450 (1893); F. M. Bail. Queensl Fl. vi. 1756 (1902) as to the citation of the Wallangarra specimens only; Domin Biblioth. Bot. xx. Heft 85, 447 (1915); Maiden & Betche Census N. S. Wales Pl. 29 (1916).

Stoloniferous; stolons 0·7 mm. diam. bearing ovoid tunicated tubers about 4 mm. long and 2·5 mm. diam. Culms tufted, oblique to erect or recurved, angular-sulcate, 3–40 cm. long, 0·5–0·7 mm. wide; leaf-sheaths membranous, oblique and somewhat scarious at apex. Spikelet lanceolate to linear, acute, chestnut brown, often proliferous, 10–20 mm. long, 2–3 mm. wide; glumes oblong or ovate-oblong, obtuse, membranous, narrowly keeled, sides stained reddish-brown and streaked with numerous linear red-brown glands, 3·5–5 mm. long; style 3-fid, very slender; stamens 3, anthers linear, very shortly apiculate, 1·7–2·1 mm. long. Nut white to pallid straw-coloured, shining, narrowly obovate or oblong-obovate, 1·3–1·5 mm. long, 0·65–0·7 mm. wide, constricted immediately below apex to a short neck about $\frac{2}{3}$ as wide, trigonous, sides convex, prominently vertically ribbed and transversely trabeculate, the external cells transversely linear-oblong in 4–5 vertical rows on each face; style-base with a rather prominent annulus, pyramidal-deltoid or somewhat depressed, the base as wide as $\frac{3}{4}$–$\frac{4}{5}$ nut and $\frac{1}{3}$–$\frac{1}{2}$ as long as wide; bristles constantly absent.—Plate VIII., figs. 20–24.

Queensland.—Darling Downs District: Stanthorpe, Feb., 1913, *Sankey;* March, 1935, *Hale;* Bald Mountain, near Wallangarra, near water, Jan., 1933, *Blake* 4536. Moreton District: Brisbane River, *Bailey* 55 (M.); Kedron Brook, Nov., 1875, *Bailey;* Northgate, Brisbane, in marshy ground, March, 1933, *Blake* 4714.

New South Wales.—Western Plains: Narrabri, October, 1914, *Boorman* (S.). Northern Tablelands: Wallangarra, "a fresh-water plant growing . . . intermingled with other plants of a swampy proclivity," Jan., 1918, *Boorman* (S.). Southern Tablelands: Near Tharwa, Federal Capital Territory, in open swampy ground ca. 2,000 ft., Feb., 1935, *Blake* 7537.

The type is *R. Brown* 5929 from Port Jackson (Herb. British Museum), of which Dr. Svenson has sent me a sketch and notes. Like most of the above-cited specimens it is immature. Indeed, Boorman's specimens from Wallangarra are the only ones in full fruit, though a very few nuts are present on *Blake* 7537. The affinities of the species are doubtful and may not truly lie with the *Aciculares,* although the nature and structure of the nut is very similar to that of typical members of that series, except for the very prominent neck and annulus. These recall certain members of the *Mutatae.* The lowermost glume is usually barren, or at most bears a vegetative shoot in its axil. Sometimes the entire spikelet is replaced by a vegetative shoot. These shoots along with the characteristic tubers appear to be the normal means of reproduction, and mature nuts are seldom formed.

Series Tenuissimae. Usually dwarf plants with tufted capillary culms and often with distichous spikelets. Nuts small (0·4–1 mm.), more or less distinctly 3-angled and in some species present at the culm-bases. Style 3-fid. The Australian species (Nos. 12–13) belong to the sub-series *Leiocarpeae* with the nuts smooth or very finely reticulate.

12. **E. nigrescens** (*Nees*) *Steud.* Syn. Cyp. 77 (1855). *Scirpidium nigrescens* Nees in Mart. Fl. Bras. ii[1]. 97 (1842).

Annual; culms tufted, oblique to erect, angular-sulcate, up to 10 cm. high and up to 0·7 mm. wide (mostly 0·3–0·5); sheaths thinly herbaceous, appressed but slightly dilated at the oblique hyaline orifice, often marcescent. Spikelet ovoid or oblong-ovoid, obtuse or subobtuse, 2·2–5 mm. long, 1·5–1·7 mm. wide, many-flowered; glumes closely spirally imbricate, somewhat spreading in fruit, oblong-elliptic, obtuse or retuse, strongly keeled, keel rather stout, green, curved in profile, disappearing below apex, the sides hyaline or stained with brown, 0·9–1·1 mm. long; style 3-fid; stamen 1, anther linear obtuse, 0·4–0·5 mm. long. Nut tawny to pale brown, shining, obovoid, truncate at the slightly narrowed apex, triquetrous, prominently but narrowly 3-ribbed, 0·45–0·55 mm. long and 0·3 mm. wide, the sides convex, very finely reticulate or striate, the external cells vertically oblong; style base very short, depressed, $\frac{2}{3}$–$\frac{3}{4}$ as wide as nut and sometimes slightly wider than its apex, but only 0·04–0·06 mm. high; bristles 0.—Plate IX., figs. 1–4.

North Australia.—Without definite locality, *Mueller* (M.).

Queensland.—Cook District: Near Mareeba, in wet places in Eucalyptus forest on sandy soil, ca. 1,400 ft., March, 1938, *Blake* 13398.

South Australia.—Southern Districts: Cataracts on Mount Lofty, Dec., 1850, *Mueller* (M.).

Chiefly found in Tropical Africa and Tropical America.

Dr. Svenson has identified this species for me and has sent me specimens from Cuba (coll. *Ekman*) and from Madagascar (*de la Bathie* 17947) for comparison. There is no difference between the Australian plants and those from these widely separated localities. The North Australian specimens were found mixed with *Fimbristylis sphaerocephala* Benth. under the latter genus, while the South Australian specimens had been placed by Mueller under *Scirpus* (*Isolepis*). The only other Australian species of *Eleocharis* which approaches it in appearance and its minute nut is *E. atropurpurea*, which, however, is readily distinguished by the colour of the glumes and of the lenticular nut, the 2-fid style, &c.

13. **E. caespitosissima** *Baker* Journ. Linn. Soc. xxi. 450 (1855). *Scirpus isdellensis* W. V. Fitzgerald Proc. Roy. Soc. W. Austr. iii. 123 (1918).

Culms tufted, flaccid, filiform, mostly 3–5 but up to 10 cm. long, angular-striate, not exceeding 0·2 mm. wide; sheaths membranous, purplish at base, oblique and not dilated at orifice. Spikelet ovate, subacute to obtuse, 1·5–2·5 mm. long, at length 1·3–1·5 mm. wide, 2–3-flrd.; glumes 4–5, lax, distichous or nearly so, 1·6–1·9 mm. long, ovate, apex rounded or slightly emarginate, membranous, keeled, sides stained deep brown particularly in the upper part; style 3-fid; stamens 2–3, anthers linear obtuse, minutely apiculate, 1·8–1·9 mm. long. Nut pale straw-coloured to brownish, narrowly obovoid-elliptic, apex rounded, 0·9 mm. long, 0·5 mm. wide, trigonous and 3-ribbed with convex faintly striate sides, the external cells minute, quadrate or shortly vertically oblong, in regular vertical series; style-base pyramidal, brown, ca. 0·25 mm. high and 0·3 mm. wide with a slightly prominent annulus; bristles 6, flat but thin, retrorsely hispid, 3 about reaching the top of the style-base, the others somewhat shorter.—Plate IX., figs. 5–7.

Western Australia.—Kimberley Division: Isdell River, near Mount Barnett Homestead, June, 1905, *W. V. Fitzgerald* 1043 (S., ex P).

And in Madagascar.

Dr. Svenson suggested the affinity of the Australian plant with this Madagascar species, and judging from the specimen of *de la Bathie* 17953 given me by him I can see nothing to separate the plants specifically. The nuts are paler in colour in the Australian plants, but they may not be *quite* mature, and some of the nuts in the Madagascar plants exactly match them. According to Chermezon (*Bull. Soc. Bot. France lxxv.* 286 (1928)), *E. caespitosissima* develops stolons and possesses 3 stamens. There are no stolons present in any of the plants I have seen, and I am unable to determine the number of stamens in the Madagascar plants. In Fitzgerald's specimens (of which I have examined 9 tufts) there appear to be never more than 2, and at times perhaps 1 only. Fitzgerald describes his *Scirpus isdellensis* as possessing a creeping rhizome, paired spikelets, and brown nuts, none of which characters is shown by his type specimens.

The discovery of this species in North-Western Australia forms another link between the flora of that region and of Eastern Africa, a connection previously indicated by the mutual sharing of that peculiar genus *Adansonia*.

Series SULCATAE (sp. 14). Coarser plants than the *Tenuissimae* with 3-fid styles and whitish or pale coloured trigonous nuts. South American species, one of them apparently introduced into New South Wales.

14. **E. pachycarpa** *Desv.* in C. Gay, Fl. Chile vi. 174 (1853).

A tufted perennial with a rather stout descending rhizome; culms rigid, slender, tetraquetrous, mostly up to 20 cm. high, about 0·3–0·4 mm. wide; upper leaf-sheath herbaceous-membranous, closely appressed, oblique and slightly dilated at orifice, sometimes minutely mucronate, extreme margin somewhat scarious, dotted with brown. Spikelet lanceolate to ellipsoid or ovoid, acute to subobtuse, 4–7 mm. long, 2–3 mm. wide, dark brown; glumes (lowermost more rigid, bracteiform, excepted) rather lax, ovate, obtuse, thinly membranous, keeled, the keel strongly curved in profile, the sides stained and streaked with red-brown, the margins hyaline-scarious, 3–2·6 mm. long; style 3-fid; stamens 3. Nut broadly obovate, slightly attenuate towards base, scarcely at all narrowed towards the apex, trigonous, the angles rounded and not at all ribbed, sides convex, tawny, minutely reticulate, the external cells minute, shortly vertically oblong and not at all prominent, 1·1 mm. long, 0·95 mm. wide, the annulus prominent but narrow, slightly undulate; style-base broadly pyramidal, closely sessile and slightly decurrent over the shoulders of the nut, discoloured and somewhat spongy, 0·6–0·7 mm. high; bristles 4, filiform, becoming pale brown, very unequal, the longest reaching to the top of the nut, slightly scabrous in the upper part only, or the smallest quite smooth.—Plate IX., figs. 8–11.

New South Wales.—Central Coast: Port Jackson District, Nov., 1900, *Camfield;* Centennial Park, Sydney, October, 1900, Nov., 1900, *Cheel* (S.), and in Dec., 1908, *Hamilton* (B., S.); and without definite locality, Nov., 1908, *Hamilton* (S.).

Apparently introduced from South America, where it occurs in Chile.

Among Hamilton's specimens from Centennial Park some have culms up to 30 cm. long with proliferous spikelets. Camfield's collection is not represented in Herb. Sydney, though accompanied by the label of that institution. Dr. Svenson tells me it is represented also in the Herbarium of the New York Botanic Garden and in the Gray Herbarium of the Harvard University, and in sending me a drawing of the latter specimen he suggested its identity with the Chilean species. It differs from *E. gracilis* in the more rigid habit, in the glumes strongly curved in profile, in the shape of the nut, in the style-base extending over the shoulders of the latter, in the more prominently ridged annulus, and in the fewer, weaker, not flattened bristles.

Series MULTICAULES (spp. 15-17). Old-world species with usually coarse culms, 3-fid styles, and trigonous, brown or olivaceous nuts.

15. **E. tetraquetra** *Nees* in Wight Contrib. 113 (1834); F. Muell. Fragm. viii. 239 (1874), First Census 125 (1882), Sec. Census 211 (1889); Benth. Fl. Austr. vii. 294 (1878); F. M. Bail. Syn. Queensl. Fl. 594 (1883), Catal. Pl. Queensl. 52 (1890), Queensl. Fl. vi. 1755 (1902), Compreh. Catal. 594 (1913); Simmonds in Proc. Roy. Soc. Queensl. vi. 225 (1889); Moore Handb. Fl. N. S. Wales 450 (1893); Domin Biblioth. Bot. xx. Heft 85, 448 (1915); Maiden & Betche Census N. S. Wales Pl. 29 (1916). *Scirpus tetraqueter* (Nees) Thwaites Enum. Pl. Zeyl. 454 (1864).

Rhizome short, descending; stolons long and slender, covered with long narrow scales. Culms tufted, erect, 3 dm. to above 10 dm. long, 0·9–1·5 mm. wide, prominently and regularly tetraquetrous, angles ribbed, sides finely striate or with a rather prominent rib; sheaths membranous or herbaceous, purplish below, the orifice of the uppermost slightly thickened and brownish, truncate or somewhat oblique with a short erect obtuse mucro. Spikelet ellipsoid to lanceolate, acute, brown, 10–20 mm. long, 3·5–5 mm. wide, many-flowered; glumes ovate, acute to obtuse, 3·7–4·2 mm. long, faintly keeled on the more or less greenish back, sides membranous, stained with brown particularly in the upper part, margins rather narrowly hyaline, sometimes brown-zonate; style 3-fid; stamens 3, anthers oblong-linear, acute or very minutely apiculate, 0·7–0·8 mm. long. Nut yellowish to brown, shining, obovate, trigonous compressed, the lateral angles not or only faintly costate, the dorsal one not prominent, 1·5–1·6 mm. long, 1–1·1 mm. wide, not constricted below the 0·6–0·7 mm. wide apex, sides most finely and lightly reticulate, the external cells vertically oblong; style-base triangular-ovate, somewhat pyramidal below, compressed above, greenish to brown, coarsely cellular, $\frac{2}{3}$–$\frac{3}{4}$ as long as nut and slightly wider than its apex; bristles 6–8, brown, flat, longer than nut and some at least overtopping the style-base, very closely retrorsely barbed with hyaline teeth much longer than the width of the bristle.—Plate IX., figs. 12–15.

Queensland.—Moreton District: Coolum, in swampy creek, April, 1938, *Blake* 13761; Sunnybank, March, 1889, *Bailey*.

New South Wales.—North Coast: Richmond River, *Hodgkinson* (M.).

There is also a sheet in Herb. S. without locality or collector's name.

The species extends through Malaya to Eastern Asia and India. I have seen specimens from the Philippines and from Japan. It is readily recognised by the regular prominently 4-angular culm (sometimes 3-angular according to C. B. Clarke), the very large style-base, and the sub-plumose bristles. Its exact systematic position is uncertain. Its truncate mucronate leaf-sheath and the nature of the surface of the nut suggest an affinity with the *Acutae,* but the shape of the latter, the massive style-base, the very small anthers, and the characteristic stolons are quite different. Svenson at first placed it in the *Tuberculosae* (Rhodora xxxi. 129), but later (in letter) suggested its affinity with *E. gracilis* and the *Sulcatae,* with which it agrees in the angular culms, the 3-angled nut, and to a lesser extent in the style-base. The unusually long and closely set teeth of the hypogynous bristles seem quite unique, though to some extent approached by some members of the *Acutae.*

16. **E. gracilis** *R. Br.* Prodr. 224 (1810); Domin Biblioth. Bot. xx. Heft. 85, 448 (1915). *E. gracilis* var. *gracillima* and var. *radicans* Hook. f. Fl. Nov. Zel. i. 270 (1864), Handb. N. Zeal. Fl. 301 (1867). *E. gracillima* (Hook f.) Hook f. Handb. N. Zeal. Fl. 745 (1867). *E. Cunninghamii* Boeck. in Flora xli. 412 (1858), in Linnaea xxxvi. 427 (1869-70); Cheeseman Man. N. Zeal. Fl. 769 (1906). *E. Hookeri* Boeck. in Linnaea xxxvi. 430 (1869-70). *E. palustris* F. Muell. Fragm. viii. 239 (1874) partly, not of R. Br. *E. multicaulis* Benth. Fl. Austr. vii. 295 (1878); F. Muell. First Census 125 (1882), Sec. Census 211 (1889); Tate Handb. Fl. Extratrop. S. Austr. 183, 264 (1890); Moore Handb. Fl. N. S. Wales 451 (1893); Tepper in Botan. Centralbl. lxiii. 38 (1895); Maiden & Betche Census N. S. Wales Pl. 29 (1916); Black Fl. S. Austr. 91 (1922); Cleland & Black Trans. Roy. Soc. S. Austr. li. 29 (1927); Ewart Fl. Vict. 224 (1930) (though scarcely figs. 128, 129), not of Sm. *Isolepis acicularis* A. Rich. Fl. Nouv. Zel. 103 (1832) not of Schlecht.

Rhizome creeping, 2–3 mm. diam., at first densely clothed with pale brown to purplish ovate striate scales. Culms tufted or approximate along the rhizome, erect or curved, slender, deeply striate but mostly flattened, at least when dry, up to ca. 20 cm. high, not exceeding 0·8 (usually 0·5–0·6 mm. wide); sheaths membranous or thinly herbaceous, striate, the uppermost dilated, thickened, and brown at the oblique orifice which is sometimes mucronate. Spikelet ovoid to oblong or lanceolate, subacute, mostly 5–9 mm. long and 2–2·5 mm. wide, but up to 12 mm. long and 4 mm. wide, brown; glumes rather dense, appressed, deciduous, ovate-oblong, rounded and not triangular at the apex, the lower ones obtuse, the upper subacute, 3·3–3·6 mm. long, obtusely keeled and somewhat concave, sides membranous, stained with reddish brown, margins hyaline; style 3-fid; stamens 3, anthers linear, minutely apiculate, 1·8–2 mm. long. Nut tawny or brown, somewhat shining, obovoid, rounded at apex, trigonous and 3-ribbed, 1·2–1·3 mm. long, 0·8–0·9 mm. wide, the sides convex, minutely reticulate punctulate to somewhat granular or transversely wavy-lined, external cells minute, shortly vertically oblong or subhexagonal; style-base usually rather stout, narrowly pyramidal, $\frac{1}{3}$–$\frac{1}{2}$ as long as nut and $\frac{1}{2}$–$\frac{2}{3}$ as wide as it, closely sessile, the annulus slightly prominent; bristles 5–6, flattened, pale brown, slender but rigid, firmly and finely retrorsely hispid, usually much overtopping style-base but sometimes scarcely so long as nut.—Plate IX., figs. 16–22.

Queensland.—Darling Downs District: Bald Mountain, near Wallangarra, near water, ca. 2,700 ft., Jan., 1933, *Blake* 4537; Wallangarra, in damp place at bottom of railway embankment, ca. 2,900 ft., Jan., 1933, *Blake* 4466.

New South Wales.—Central Tablelands: Katoomba, March, 1910, *Hamilton* (S.); Wattle Ridge, *via* Hilltop, Feb., 1912, *Cheel* (S.); Burragorang to Wentworth Falls, Nov., 1893, *Maiden* (S., M.). Central Coast: Parramatta *Woolls* in 1871 (M.); Narrabeen, near Sydney, in marshy ground near sea-level, Jan., 1935, *Blake* 7429, 7431. Hunter's Hill (Sydney), *A. G. Hamilton* (S.); Kogarah, Nov., 1893, *Camfield* (S.); Kogarah Bay, Dec., 1899, *Cheel* (S.); Port Jackson District, Nov., 1897, *Betche* (S.); Lilipili Gully, Hurstville, Jan., 1900, *Cheel* (S.).

Victoria.—Western District: Hawkesdale, Nov., 1900, *Williamson.*

South Australia.—Southern Districts: Lofty Range, by stream, Dec., 1847, *Mueller* (M., S.); Mount Lofty, August, 1924, *Ising* (Bl.), in swamps, Nov., 1882, *Tate* (T.); Waterfall Gully, Dec., 1880, *Tate*

(T.); Clarendon, Blewitt's Spring, April, 1882, *Tepper* 614 (M.); Myponga, Jan., 1929, *Cleland* (Bl., Cl.); Encounter Bay: Hall's Creek, *Cleland* (Cl.), Back Valley, in swamp, Jan., 1926, *Cleland* (Cl.), and in creek, Jan., 1925, *Cleland* (Bl., Cl.); Upper Tunkalilla Creek, west of Encounter Bay, June, 1930, *Cleland* (Bl., Cl.); Kangaroo Island: Squashy Creek, 27 miles E. of C. Borda, March, 1926, *Cleland* (Cl.); Stun-sail Boom River, Jan., 1883, *Tate* (M., T.). South-east: Lake George (T.).

New Zealand.—North Island: Auckland Province: Tauroa, Jan., 1913, *Carse*; Paeroa, Thames Valley, Dec., 1909, *Petrie*. New Zealand, without definite locality, *Hooker* (M.).

Also in Norfolk Island (*Maiden and Boorman* in 1902 in Herb. Kew *fide* Svenson).

The species differs from the European *E. multicaulis* Sm. in the development of a creeping rhizome, the more slender, harder culms, the more rigid orifice to the leaf-sheath, the nut more abruptly rounded in the upper part, not olivaceous, not finely vertically striate but more or less distinctly transversely wavy-lined, and in the better developed bristles. The actual degree of slenderness of habit varies considerably, both in Australian and New Zealand specimens. The style-base in the latter is at least usually smaller than in the Australian specimens and the bristles rather weaker than the average. The Queensland specimens are the most outstanding by reason of their rigid, flattened culms up to 0·8 mm. wide, the finely granular rather than reticulate nut, and the rather weak bristles. However, these features occur in various combinations in other plants, and the extremes are no greater than which occur in most other species of the genus.

Besides the specimens cited above, I have sketches communicated by Dr. Svenson of the types of *E. gracilis* (Port Jackson, *R. Brown* 5932) and *E. Cunninghamii* (Bay of Islands, *Cunningham*). The above-cited specimens of Hooker's appear to be co-type material of *E. Hookeri* and *E. gracilis* var. *gracillima*.

17. **E. Dietrichiana** *Boeck.* in Flora lviii. 107 (1875); Domin Biblioth. Bot. xx. Heft 85, 447 (1915) in small part only.

Rhizome short, horizontal; culms densely tufted, more or less erect, subterete (or flattened when dry) but prominently 6–9-ribbed, up to 3 dm. long, 0·7–1 mm. wide; sheath purplish, membranous, orifice truncate and thickened, dark-coloured, prominently mucronate. Spikelet ovate or oblong, acute to subobtuse, 6–9 mm. long, 2–3 mm. wide, more or less dark brown; glumes not very numerous, appressed in flower, rather spreading in fruit, oblong-ovate with a rather acute triangular apex, thinly membranous, keeled, sides stained brown, margins hyaline, 3·3–3·6 long; style 3-fid; stamens 3, anthers linear, prominently apiculate, 1·8–2 mm. long, including the 0·2–0·25 long setaceous appendage. Nut tawny to dark brown, obovate, somewhat attenuate below the middle, gradually narrowed above and slightly expanded and thickened at apex, subequally trigonous, 3-ribbed, 1·2–1·4 mm. long, 0·7–0·8 mm. wide, sides convex, rather shining, minutely and finely reticulate or longitudinally striate, external cells very small, shortly vertically oblong; style-base short, pyramidal, about $\frac{1}{2}$ as wide as nut and about as long as wide, finely cellular, whitish or brownish; bristles 6, brown, firm, closely and shortly retrorsely scabrous, as long as $\frac{1}{2}$–$\frac{3}{4}$ nut.—Plate IX., figs. 23–29.

Queensland.—Port Curtis District: Rockhampton, *Thozet* 112 (M.), wet places in railway enclosure, ca. 25 ft., March, 1935, *Blake* 7821; near Rockhampton, *Dietrich* 714 (type ex Berlin, M.), edge of fresh-water swamps ca. 15 ft., March, 1937, *Blake* 12738. Moreton District: Lawes, near Gatton, October, 1938, *Roe;* bottom of railway embankment, Sept., 1933, *Blake* 4946.

An interesting plant of uncertain range. Bentham (Fl. Austr. vii. 295) suggested that this species *may* be the same as his *E. acuta* var. *pallens* (*E. pallens* S. T. Blake); but did not state that it is. In the original description Boeckeler describes the style as bifid, while of the nut he states, *inter alia,* it is "biconvex, the dorsal side higher with a prominent angle." Clarke [Kew Bull. Add. Ser. viii. 105 (1908)] arranged the species among those with bifid styles and determined also as belonging to it some specimens of *E. pallens* (see discussion under that species). There is an excellent series of specimens of *Dietrich* 714 (the type collection) in Herb. Melbourne and Dr. J. Mattfeld has very kindly presented me with two spikelets (one in flower and one in fruit) from the type-sheet in Herb. Berlin. In all the style is trifid, and Dr. Svenson tells me that such is also the case in specimens of the same collection in the United States National Herbarium at Washington. So it appears certain that Boeckeler's description of the style is incorrect and also that his description of the nut is somewhat misleading.

Actually the species is very close in its floral characteristics to *E. gracilis,* differing chiefly in the somewhat narrower nut more gradually rounded in its upper part with a small but distinct neck immediately below the apex, the prominently apiculate anthers, and in the glumes with a less rounded rather acute triangular apex. The prominently ribbed culms with very thin tissue between the ribs, the mucronate truncate apex of the leaf-sheath, and the lack of a creeping rhizome further serve to distinguish it.

Series ACUTAE. Rather rigid tufted perennials with or without a creeping rhizome, the orifice of the leaf-sheath rigid and truncate with a prominent erect mucro; nuts lenticular, tawny to brown, the external cells vertically oblong, small, and not very prominent; style 3-fid. (Species 18–21.) Australasian species.

18. **E. acuta** *R. Br.* Prodr. 224 (1810); Benth. Fl. Austr. vii. 294 (1878) excl. var.; F. Muell. First Census 125 (1882) and Sec. Census 211 (1889); F. M. Bail. Syn. Queensl. Fl. 594 (1883), Catal. Plants Queensl. 52 (1890), Queensl. Fl. vi. 1755 (1902) excl. var., Compreh. Catal. 594 (1913), excl. var.; Tate Handb. Fl. Extratr. S. Austr. 183, 264 (1890); Moore, Handb. Fl. N. S. Wales 450 (1893) partly; Tepper in Botan. Centralbl. lxiii. 38 (1895); Turner in Proc. Linn. Soc. N. S. Wales xxviii. 306 (not 439) (1903), xxx. 84 (1905) chiefly; Maiden ibidem xxix. 724 (1904); Cheeseman Man. N. Zeal. Fl. 768 (1906); Maiden & Betche Census N. S. Wales Pl. 29 (1916); Black Fl. S. Austr. 91 (1922); Cleland & Black Trans. Roy. Soc. S. Austr. li. 29 (1927); Ewart Fl. Vict. 283 (1930); Gardner, Enum. Plant. Austr. Occid. 12 (1930). *E. mucronulata* Nees in Ann. Nat. Hist. sér. i. vi. 46 (1841); Steud. Syn. Pl. Glum. ii. 82 (1855); Boeck. in Linnaea xxxvi. 466 (1869-70); Palla in Kneucker: Cyperaceae (exclus. Carices) Restionaceae, Centrolepidaceae & Juncaceae exsiccatae, Lief vii. nr. 192 (1909) partly; *E. gracilis* var. β Hook. f. Fl. Tasm. ii. 85 (1860). *E. gracilis* (excl. var. β and γ) Hook. f. Fl. Nov. Zel. i. 270 (1864), Handb. N. Zeal. Fl. 301 (1867) not of R. Br. *E. palustris* Fragm.. viii. 240 (1874) partly,

not of R. Br. *Scirpus acutus* (R. Br.) Spreng. Syst. i. 203 (1825). *S. tener* Spreng. loc. cit. 204. *E. ambigua* Kirk ex Buch. in Trans. N. Zeal. Inst. vi. 225 (1874).

Rhizome slender, woody, stoloniform; culms in distant tufts, more or less erect, up to 90 cm. high and up to 3 (mostly 1–2) mm. wide, terete or (when dry) more or less flattened, but always trigonous under the spikelet, usually longitudinally striate, rarely also irregularly pitted; sheaths herbaceous or rigidly membranous, appressed, striate, more or less purplish at base, the orifice of the uppermost dark brown, somewhat thickened, truncate or nearly so, prominently mucronate. Spikelet linear, more or less acute, usually dark brown or variegated with brown, 15–30 mm. long, 3–7 mm. wide; glumes rather dense, the two lowermost broad, rounded, shorter than the others, overlapping each other, herbaceous with hyaline margins and an internal brown zone: the remainder ovate-lanceolate, subobtuse to very acute at the triangular apex, 3·5–4·3 mm. long, membranous, faintly keeled (1-nerved on the greenish back), sides very thin, stained deep brown or reddish brown, margins and apex hyaline; style 3-fid; stamens 3, anthers linear, prominently apiculate, 1·6–2·5 mm. long including the 0·2 mm. long subulate uncrested appendage. Nut yellowish to brown, shining, broadly obovate, plano-convex to biconvex, often turgid, sometimes when young, showing traces of a third angle, sometimes with 1–2 faint longitudinal furrows, margins not costate, 1·4–1·8 (usually 1·5–1·7) mm. long, 1·0–1·4 (usually 1·1–1·2) mm. wide, sides smooth or somewhat roughened, external cells minute, shortly vertically oblong; style-base ovate to triangular, compressed, often showing traces of a third angle, whitish or discoloured, cellular, 0·4–0·8 (usually 0·4–0·6) mm. high, 0·5–0·8 (usually 0·5–0·6) mm. wide, the annulus prominent; bristles mostly 7, rarely 6, more rarely 8–9, rather slender, flattened below, strongly retrorsely toothed, rather unequal, reaching or somewhat overtopping the style-base, occasionally short and ill-developed.—Plate X., figs. 1–7.

Queensland.—Port Curtis District: Gracemere, common in wet places, August, 1867, *O'Shanesy* 107 (M.). Darling Downs District: Jimba, Plains of the Condamine, *Hartmann* (M.); Dalby, April, 1916, *White;* between Bald Mountain and Wyberba, in mud on creek bank, Jan., 1933, *Blake* 4510; between Bald Mountain and Wallangarra, in marshy ground, Jan., 1933, *Blake* 4482.

New South Wales.—Western Plains: Bengalla, *Leichhardt* (M.). North-west Slopes: Liverpool Plains, coll. ? (M.). Northern Tablelands: Tenterfield, *Stuart* 1028 (M.); Glen Innes, Dec., 1913, *Boorman* (S.); Elderbury Creek, 6 miles S.W. of Guyra, Dec., 1931, *McKie* 224 (S.); Walcha, "common . . . in shallow water . . .," Jan., 1913, *Boorman* (S.); Walcha District, Dec., 1898, *Betche* (S.). Central Tablelands: Orange, Jan., 1908, *Boorman* (S.). Central Coast: Duck Creek, Clyde, March, 1909, *Hamilton* (S.); Oatley, Jan., 1908, *Boorman* (S.); Centennial Park, Sydney, March, 1899, *Cheel* (S.), in damp peaty soil, Jan., 1908, *Boorman in Kneucker* 192 (Herb. Blake). Southern Tablelands: Queanbeyan, Dec., 1911, *Cambage* 3347 (S.); near Tharwa, Federal Capital Territory, in open swampy ground, ca. 2,000 ft., Feb., 1935, *Blake* 7539; Rock Flat, near Cooma, in stream, Dec., 1896, *Maiden* (S., M.).

Victoria.—Mallee: Lake Albacutya, near water's edge, Nov., 1899, *D'Alton* 2 (M.). Wimmera: Nhill, *D'Alton* 3 (M.); near Dimboola, *Reader* 32 (M.); Shire of Dimboola, in swamps, Sept., 1892, *Reader* (M.); Lake Hindmarsh, April, 1895, *Reader* 5 (M.); Wycheproof, Sept., 1917, *Watts* 401, (S.); and without locality, *Mueller* (M.). Western District: Mount William Creek, *Sullivan* 5 (M.); near entrance to Hopkins River, *Knight* (M.); Garvoc, Dec., 1911, *Tovey* (M.); Skipton, on plains, *Whan* 125 (M.). North Central District: Harcourt, April, 1919, *Semmens* 53 (M.). Central District: Near Dandenong Ranges, *Dixon* in 1891 (M.); Tooradin, in swamps, Jan., 1935, *Blake* 7283.

South Australia.—Southern District: St. Vincent Gulf, in coastal swamps, *Mueller* (M.); Bethany, coll. ? (M.); Angas River, *Mueller* in 1848, (M.); Mt. Gawler (T.); Reedbeds near Adelaide, Dec., 1879, (T.); Bridgewater, *Black* in 1904 (Bl.); Happy Valley, Nov., 1906, *Black* (Bl.); National Park, Belair, Jan., 1924, *Black* (Bl.); Myponga, Dec., 1910, *Griffith* (Bl.); Black Swamp, Jan., 1924, *Cleland* (Cl.); Port Elliot, *Hussey* 510, (M.); Inman Valley, *Cleland* (Cl.); Hindmarsh Valley, Encounter Bay, Jan., 1922, *Cleland* (Cl.); Kangaroo Island, without definite locality, *Tate* in 1882 (M.), Cygnet River, Jan., 1883, *Tate* (M., T.). Murray Lands: River Murray Lagoons, Jan., 1884, and Mannum, March, 1883, *Tate* (T.); near Swan Reach, Nov., 1913, *Cleland* (Cl.). South-east: Millicent Drain, Dec., 1917, *Black* (Bl.); Lake Bonney, Dec., 1922, *Cleland* (Cl.). Eyre's Peninsula: Port Lincoln (T.).

Western Australia.—South-western Division: Greenough River, *Walcott* (M.); Stirling Range, Jan., 1857, *Mueller* (M.); and without locality, *Drummond* 364 (M.).

Tasmania.—Diana's Basin, October, 1892, *Rodway* (S.); South Esk, wet places, *ex Herb. Archer* (S.), in water, *Stuart* 254 (M.); Swanport, edges of creeks, *Story* (M.); Claremont, *Lucas* (S.); New Norfolk, Dec., 1860, *Gunn* 573 (S.).

Norfolk Island.—October, 1905, Drummond 76 (S.).

New Zealand.—Without definite locality, *Hooker* (M.), and *Colenso* (ex herb. Hooker in M.). North Island: Wellington Province: Bunnythorpe, near Palmerston North, in swamp, Dec., 1928, and in damp places in pastures, Nov., 1928, *Zotov*. South Island: Westland Province: Greymouth, *Helms*; Pukekura, boggy places on forest margin, Jan., 1937, *Poole*. Canterbury Province: Ashburton, margin of water-race in tussock grassland, Dec., 1918, *Allan;* Wakanui Beach, in brackish water on margin of creek, Jan., 1918, *Allan*. Otago Province: Dart River, head of Lake Wakatipu, in boggy ground, Jan., 1936, *Zotov*.

Certainly the most variable of the Australasian species. The culms vary a great deal in stoutness and hardness, the leaf-sheath at times tends to become oblique, particularly in New Zealand specimens, the spikelet varies greatly in width (partly dependent on the width of the culm), the glumes in size and acuteness, the nut in turgidity, length, breadth, and smoothness, the style-base in form and size, and the bristles in degree of development. The variations occur in a multiplicity of combinations and seem to depend largely on local ecological factors. In view of this it is not at all surprising that a tremendous amount of confusion has existed in connection with this and related species. The following combination of characters serve to distinguish it:—Culms more or less terete in distant tufts on a creeping rhizome, the mucronate orifice to the upper leaf-sheath, the usually acute spikelet with prominently triangular hyaline apices to the glumes which are not readily deciduous and frequently fall away in basipetal succession, the 3-fid style but lenticular nut without costate margins, and the long subulate uncrested appendage to the anthers. From *E. palustris* it is sufficiently distinguished by the mucronate leaf-sheath and 3-fid style, and from *E. gracilis* by the lenticular unribbed nut, besides other characters. To judge from the specimens in Herb. Sydney, *Gunn* 573, the type of *E. mucronulata* Nees, does not differ from the general trend of *E. acuta* except that the style-base is rather larger than usual, and is also a stout, though not exceptionally stout plant. Palla in *Kneucker* 192 distinguishes the species by several characters, but the specimens I possess distributed under that number do not at all agree with his characters for *E. mucronulata* and are merely depauperate plants of *E. acuta* similar to some of the Victorian ones, with culms about 10 cm. high on very slender rhizomes and greatly reduced bristles. It appears that Palla based his diagnoses on other plants, and seems to have confused *E. acuta* with *E. pallens.*

E. acuta var. *platylepis* Hook. f. Handb. N. Zeal. Fl. 745 (1867) and *E. acuta* var. *tenuis* Carse Trans. N. Zeal. Inst. lvii. 89 (1926) are both typical *E. acuta.*

19. **E. plana** *S. T. Blake* Proc. Roy. Soc. Queensl. xlix. 155 (1938).

Rhizome long-creeping, ca. 2 mm. diam.; culms in distant tufts, erect or oblique, up to 80 cm. high, flat or slightly plano- or concavo-convex, 2–4 (usually 3) mm. wide, longitudinally striate, transversely irregularly rugulose; sheaths rigidly membranous or subherbaceous, striate, the upper one discoloured, thickened, and truncate or nearly truncate at the orifice with a rigid dorsal mucro 1·5–3 mm. long. Spikelet pallid or brownish, linear-cylindrical, subacute, mostly 10–15 mm. long, 2–2·5 mm. wide; glumes, excepting the two lowermost bracteiform, ovate, acute, faintly keeled, thinly membranous, straw-coloured, apex triangular and with the margins broadly hyaline, 3·4–3·7 mm. long; style 3-fid; stamens 3, anthers linear, prominently apiculate, and including the 0·2 mm. long linear appendage, 1·4 mm. long. Nut at length shining brown, obovate, biconvex, turgid, the margins scarcely costate, minutely punctulate or wrinkled, 1·2–1·8 (usually 1·4) mm. long, 1–1·1 mm. wide, the external cells shortly vertically oblong; style-base triangular or ovate, compressed, pallid, cellular, often somewhat hispidulous at the base, about ½ as long and ½ as wide as nut; bristles 6–8, slender, retrorsely scabrous, about as long as the nut together with style-base.—Plate X., figs. 8–11.

Queensland.—Port Curtis District: Herbert Creek, *Bowman* in 1870 (M.); Gracemere, common in wet places, August, 1867, *O'Shanesy* 109 (M.). Darling Downs District: Palardo, west of Miles, in swamps, 1,100 ft., Feb., 1935, *Blake* 7615 (TYPE in B.); Chinchilla, in water, Nov., 1933, *Beasley* 208; and in water or on wet mud in railway enclosure, ca. 985 ft., Feb., 1935, *Blake* 7674; Macalister, April, 1916, *Bick;* Jondaryan, damp depressions in grassland, 1,250 ft., Feb., 1935, *Blake* 7757; Milmerran, around pond in heavy black soil in paddock on cleared Eucalyptus forest land, 1,382 ft., March, 1931, *Hubbard* 5873. Moreton District: Tarampa Creek, *Bailey* (M.); Lawes, near Gatton, bottom of railway embankment, 294 ft., Sept., 1933, *Blake* 4944, 4945.

New South Wales.—Western Plains: Cobar, August, 1911, *Abraham* 145 (S.). North-west Slopes: Liverpool Plains, coll. ? (S.). Northern Tablelands: Tia to Walcha, Nov., 1897, *Maiden* (M.). North Coast: Without further indication of locality or collector (S.). Central Western Slopes: Narramine, Nov., 1892, *Helms* (S.).

A very critical species, often very difficult to distinguish from *E. acuta* and requiring further study. Only six of the above-cited collections are mature and some of these differ among each other somewhat in the size and colour of nut and style-base. In these and other spikelet characters the species is exceedingly like *E. acuta*, but the spikelet is sometimes more obtuse and the style-base often more distinctly hispidulous than ever observed in that species. Well-developd specimens are easily known by the strongly flattened culms as broad as or broader than the spikelet, more or less distinctly ribbed on the margin, and reticulate-wrinkled on the sides. The flattened culm is very prominent in the living plant, and has been remarked upon by more than one collector. In the herbarium they are distinguishable from artificially flattened specimens of *E. acuta* by the fact that they are flat even at the very apex and that the very prominent mucro to the leaf-sheath always occupies the middle of one side of the culm, whereas in *E. acuta* the culm is subtrigonous or subterete under the spikelet and the mucro may appear to occupy any position relative to the flattening of the culm. Slender specimens, such as *Blake* 4944, 4945, both regrowths after fire, are especially difficult to identify.

Bailey's specimens were referred by Bentham to *E. spiralis*, and his description of the latter species is based to some extent on this collection. The broad culm probably led Bentham into this mistake, for otherwise the two species have nothing in common. Clarke and Domin referred the same specimens to *E. cylindrostachys*, which differs sharply in the absence of a creeping rhizome, the more slender terete culms, the very deciduous obtuse glumes, the costate-margined nut, and the very shortly apiculate anthers, and in other characters.

20. **E. pallens** *S. T. Blake* Proc. Roy. Soc. Queensl. xlix. 154 (1938). *E. acuta* var. *pallens* Benth. Fl. Austr. vii. 295 (1878); F. M. Bail. Queensl. Fl. vi. 1755 (1902) and Compreh. Catal. 594 (1913). *E. acuta* Moore Handb. Fl. N. S. Wales 451 (1893) partly; Turner Proc. Linn. Soc. N. S. Wales xxviii. 439 (1903) not p. 306, and xxix. 177 (1904); Ewart & Davies Fl. North Territ. 57 (1917); Black Trans. Roy. Soc. S. Austr. xli. 635 (1917); Cleland, Black, and Reese ibidem xlix. 110 (1925) not of R. Br. *E. Dietrichiana* Baker Proc. Linn. Soc. N. S. Wales xxv. 671 (1900) at least in part; Diels & Pritzel in Engl. Bot. Jahrb. xxxv. 79 (1904); Domin Biblioth. Bot. xx. Heft 85, 447 (1915) excl. Dietrich 714; Maiden & Betche Census N. S. Wales Pl. 28 (1916); Gardner, Enum. Plant. Austr. Occid. 12 (1930); not of Boeck. *E. mucronulata* Palla in Kneucker: Cyperaceae (excl. Carices), Restionaceae, Centrolepidaceae & Juncaceae exsiccatae, Lief vii. nr. 192 (1909) partly, not of Nees.

Rhizome very short; culms very densely tufted, erect or sub-erect, up to 5 dm. high, slender, slightly thickened at base, subterete, smooth but longitudinally prominently 9–10-sulcate, 0·6–1 mm. wide; sheaths firmly membranous, closely appressed, lightly striate, the orifice of the uppermost truncate, thickened and discoloured, with an erect mucro up to 2 mm. long. Spikelet linear-cylindrical, obtuse at the base, acute or subacute at the apex, brown or tawny, usually pallid, dense-flowered, mostly 1–2 cm. long, 2 mm. wide; glumes numerous, closely appressed, rarely somewhat spreading, readily deciduous, ovate or oblong-ovate, acute with a triangular apex, scarious, faintly keeled and more or less stained with brown on the back, otherwise hyaline, 2·9–3·5 mm. long; style 3-fid, very rarely accidentally 2-fid; stamens 3, anthers linear, apiculate, and including the 0·15 mm. long appendage 1·5–2 mm. long. Nut broadly obovate or suborbicular, sometimes somewhat attenuate towards the base, biconvex to subplanoconvex, often turgid, 1·1–1·4 mm. long, 0·9–1·0 mm. wide, tawny, brown, or sometimes dark brown, the margins costiform, the sides smooth or rugulose, usually lightly reticulate, the external cells small, shortly vertically oblong, sometimes rather prominent; style-base very variable in the same spikelet, mostly more or less deltoid or ovate-triangular, most often compressed, pallid or tawny, in the lower part more or less spongy and fimbriolate, as long as up to $\frac{1}{3}$ nut and $\frac{1}{3}$–$\frac{3}{4}$ as wide as it, often, however, strongly depressed and ovate or strongly constricted at base; bristles 7–10 flat, retrorsely scabrous, usually stout, pallid or brownish, usually subequal, shorter or longer than the nut, occasionally short or very long.—Plate X., figs. 12–19.

North Australia.—Upper Victoria River, *Mueller* (M.); Lake Woods, August, 1911, *Hill* 489 (B., S., M.); without definite locality, *Reid* in 1874 (M.).

Central Australia.—Deering Creek, *Horn Expedn.* (T., S.); Charlotte Waters, May, 1875, *Giles* 75 (M.).

Queensland.—Burke District: Hughenden, June, 1919, *Hawthorn.* Mitchell District: Prairie, in depressions in Eucalyptus forest on sand, 1,400 ft., May, 1936, *Blake* 11607; Muttaburra, April, 1919, *White;* Bowen Downs, *Birch* (M.); Darr River, *Birch;* Geera, east of Barcaldine, edge of lagoons on sand, 900 ft., Dec., 1935, *Blake* 10361. Gregory South District: Near Windorah, on alluvial plain, July, 1936, *Blake* 12046; Earlstoun, between Quilpie and Windorah, edge of small stream on mud, April, 1934, *Blake* 5456. Warrego District: Thargomindah, on creek bank, ca. 400 ft., June, 1936, *Blake* 11773; Charleville, on wet mud in Eucalyptus parkland, 950 ft., April, 1936, *Blake* 11042; Offham, ca. 25 miles south of Wyandra, in depressions in grassland, 700 ft., April, 1936, *Blake* 11235 (TYPE in B.); Curragh Station, near Cunnamulla, alongside of bore-drain in brown loam, Jan., 1931, *Hubbard & Winders* 6230. Cunnamulla, wet depressions in grassland plain, 600 ft., April, 1936, *Blake* 11205. Maranoa District: Roma, May, 1914, *Soutter;* and in depressions in Eucalyptus forest, on mud, ca. 1,000 ft., March, 1936, *Blake* 10891; Miltonise Station, ca. 30 miles west of St. George, in gilgai in brigalow (*Acacia harpophylla*) scrub, ca. 600 ft., March, 1936, *Blake* 10814; St. George, May, 1894, *Wedd* 619; Ballandool River, *Looker* 143 (M.); Noondoo Station, near Dirranbandi, depressions in *Eucalyptus coolabah* parkland, ca. 600 ft., Feb., 1936, *Blake* 10583. Darling Downs District: Jondaryan, damp depressions in grassland, 1,250 ft., Feb., 1935, *Blake* 7758; without further indication of locality, *Ford* (M.). Leichhardt District: Comet, *O'Shanesy* 4099 (M.) Port Curtis District: Rosewood, wet places, Jan., 1876, *O'Shanesy* 1570 (M.).

New South Wales.—Far Western Plains: Mount Poole, Sept., 1887, *Bäuerlen* (S.); west of Paroo, *A. W. Mueller* 45 (S.); Mount Murchison, *Bonney* 49 (M.), *Dallachy & Goodwin* (M.); 45 miles east of Broken Hill, May, 1917, *Cleland* (S.); Wonnaminta, Dec., 1887, *Bäuerlen* (S.); beyond the Darling River, Feb., 1867 *Beckler* (M.). Western Plains:

Warrego River, Sept., 1885, *Boorman* 31 (M.); near Bourke, Sept., 1893, *Campbell* (S.); Brewarrina, Nov., 1903, *Boorman* (S.); Namoi River, March, 1887, *Carson & Carson* (M.); Narrabri, Nov., 1935, *Anderson* (S.); Cobar, July, 1911, *Abraham* 151 (S.); Euabalong, May, 1906, *Boorman* (S.); between the Darling and the Lachlan, *Burkitt* (M.); Moama, Feb., 1894, *Guilfoyle* (S.). North-west Slopes: Inverell, Jan., 1913, *Thomas* (S.). Central Western Slopes: Narramine, Nov., 1892, *Helms* (S.). Northern Tablelands: Glen Innes, Jan., 1914, *Rupp* 3 (S.); Armidale, *Perrott* 63, 97 (M.).

Victoria.—Wimmera: Avoca River, dried-out flooded places, Dec., 1853, *Mueller* (M.).

South Australia.—Far North: Cordillo Downs, in watercourse, May, 1924, *Cleland* (Bl., Cl.); Strzelecki Creek, Sept., 1916, *A. S. White* (Bl.); Cooper's Creek, coll. ? (S.). Flinders Range: Mount Lyndhurst, Feb., 1897, *Agric. Bureau of South Australia* 108 (S.). Lake Torrens: Arcoona, round edge of small lake, but on dry land, Sept., 1927, *Murray* (Bl.); by Termination Hill, June, 1883, (T.).

Western Australia.—I have seen no specimens from this State, but from Svenson's notes *Diels* 3726 from Shark Bay seems certainly to belong to the present species.

The species is confined to the Australian mainland and is almost restricted to the interior. It has been consistently confused with *E. acuta* and was regarded as a variety of that species by Bentham, and more recently with *E. Dietrichiana.* From the former it differs in general habit, the lack of a creeping rhizome, the costate margins of the usually smaller nut, the broader bristles, etc., and from the latter in the harder culms, the longer spikelets, the lenticular nut not constricted into a neck, the nature of the style-base and to a lesser extent of the bristles, and from both in the glumes readily deciduous in acropetal succession and usually pale in colour, and in the shorter cristulate appendage to the anthers as well as in details of the style-base. As a matter of fact *E. pallens* is very close to *E. cylindrostachys,* from which it differs chiefly in the more acute spikelets and glumes and the better-developed appendage to the anthers. The confusion surrounding the species has, however, been such that the unravelling of the bibliographical references has proved a very intricate task. Although fairly homogeneous in aspect, considerable variation in floral characters occur. For the most part this variation is restricted to the degree of roughening of the surface of the nut and to the shape and bulk of the style-base. The latter is usually more or less triangular in outline, or else ovate, due to constriction near the base, usually dorso-ventrally flattened, mostly rather less than $\frac{1}{3}$ as long and $\frac{1}{2}$–$\frac{2}{3}$ as wide as nut. There is a tendency for the style-base to become depressed, usually with a coincident tendency towards an increase in breadth and rounding at the apex. Thus in the extreme state, the style-base becomes quite short and extends over the shoulders of the nut, attaining about $\frac{3}{4}$ the width of the latter. Occasionally the larger style-bases show a median line or even a somewhat prominent angle on the abaxial face, and in one such case (*Campbell's* specimens from Bourke in Herb. S.) a faint dorsal angle occurs on some of the nuts. Perhaps the most interesting sport—for one can call these aberrant cases nothing more—is the *very occasional* occurrence of 2-fid styles, usually in spikelets with normal styles as well. This aberration is to be found in some of the specimens cited by Bentham, and appears to be the basis on which Clarke and Domin united this species with *E. Dietrichiana,* which, as pointed out above, was erroneously described by Boeckeler as possessing a 2-fid style. Another interesting aberration occurs in *Mueller* 45 and in *Cleland's* specimens from east of Broken Hill, both in Herb S., in which a short creeping rhizome is developed. The culms are, however, approximate and not in distant tufts, and it appears that some of the plants at least were growing on a steeply sloping bank. The collection constituting the type was selected as such because the large number of specimens in it would seem, from field considerations, to be descendants of possibly a single individual, while at the same time exhibiting nearly every variation yet observed. As no other species of the genus is known to occur within 80 miles (*E. pusilla* occurs at Charleville) and no near relative within 250 miles, there is good reason for believing that these plants are genetically homogeneous.

21. **E. cylindrostachys** *Boeck.* in Flora lviii. 108 (1875); Benth. Fl. Austr. vii. 294 (1878); F. M. Bail. Syn. Queensl. Fl. 594 (1883); Proc. Roy. Soc. Queensl. l. 75 (1884), Catal. Pl. Queensl. 52 (1890), Queensl. Fl. vi. 1755 (1902), Compreh. Catal. 594 (1913); F. Muell. First Census 125 (1882), Sec. Census 211 (1889); Moore Handb. Fl. N. S. Wales 450 (1893); Turner Proc. Linn. Soc. N. S. Wales xxviii. 306 (1903), xxx. 84 (1905); Hamilton ibidem xxxvi. 82 (1911) and Austr. Natur. v. 2 (1913); Domin Biblioth. Bot. xx. Heft 85, 448 (1915); Maiden & Betche Census N. S. Wales Pl. 29 (1916); Dovey, Queensl. Nat. ix. 91 (1935). *E. obtusa* F. Muell. Fragm. viii. 240 (1874), not of Schult.

Rhizome very short or descending; culms tufted, erect or nearly so, mostly 30–50 cm. high, subterete or (when dry) compressed, finely and lightly longitudinally striate, 1–1·7 mm. wide, somewhat thickened at base; sheaths membranous or thinly herbaceous, the uppermost closely striate, appressed, the orifice truncate or slightly oblique, with a prominent, rigid, erect dorsal mucro, brown and usually thickened at the margin. Spikelet pallid or very pale brown (rarely dark brown), linear cylindrical, obtuse, many-flowered, 10–15 mm. long or at length attaining 20 mm. after the fall of the lower glumes, 2·5–3 mm. wide; glumes numerous and very dense, the lowermost short bracteiform persistent, the remainder very deciduous, ovate, obtuse, thinly membranous, keeled, the keel disappearing some distance below the apex, margins broadly hyaline, 2·2–2·5 mm. long; style 3-fid; stamens 3, anthers linear, subacute or most minutely apiculate, 1·0–1·2 mm. long. Nut yellowish to golden brown or brown, obovate, cuneate or slightly attenuate towards base, equally and rather turgidly biconvex, margins prominently ribbed, even over apex, 1·1–1·25 mm. long, 0·7–0·9 mm. wide, sides smooth and shining, cells very minute, shortly vertically oblong but quite inconspicuous; style-base ovate or triangular-ovate, strongly flattened though usually with a median line on the abaxial face, somewhat spongy and roughened, $\frac{1}{3}$ to nearly $\frac{1}{2}$ as long and $\frac{1}{2}$–$\frac{2}{3}$ as wide as nut; bristles 8–9, subequal, brown, rather stout, flattened and striate, closely and shortly retrorsely toothed, about as long as the nut together with style-base.—Plate X., figs. 20–23.

Queensland.—North Kennedy District: Ravenshoe, open swampy ground ca. 3,000 ft., June, 1935, *Blake* 9549. Port Curtis District: Rockhampton, damp places, *Thozet* 813 (M.); Boyne River, *Hartman* 89 (M.); Rosedale, clay-loam waterholes, not common, Nov., 1930, *Dovey* S. 18. Leichhardt District: Wandoan, abundant round lagoons and creeks in heavy soil, 890 ft., with *Juncus* sp., Nov., 1930, *Hubbard* 4991.

Burnett District: Mount Perry, *Keys* 367; Monto, open damp places ca. 750 ft., March, 1937, *Blake* 12825. Darling Downs District: Near Palardo, between Miles and Roma, on creek bank ca. 1,100 ft., May, 1934, *Blake* 5887; Baking Board, 5 miles west of Chinchilla, edge of lagoon, March, 1933, *Quinlan*; Brigalow, in melonhole in dead brigalow scrub ca. 1,000 ft., Feb., 1938, *Blake* 13309; Milmerran, around pond in heavy black soil in paddock from Eucalyptus forest land, 1,382 ft., March, 1931, *Hubbard* 5872; Bald Mountain, near Wallangarra, in railway gutter, 2,750–3,000 ft., Jan., 1933, *Blake* 4462. Moreton District: Buderim, May, 1933, *Middleton;* Durundur Lagoon and Archer's Lagoon, November, 1843, *Leichhardt* (M.); Moreton Bay, Nov., 1858, *Stuart* 111 (M.); various places near Petrie, in or at edge of water, *Blake* 1016, 1046, 1115, 1145, 1219, 1222, 1233; Geebung (Brisbane), in small creek in *Melaleuca nodosa* forest, Nov., 1932, *Blake* 1408; Rocklea (Brisbane), Nov., 1909, *White;* Enoggera Creek, April, 1908, *White;* Brisbane, in swamps, March, 1875, *Bailey;* Yatala, Sept., 1931, *Michael* 1848; Pimpama, Jan., 1933, *Cribb;* Marburg, October, 1930, *Kunze in Herb. Hubbard* 5480; Forest Hill, near Gatton, *Brimblecombe;* Mudgeeraba, in swamp with *Juncus* sp., 15 ft., cleared rain-forest country, Sept., 1930, *Hubbard* 4289; Tamborine Mountain, in stream with *Juncus* spp. and *Sparganium* sp., 1,800 ft., open situation, red soil, very common, May, 1930, *Hubbard* 2521; Lanefield, 38 miles S.W. of Brisbane, in shallow pool in grassland, 152 ft., April, 1930, *Hubbard* 2123.

New South Wales.—North-west Slopes: Nangara Cerek, Barraba, April, 1913, *Rupp* (S.). Northern Tablelands: Wallangarra, April, 1914, *Boorman;* Deepwater, Jan., 1911, *Boorman* (S.); New England, *Stuart* 6, 355 (M.). North Coast: Clarence River, *Wilcox* (M.); Ballina, Dec., 1892, *Bäuerlen* (S.); Coraki to Casino, June, 1906, *Maiden* (S.); Port Macquarie, Feb., 1891, *Boorman* (S.); Awaba, Oct., 1899, *Boorman* (S.). Central Coast: Parramatta, *Woolls* (M.); Richmond, *Woolls* (M.), October, 1910, *Greenwood* (S.); Douglas Park, Dec., 1910, *Hamilton* (S.); Duck Creek, Clyde, March, 1909, *Hamilton* (S.); Nepean River, Dec., 1910, *Hamilton* (S.).

Differs from the American *E. obtusa* (Willd.) Schult, to which it has been referred by Mueller, by the longer, narrower spikelets, the narrower glumes, the constantly 3-fid style, the perennial habit, etc. Among the Australian species it is fairly easily recognised by the long obtuse spikelets and the very deciduous obtuse glumes, though in most characters it is very close to *E. pallens,* as pointed out under that species. In a few specimens from New South Wales the glumes are dark brown.

Series PALUSTRIFORMES sub-series PALUSTRES. Rather rigid, usually stoloniferous perennials with the upper leaf-sheaths oblique at orifice; nuts biconvex, yellow or brown, smooth; style 2-fid; style-base spongy, rarely depressed. (Species 22.)

22. **E. neozelandica** *C. B. Clarke* ex T. Kirk in Trans. N. Zeal. Inst. xxvi., 260 (1894) and Ill. Cyp. t. xxxvi. figs 10–14 (1909); Cheeseman Man. N. Zeal. Fl. 768 (1906).

Rhizome creeping, branched, slender but rigid, 0·7–1 mm. diam., brown to purplish brown. Culms solitary or in distant small tufts, rigid, somewhat spongy, often curved, striate-angular, 0·4–0·5 mm. wide, up to 6 cm. long; sheaths deep purplish near base, firmly membranous, striate, the upper one sometimes red-streaked, somewhat inflated at the rigid oblique or very oblique orifice. Spikelet broadly ovoid, acute to obtuse, 5–7 mm. long, 3–4 mm. wide, 4–10-flowered; glumes broadly ovate, obtuse, 3·3–3·4 mm. long, concave, back 1-nerved, pallid to greenish, sides membranous stained reddish- or purplish-brown, margins hyaline; style short, 2-fid, branches long; stamens 3–2, anthers linear, prominently apiculate, 1·6–1·8 mm. long, including the 0·3 mm. long appendage. Nut shining golden brown, slightly asymmetrically obovate, subequally biconvex with a faint furrow on the abaxial face, not turgid, margins obtuse not costate, 1·7–1·8 mm. long, 1·2–1·3 mm. wide, not constricted below the apex, which is only ¼ as wide, smooth, external cells vertically oblong, minute and inconspicuous; style-base deep brown, very small, sessile, depressed but thin, only 0·2–0·25 mm. high, as wide as apex of nut, the annulus prominent; bristles absent.—Plate X., figs. 24–28.

New Zealand.—North Island: Auckland Province: Tanau Tanau Beach, near Reef Point, sandy margin of tidal creek, Jan., 1915, *Carse.* Wellington Province: Himatangi, near Foxton, boggy places in sand-dunes, March, 1931, *Zotov*. South Island: Nelson Province: Farewell Spit, *Kirk* 1248 (TYPE in Herb. Kew; see below).

An interesting little New Zealand endemic; I have not seen the type, but Dr. Svenson has sent me sketches and notes of its salient characters. These agree with Clarke's figures, so far as the latter go, which were derived from *Kirk* 1005 from Cape Farewell, and indicate a hyaline orifice to the leaf-sheath. In most of the cases I have seen the orifice is more or less brownish, while the degree of obliquity varies considerably. Sometimes it is nearly truncate, sometimes almost lanceolate. Other interesting points are the obliquely obovate nut, one edge being concave inwards near the base, the other slightly convex outwards; the very small style-base; and the absence of bristles. The position of the species in the genus is by no means clear, for while in the characters of style, nut, and leaf-sheath it corresponds closely with the *Palustres*, the very small style-base and complete absence of bristles do not. There does, however, seem to be in New Zealand a distinct tendency for other species to produce unusually small style-bases, so that this species may not be so abnormal in this respect as might appear. It is of course possible that it has been derived from the *E. acuta* type, in which, as has been pointed out above, tendencies towards the reduction in style-branches, reduction in size and development of style-base and bristles, and increase in degree of obliquity of orifice of leaf-sheath have been observed.

Series Maculosae. Nut biconvex, black to reddish-brown or olive, the surface smooth or minutely wrinkled; style 2-fid; style base conical or depressed, not strongly flattened. There are two sub-series, differentiated as follows:—

> Sub-series Rigidae. Non-stoloniferous annuals with sheaths firm at the apex. Nuts black or purplish, the pericarp not marcescent (Species 23–24).
>
> Sub-series Ocreatae. Stoloniferous perennials, the sheaths scarious at the apex. Nuts black to reddish-brown or olivaceous, the pericarp marcescent, often slightly wrinkled. (Species 25.)

The species of this series are chiefly tropical, and especially numerous in America.

23. **E. geniculata** (*L.*) *R. & S.* Syst. Veg. ii. 150 (1817); Svenson, Rhodora xli. 50 (1939). *Scirpus geniculatus* L. Sp. Pl. i. 48 (1753) partly. *S. caribaeus* Rottb. Descrip. Pl. Rar. Progr. 24 (1772). *E. caribaea* (Rottb.) S. F. Blake in Rhodora xx. 24 (1918); Svenson ibid. xxxi. 225 (1929). *E. capitata* R. Br. Prodr. 225 (1810); F. Muell. Fragm. vi. 94 (1867), viii. 240 (1874), First Census 125 (1882), Sec. Census 211 (1889); Boeck. Linnaea xxxvi. 461 (1869-70); Benth. Fl. Austr. vii. 296 (1878); F. M. Bail. Syn. Queensl. Fl. 594 (1883), Catal. Pl. Queensl. 52 (1890), Queensl. Fl. vi. 1756 (1902), Compreh. Catal. 594 (1913); Tate in Rep. Horn Exp. iii. 181 (1896); Domin Biblioth. Bot. xx. Heft 85, 446 (1915); Ewart and Davies Fl. North. Territ. 57 (1917). *E. setacea* R. Br. Prodr. 225 (1810), not Prodr. 224. *S. Brownei* Spreng. Syst. i. 204 (1825); *Eleogenus capitata* Nees in Wight Contrib. Bot. Ind. 112 (1834); *Chlorocharis capitata* Rikli in Pringsh. Jahrb. xxvii. 564 (1895).

Annual; culms oblique to erect up to 4 dm. long and up to 0·7 mm. wide, rather rigid, angular-striate; sheaths rather rigid, appressed, purplish at base, uppermost with a rigid, oblique and more or less lanceolate orifice. Spikelets mostly rather reddish brown, globose to ovoid, 4–5 mm. long, 3·5–4 mm. wide; glumes dense, deciduous, broadly ovate to broadly obovate (suborbicular), very obtuse, membranous, more or less stained with brown, keeled, keel mostly greenish or pallid, 1·8–2 mm. long; style 2-fid; stamens 2 or 3; anthers linear-oblong, minutely apiculate, 0·5 mm. long. Nut shining black, obovate with rounded apex, biconvex with faintly ribbed margins, 0·9–1 mm. long, 0·7–0·8 mm. wide, the sides smooth with the minute subquadrate external cells quite inconspicuous; style-base white and spongy, conical to ovate but usually depressed, in height not exceeding $\frac{1}{5}$ the length of the nut and scarcely $\frac{1}{3}$ as wide as it; bristles 6–8, rather coarse, somewhat scabrous, brown to white, usually as long or somewhat longer than nut.—Plate X., figs. 29–31.

Western Australia.—South-west Division: Murchison River, wet places by the Brook Oolinyarrah, *Oldfield* (M.).

North Australia.—Victoria River, *Mueller* in 1855 (M.); on creeks flowing into the Victoria River, Nov., 1855, *Mueller* (M.); Sea Range, *Mueller* in 1855, (M.).

Central Australia.—Palm Creek, Glen of Palms, July, 1894, *Tate* (T., M.).

Queensland.—Burke District: Carpentaria, *R. Brown* (B., S., M.); Riversleigh, on brink of Gregory River, 19° 0′ S., 138° 45′ E., April, 1935, *Blake* 8692; Normanton, on low sandpan, May, 1935, *Blake* 8985, and on open slightly saline swampy ground, August, 1936, *Blake* 12489. Cook District: Chillagoe, Dec., 1925, *Campbell* (S.), and in wet places among limestone boulders near creek, 1,150 ft., March, 1938, *Blake* 13539; Mareeba, on bank of Granite Creek on wet sand, 1,300 ft., June, 1935, *Blake* 9523; Newcastle Range, between Forsayth and Einasleigh, sandstone country, in gullies, Feb., 1928, *Brass* 1755; Einasleigh, in swamps, *Armit* 461 (B.M.); Barron River Gorge, near Cairns, below 100 ft., on wet sand, June, 1935, *Blake* 9441. Moreton District: Coolum, wet muddy places chiefly near the sea, April, 1938, *Blake* 13741; Caloundra, in a rock crevice facing the sea, August, 1932, *Blake* 1379;

Moreton Island, edge of *Juncus maritimus* swamp, May, 1937, *Blake* 13035; Stradbroke Island, at Point Lookout, in wet places near the sea, July, 1938, *Blake* 13824.

In most warm countries, both in the Old and in the New World. In Queensland its chief habitats appear to be of a calcareous or saline nature. The hypogynous bristles are usually described as brown in colour, but in Australian specimens they are usually white. Occasionally they are absent, but appear to be always present in Australian plants.

The nomenclature of this species has been the cause of extreme confusion as it has also involved the status of commonly used names of other species. It has now been shown that the name *E. capitata* R. Br. was *not* based on *Scirpus capitatus* L., and that Brown's species is identical with *S. geniculatus* L. Hence the correct name is *E. geniculata* (L.) R. & S. although the American species which has usually been so called is *E. elegans* (HBK) R. & S. A more thorough statement of the position is given by Svenson in Rhodora xli. pp. 50-51 (1939), which came to hand as this paper was in press.

24. **E. atropurpurea** (*Retz.*) *Kunth* Enum. ii. 151 (1837); Boeck. Linnaea xxxvi. 458 (1869–70) excl. vars.; F. Muell. Fragm. viii. 240 (1874), First Census 125 (1882), and Sec. Census 211 (1889); Benth. Fl. Austr. vii. 296 (1878) partly; C. B. Clarke Ill. Cyp. t. xxxvi. figs. 6–9 (1909); Domin Biblioth. Bot. xx. Heft 85, 446 (1915); Ewart and Davies Fl. North. Territ. 57 (1917); W. V. Fitzgerald Proc. Roy. Soc. W. Austr. iii. 118 (1918); Svenson Rhodora xxxi. 227 (1929); Gardner Enum. Plant. Austr. Occid. 12 (1930); not of F. M. Bail., Moore, or Maiden and Betche. *E. atropurpurea* var. *setiformis* Benth. Fl. Austr. vii. 297 (1878); F. M. Bail. Syn. Queensl. Fl. 595 (1883), Catal. Pl. Queensl. 52 (1890), Queensl. Fl. vi. 1756 (1902), and Compreh. Catal. 594 (1913). *Scirpus atropurpureus* Retz. Obs. v. 14 (1789).

Annual, usually dwarf; culms tufted, up to 10 cm. long but mostly much smaller, filiform but more or less triquetrous, rarely exceeding 0·3 mm. wide; sheaths thin, purplish or brownish at base, apex of uppermost appressed, firm but thin, oblique or attenuate. Spikelet ovoid oblong, obtuse, mostly blackish, 2–4 mm. long, 1·5–2 mm. wide; glumes numerous, dense, at length more or less spreading, elliptic, obtuse, membranous, keeled, keel greenish, sides stained purplish brown, mostly 1–1·3 mm. long; style 2-fid; stamen 1, anther linear or oblong-linear, obtuse, most minutely apiculate, 0·3 mm. long. Nut 0·6–0·65 mm. long, 0·4–0·45 mm. wide, glistening black and almost quite smooth, obovate, rounded or rarely subtruncate at apex, biconvex, the margins very narrowly ribbed, the sides sometimes minutely striate, the external cells very minute and inconspicuous; style-base very small, strongly depressed, white, $\frac{1}{4}$–$\frac{1}{3}$ as wide as nut, ca. 0·05 mm. high; bristles mostly 4–6, slender, glistening white, translucent, minutely scabrous or nearly smooth, shorter than nut, sometimes rudimentary or absent.—Plate X., figs. 32–33.

Western Australia.—Kimberley Division: Isdell River, 5 miles below Mount Bartlett, July, 1905, *Fitzgerald* 1274 (ex P.).

North Australia.—Victoria River, *Mueller* (M.).

Queensland.—Cook District: Koolatah, 15° 15′ S., 142° 25′ E., on edge of lagoon, ca. 200 ft., August, 1936, *Blake* 12596; North of Chillagoe, in channels of Walsh River on sand, ca. 1,000 ft., April, 1938, *Blake* 13622; Mount Molloy, banks of lagoons, April, 1932, *Brass* 2484; Cairns in *Melaleuca* swamp at about sea-level, June, 1935, *Blake* 9359. Burke

District: Near Normanton, 17° 10′ S., 141° 15′ E., edge of fresh-water lagoon, August, 1936, *Blake* 12627; Normanton, edge of lagoon, August, 1936, *Blake* 12521; Carron Creek, *Gulliver* 14 (M.). Mitchell District: Edge of Warrigal swamp near Torrens Creek, March, 1933, *White* 8777. Leichhardt District: Gainsford, *Bowman* (M.). Port Curtis District: Rockhampton, wet places, August, 1867, *O'Shanesy* 95 (M.), Nov., 1867, *O'Shanesy* 65, ser. 8 (M.); Gracemere, annual rills on sides of ranges, Nov., 1870, *O'Shanesy* 1272 (M.). Maranoa District: Miltonise Station, about 30 miles west of St. George, in gilgai in brigalow (*Acacia harpophylla*) scrub, ca. 600 ft., March, 1936, *Blake* 10819.

Scattered through the tropical regions of both the Old and the New World.

The species can be readily identified by the tiny glistening black nut and the translucent bristles. The preceding species is its closest relative in Australia, but besides the smaller size of all its parts, the glumes of *E. atropurpurea* are more prominently keeled, giving to the spikelet a distinctly angular appearance, and usually blacker in colour. In *Blake* 12521 the plants are unusually coarse (culms up to 0·6 mm. wide) and lax, and the glumes are up to 1·4 mm. long.

Bentham confused this species with the following one (*E. minuta*). The copious synonymy of the species is cited by Svenson *loc. cit.*

25. **E. minuta** *Boeck.* in Engler Bot. Jahrb. v. 503 (1884). *E. atropurpurea* Benth. Fl. Austr. vii. 296 (1878) partly and excl. var.; F. Muell. First Census 125 (1882) partly and Sec. Census 211 (1889) partly; F. M. Bailey Syn. Queensl. Fl. 595 (1883), Catal. Pl. Queensl. 52 (1890), Queensl. Fl. vi. 1756 (1902), Compreh. Catal. 594 (1913) all excl. var.; Moore, Handb. Fl. N. S. Wales 451 (1893); Maiden and Betche Census N. S. Wales Pl. 28 (1916). *E. Maidenii* Kükenthal in Fedde, Rep. Spec. Nov. xiii. 135 (1914) incl. var. *subaquatica*. *E. ocreata* Domin Biblioth. Bot. xx. Heft 85, 446 (1915) not of Nees.

Perennial, but flowering the first year, sometimes producing short stolons or rhizomes. Culms tufted, at times also some in rather loose linear series when rhizomes are present, erect, spreading or recurved, mostly 5–15 cm. long but frequently smaller, and sometimes up to 20 cm., angular-sulcate and usually rather soft and compressible, 0·4–0·6 mm. wide; sheaths purplish at base, thinly membranous, dilated, oblique, thinly scarious, and often torn at the orifice. Spikelet ovoid or oblong-ovoid, obtuse or sub-acute, dark-coloured, 3–7 mm. long, 2 mm. wide, dense-flowered; glumes numerous, elliptic-ovate, obtuse, membranous, keeled, keel green rather prominent, sides stained with purplish-brown above, 1·7–1·8 mm. long; style 2-fid; stamens 2, anthers oblong-linear, minutely apiculate, 0·35–0·4 mm. long. Nut obovate, sometimes slightly attenuate near the base, rather turgidly biconvex, margins ribbed, 0·95–1 mm. long, 0·65–0·7 mm. wide, shining, minutely reticulate and roughened, olivaceous to dark greenish brown but the pericarp tending to blacken and wither at maturity, the external cells vertically oblong; style-base whitish, depressed, conical-acuminate, about $\frac{1}{6}$ as long and $\frac{1}{3}$ as wide as nut, the annulus prominent, somewhat wider than the rounded apex of the latter, upwardly curved from the middle; bristles 7–5, firm, unequal, shorter or somewhat longer than the nut, retrorsely scabrous, whitish, strongly united at base, somewhat translucent when young.—Plate X., figs. 34–37.

Queensland.—Wide Bay District: Nikenbah, N.E. from Maryborough, June, 1927, *Tryon*. Moreton District: Coolum, in wet places, April, 1938, *Blake* 13794; Buderim, May, 1933, *Middleton;* Caloundra, in swamp near coast, August, 1932, *Blake* 1372; Petrie and neighbourhood, in swampy places, *Blake* 1143, 1254, 1255, 1262; various places in the neighbourhood of Brisbane in wet places, *Blake* 1271, 1361, 1423, 1436, 4723, 4724, 5018, 12967, *Bailey* 56 (M.), 91 (B., M.), *White;* Tamborine Mountain, ca. 45 miles S. of Brisbane, in stream through pastures, red soil, 1,800 ft., May, 1930, *Hubbard* 2524; Stradbroke Island, edge of *Melaleuca* swamp, Dec., 1934, *Blake* 7100; and in wet places inland near Point Lookout, July, 1938, *Blake* 13825.

New South Wales.—North Coast: Byron Bay, *Forsyth* 37 (S.). Central Coast: Narrabeen, near Sydney, inundated in lagoon and in dry claypan, April, 1909, *Hamilton* (S.), on marshy ground, Jan., 1935, *Blake* 7430; Centennial Park, Sydney, Jan., 1909, *Hamilton* (S.), "growing under water," Feb., 1909, *Hamilton* (S.), "whole plant (except the inflorescence) submerged in the ponds," Jan., 1900, *Cheel* (S.).

Victoria.—Central District: Port Melbourne, near mouth of Yarra River, Dec., 1891, Feb., 1892, Dec., 1894, March, 1895, *Reader* (M.).

And in East Africa, Socotra, Madagascar, and Mauritius.

I am indebted to Dr. Svenson for the identification of this species.

There is a great deal of variation, particularly in habit, and this may be indicated as follows:—

(1.) The most common state is that in which the plants form often dense tufts with culms of medium height and rigidity; soft rhizomes or stolons are sometimes developed. This is typical *E. Maidenii*, and, according to Svenson, is indistinguishable from the type of *E. minuta*.

(2.) Cheel's specimens and one collection of Hamilton's from Centennial Park, both indicated as being taken from submerged plants, have elongated very flaccid culms up to 3 dm. long with greenish spikelets. They form the basis of *E. Maidenii* var. *subaquatica* Kükenthal, but are certainly merely an accidental state due to the habitat.

(3.) The Victorian specimens have well-developed hardened rhizomes, rigid culms with prominent scarious sheaths, nearly globular spikelets, browner nuts, and rather larger style-bases. Hamilton's collection from a dry clay-pan at Narrabeen approaches them very closely.

(4.) *Blake* 12967 comprises mostly tiny plants with few tufted filiform culms, and are very similar in appearance to small plants of *E. atropurpurea*. They are flowering in their first year, and are clearly the result of the unusually rapid drying-up of the ground due to adverse weather conditions. Similar dwarf and depauperate plants of other species were associated, while normal plants occupied wet places nearby.

The Victorian plants are the least closely bound to the general trend on account of the browner nut. Generally the nut is yellowish when very young, later becomes greenish, and then greenish-brown. At extreme maturity the pericarp becomes wrinkled and blackish on the wrinkles.

EXCLUDED OR DOUBTFUL SPECIES.

Eleocharis geniculata *R. Br.* Prodr. 224 (1910). [i.e. *E. elegans* (HBK) R. & S.] According to Domin in Biblioth. Bot. xx. Heft 85, 449 (1915) this American species has been introduced to the neighbourhood of Sydney, where it was collected by Hooker. I have seen no specimen from thence.

E. halmaturina *J. M. Black* Trans. Roy. Soc. S. Austr. li. 378 (1927). This species was based on very immature specimens collected by Cleland on Kangaroo Island. It is certainly no *Eleocharis*, and the specimens appear to be small plants of a *Tetraria*.

RELATIONSHIPS.

The geographical relationships of the Australasian species of *Eleocharis* are summarised in the following table:—

TABLE SHOWING GEOGRAPHICAL RANGE OF THE AUSTRALASIAN SPECIES OF ELEOCHARIS.

AUSTRALASIAN ENDEMICS.			WIDES.				
				OLD WORLD TROPICS.			
AUSTRALIA.	NEW ZEALAND.		PANTROPICAL.	Australia-India.	Australia-India-Madagascar.	Australia-Africa.	INTRODUCED.
difformis ..	*neozelandica* ..	*sphacelata* ..	*fistulosa* ..	*philippinensis* ..	*spiralis* ..	*cæspitosissima* ..	*pachycarpa*
Brassii ..		*pusilla* ..	*geniculata* ..	*tetraquetra* ..	*dulcis* ..	*minuta* ..	
nuda ..		*gracilis* ..	*atropurpurea* ..		*equisetina* ..		
atricha ..		*acuta* ..	(also N. Temp.)				
Dietrichiana ..			*nigrescens* ? ..				
plana ..							
pallens ..							
cylindrostachys ..							
Total— 8 (32%)	1 (4%)	4 (16%)	4 (16%)	2 (8%)	3 (12%)	2 (8%)	1 (4%)
				5 (20%)			
13 (52%)			12 (48%)				

The chief phylogenetic interest centres round those groups in which endemic species occur. These are the *Mutatae*, the *Multicaules* and *Acutae* together with *E. neozelandica*, and the *Aciculares*. The *Mutatae* comprise in all 18 or 19 species, none of which occur in Europe. In Africa 5 or 6 species are known. One of these, *E. fistulosa*, is widespread, *E. variegata* is endemic to Madagascar and Mauritius but is closely related to the Indo-Malayan *E. laxiflora*. *E. spiralis, E. dulcis*, and *E. equisetina* are found in Madagascar. The remainder of the distribution is as follows:—

Asia (South-east and Malaya): *fistulosa, spiralis, dulcis, equisetina, philippinensis, laxiflora.**

Australia: *fistulosa, spiralis, dulcis, equisetina, philippinensis, sphacelata,* nuda,* Brassii,* difformis.**

Central America, West Indies, Northern South America: *fistulosa, cellulosa, mutata,* plicarhachis,* interstincta.**

North America (Eastern): *cellulosa, equisetoides,* quadrangulata,* Robbinsii,* elongata.**

There thus appears to be two major centres of concentration, one in the Old World and one in the New World. One species, *E. acutangula*, is common to both, though there is a tendency towards the development of distinct trends, and *E. spiralis* of the Old World is closely allied to *E. cellulosa* of the New World. The other American species need not concern us here except for the fact that *E. Robbinsii* and less frequently *E. elongata* exhibit the primitive character of a trigonous nut. Of the 10 species occurring in Asia and Australia, 9 occur on the latter continent (all to be found in Queensland), and four are restricted thereto (except that *E. sphacelata* also occurs in New Zealand). This is interesting, for it is scarcely in accordance with the generally accepted dictum that much of the flora of northern Australia is of Indo-Malayan origin. This theory has been greatly over-stressed, while far too little attention has been given to the possibility that northern Australia may have been a centre of distribution from which Malaya may have received part of its flora. There is quite a lot of evidence in favour of the latter, and a great deal against the former generally accepted view, though this is scarcely the place to discuss the subject.

The group of species *E. gracilis, E. pachycarpa, E. Dietrichiana, E. tetraquetra, E. acuta, E. plana, E. pallens, E. cylindrostachys*, and *E. neozelandica* is a most interesting one, and though distributed between four series, the species are undoubtedly closely allied. Whether *E. pachycarpa* be truly indigenous or only introduced as seems more likely, matters little. Chiefly by reason of its triquetrous nut and well-developed rhizome *E. gracilis* appears to be the most primitive member of the group, while the affinities of the other species may be indicated as follows:—

E. gracilis	⟶	cf. *E. pachycarpa*	⟶	*E. tetraquetra*
↓		↓		
E. Dietrichiana				
↓				
E. pallens		*E. acuta*	⟶	*E. neozelandica*
↓		↓		
E. cylindrostachys		*E. plana*		

* The species endemic in the respective areas are indicated by an asterisk.
Recently admitted or described species brings the number up to 23. Of the extra species 2 are endemic in Africa, and 2 in Central America, etc.

There seems little doubt that the group is of southern origin. *E. tetraquetra*, however, extends into south-eastern Asia, having a somewhat similar range to some of the *Mutatae*.

The *Aciculares* find their greatest development in America (south-western United States, Mexico, and the Andes), where all the species of the series are found, except for the two Australian species. One of the latter, *E. pusilla*, is most closely allied to an Andean species, while *E. atricha* appears to hold an isolated position in the series.

INDEX.

In the following index only names based on Australasian specimens are mentioned:—

plana S. T. Blake	19
plantaginea F. Muell.	*E. equisetina*
plantaginoides Domin	*E. equisetina*
pusilla R. Br.	10
radicans Hook f.	*E. gracilis*
setacea R. Br.	*E. caribaea*
sphacelata R. Br.	7
sphacelata auctt.	*E. sphacelata* + *E. dulcis* + *E. equisetina*
spiralis Benth.	*E. spiralis* and *E. plana*
spiralis R. & S.	2
striatula C. B. Clarke	*E. pusilla*
tetraquetra Nees	15
tuberosa R. & S.	*E. dulcis*
variegata Benth.	*E. spiralis* and *E. Brassii*
variegata Fitzg.	*E. philippinensis*
Isolepis—	
acicularis A. Rich.	*E. gracilis*
Scirpus—	
acutus Poir.	*E. acuta*
compactus Spreng.	*E. spiralis*
isdellensis Fitzg.	*E. caespitosissima*
pumilio Spreng.	*E. pusilla*
pusillus Poir.	*E. pusilla*
sphacelatus Poir.	*E. sphacelata*
tener Spreng.	*E. acuta*

EXPLANATION OF PLATES.

In all plates the nut is shown from the dorsal (abaxial) view with the filaments removed, the transverse section of the nut with the dorsal side or angle downwards, the flower from the adaxial view, and the glume from the abaxial view.

PLATE VII.: SERIES *MUTATAE*.

FIGS. 1–3, *Eleocharis fistulosa* (*Blake* 9371); 1, spikelet, natural size; 2, glume, x 5; 3, nut, x 15. FIGS. 4–6, *E. spiralis* (*Blake* 12790): 4, spikelet, natural size; 5, glume, x 5; 6, nut, x 15. FIGS. 7–10, *E. philippinensis* (*Blake* 12968): 7, spikelet, natural size; 8, transverse secton of culm, x 2; 9, glume, x 5; 10, nut, x 15. FIGS. 11–15, *E. difformis* (*Blake* 13203); 11, terrestrial plant, natural size; 12, glume, x 5; 13, flower, x 5; 14, nut, x 15; 15, surface of nut, x 50. FIGS. 16–19, *E. Brassii* (*Brass* 1864): 16, portion of plant, natural size; 17, glume, x 5; 18, flower, x 5; 19, nut, x 10. FIGS. 20–22, *E. nuda* (*Blake* 9360): 20, spikelet, natural size; 21, glume, x 5; 22, nut, x 15.

PLATE VIII.: SERIES *MUTATAE* AND *ACICULARES*.

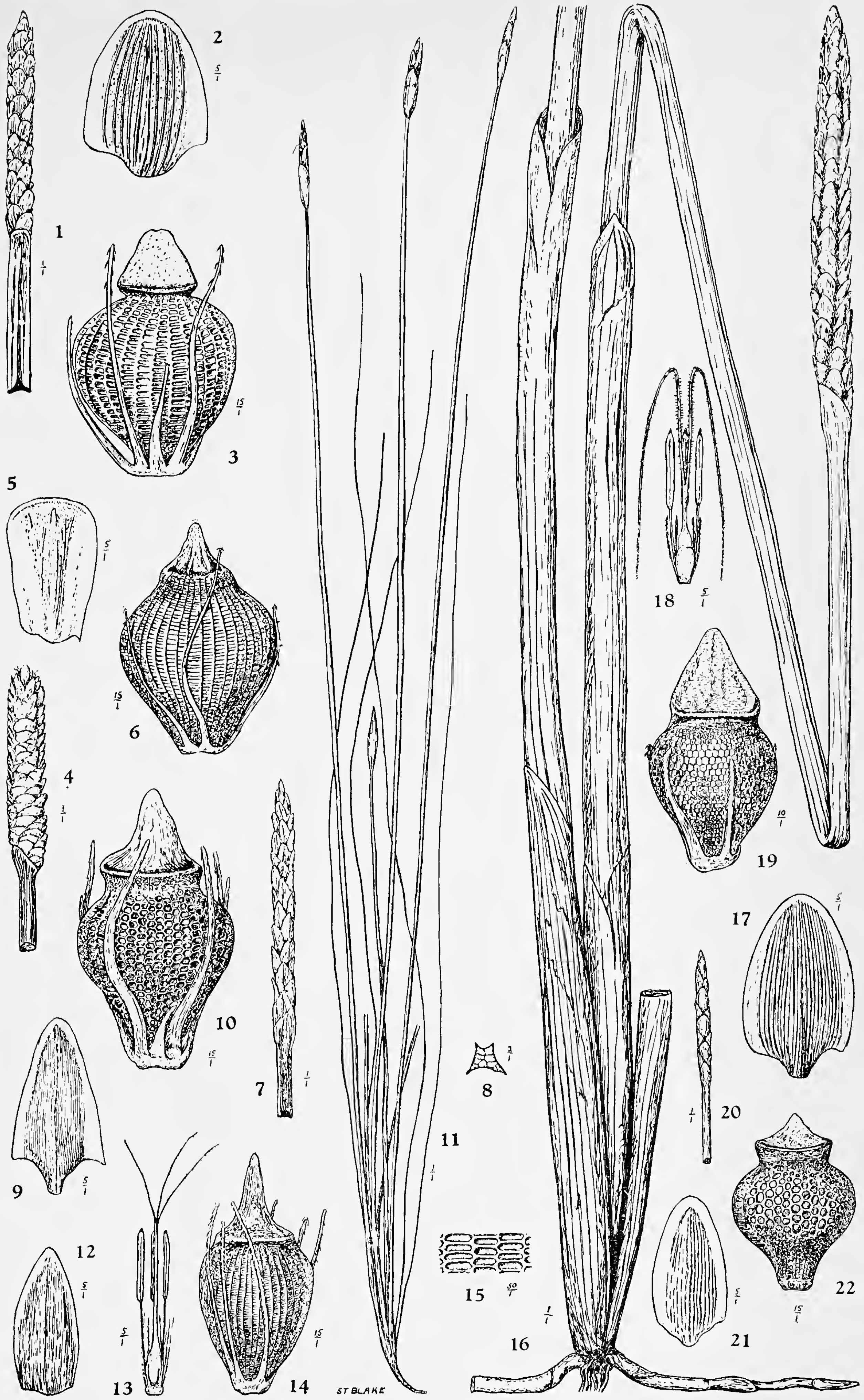
FIGS. 1–5, *Eleocharis sphacelata* (*Blake* 4618): 1, base of plant, natural size; 2, upper part of culm with spikelet, natural size; 3, glume, x 5; 4, nut, x 10; 5, surface of nut, x 50. FIGS. 6–9, *E. dulcis* (*Blake* 4781): 6, spikelet, natural size; 7, glume, x 5; 8, nut, x 10; 9, surface of nut, x 50. FIGS. 10–13, *E. equisetina* (*Blake* 1440): 10, spikelet, natural size; 11, glume, x 5; 12, nut, x 10; 13, surface of nut, x 50. FIGS. 14–19, *E. pusilla* (*Blake* 4943): 14, plant, natural size; 15, glume, x 10; 16, flower, x 10; 17, nut, x 20; 18, transverse section of same; 19, surface of nut, x 50. FIGS. 20–24, *E. atricha* (*Blake* 7537): 20, plant, natural size; 21, glume, x 5; 22, nut, x 20; 23, transverse section of same; 24, surface of nut, x 50.

PLATE IX.: SERIES *TENUISSIMAE*, *SULCATAE*, AND *MULTICAULES*.

FIGS. 1–4, *Eleocharis nigrescens* (*Blake* 13398): 1, plant, natural size; 2, flower, x 15; 3, nut, x 25; 4, transverse section of same. FIGS. 5–7, *E. caespitosissima* (*Fitzgerald* 1043): 5, plant, natural size; 6, nut, x 15; 7, surface of nut, x 50. FIGS. 8–11, *E. pachycarpa* (*Camfield*): 8, spikelet, natural size; 9, upper part of leaf-sheath, x 5; 10, nut, x 15; 11, transverse section of same. FIGS. 12–15, *E. tetraquetra* (*Blake* 13761): 12, spikelet, natural size; 13, upper part of leaf-sheath, x 5; 14, nut, x 15; 15, transverse section of same. FIGS. 16–22, *E. gracilis* (*Blake* 7431): 16, plant, natural size; 17, upper part of leaf-sheath, x 5; 18, glume, x 7; 19, flower, x 7; 20, nut, x 15; 21, transverse section of same; 22, surface of nut, x 50. FIGS. 23–29, *E. Dietrichiana* (*Dietrich* 714): 23, plant, natural size; 24, upper part of leaf-sheath, x 5; 25, glume, x 7; 26, flower, x 7; 27, nut, x 15; 28, transverse section of same; 29, surface of nut, x 50.

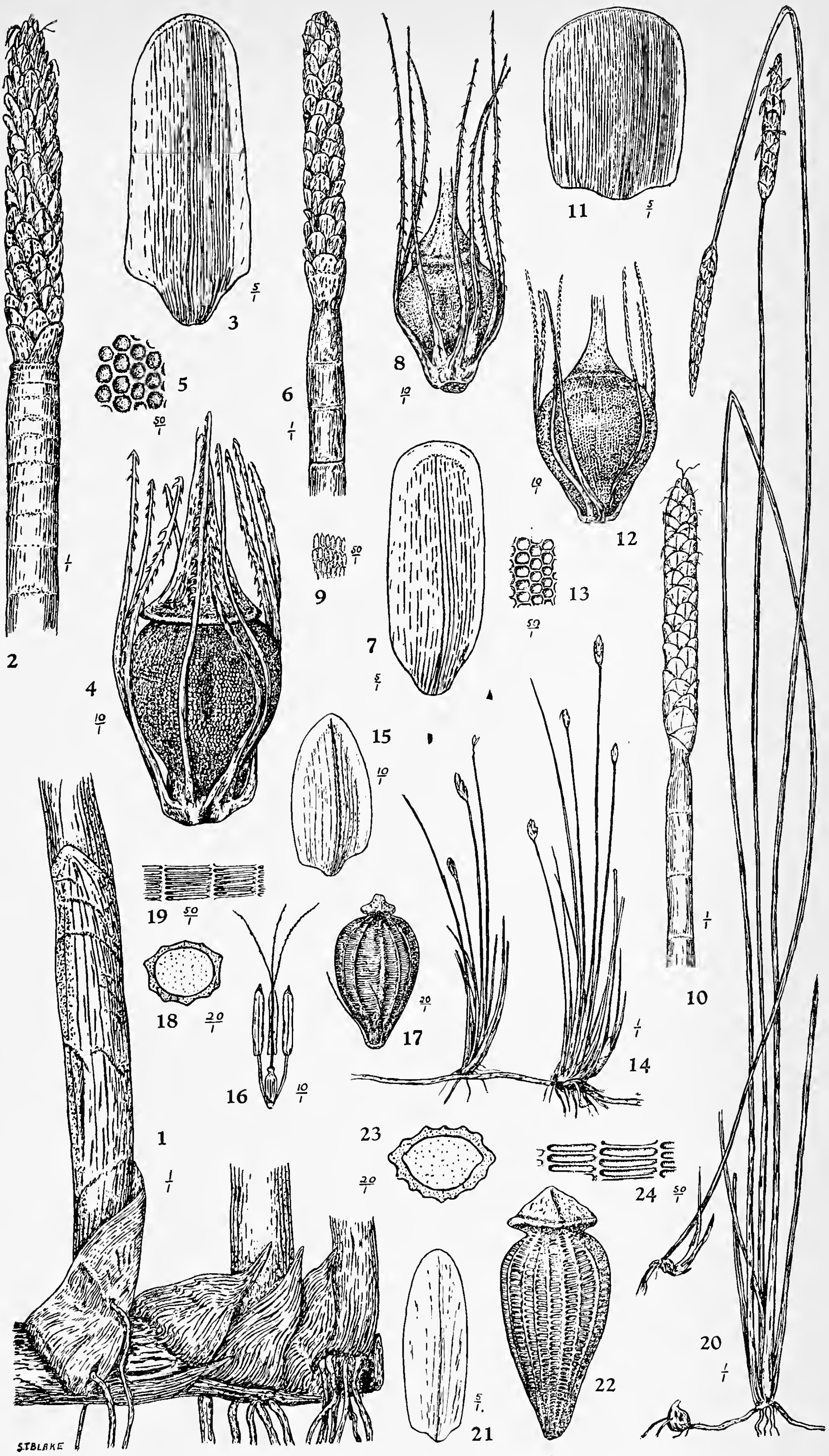
PLATE X.: SERIES *ACUTAE, PALUSTRIFORMES,* AND *MACULOSAE.*

FIGS. 1–7, *Eleocharis acuta* (*Blake* 7539): 1, plant, natural size; 2, upper part of leaf-sheath, x 2; 3, glume, x 7; 4, flower, x 7; 5, nut, x 15; 6, transverse section of same; 7, surface of nut, x 50. FIGS. 8–11, *E. plana* (*Blake* 7615): 8, spikelet, natural size; 9, upper part of leaf-sheath, natural size; 10, transverse section of culm, x 2; 11, nut x 15. FIGS. 12–19, *E. pallens* (*Blake* 11235) 12, portion of plant, natural size; 13, upper part of leaf-sheath, x 5; 14, glume, x 7; 15, flower, x 7; 16, nut, x 15; 17, transverse section of same; 18, upper part of another nut, x 15; 19, surface of nut, x 50. FIGS. 20–23, *E. cylindrostachys* (*Blake* 13309): 20, spikelet, natural size; 21, glume, x 7; 22, nut, x 15; 23, transverse section of same. FIGS. 24–28, *E. neozelandica* (*Carse*): 24, portion of plant, natural size; 25, flower, x 7; 26, nut, x 15; 27, transverse section of same; 28, surface of nut, x 50. FIGS. 29–31, *E. geniculata* (*Blake* 13539): 29, plant, natural size; 30, nut, x 15; 31, transverse section of same. FIGS. 32–33, *E. atropurpurea* (*Blake* 13622): 32, plant, natural size; 33, nut, x 15. FIGS. 34–37, *E. minuta* (*Blake* 4724): 34, portions of two plants, natural size; 35, flower, x 10; 36, nut, x 15; 37, surface of nut, x 50.



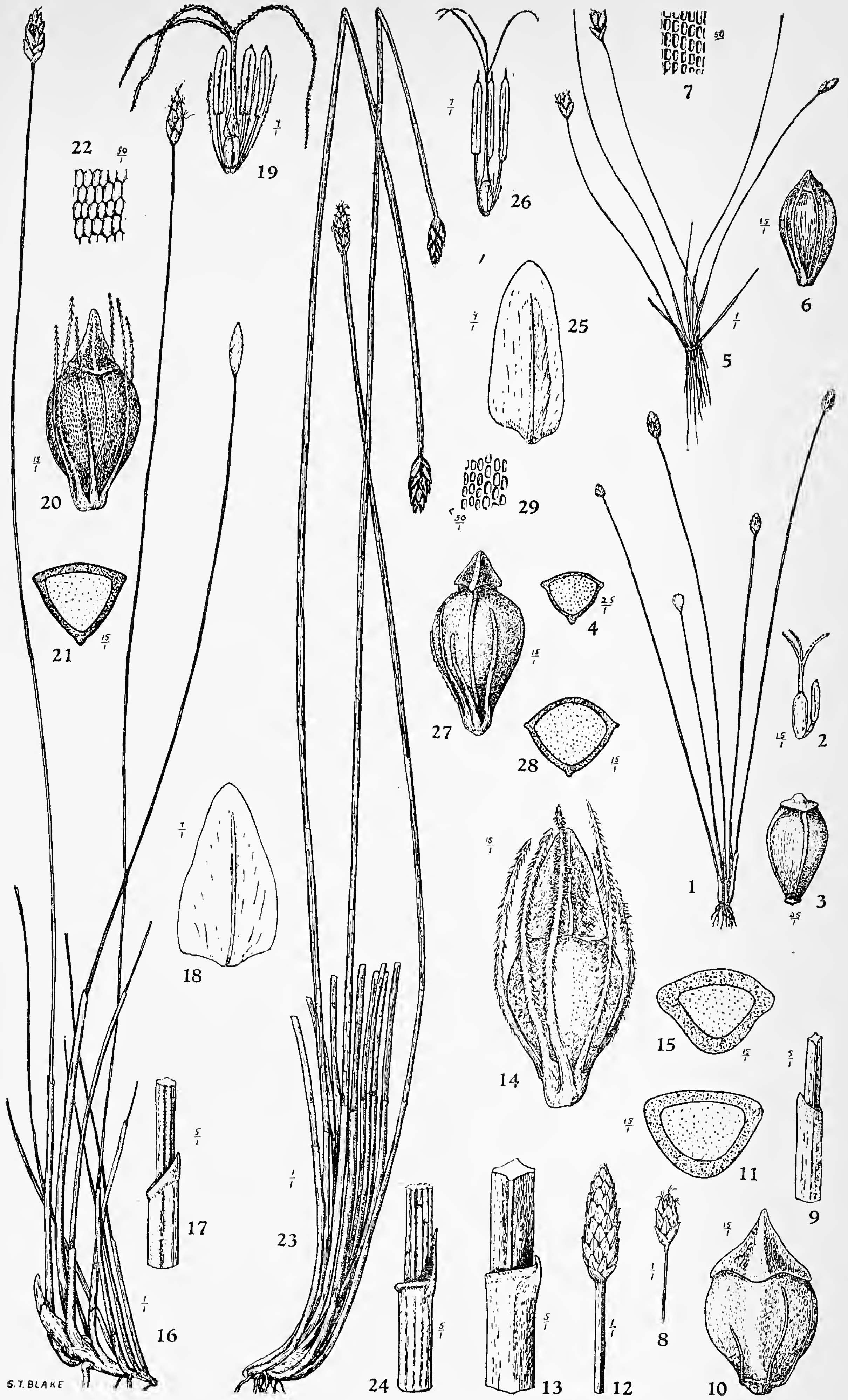
Eleocharis, *Series* Mutatae.

Figs. 1-3, *Eleocharis fistulosa* (Poir.) Link. Figs. 4-6, *E. spiralis* (Rottb.) R. & S. Figs. 7-10, *E. philippinensis* Svenson. Figs. 11-15, *E. difformis* S. T. Blake. Figs. 16-19, *E. Brassii* S. T. Blake. Figs. 20-22, *E. nuda* C. B. Clarke.



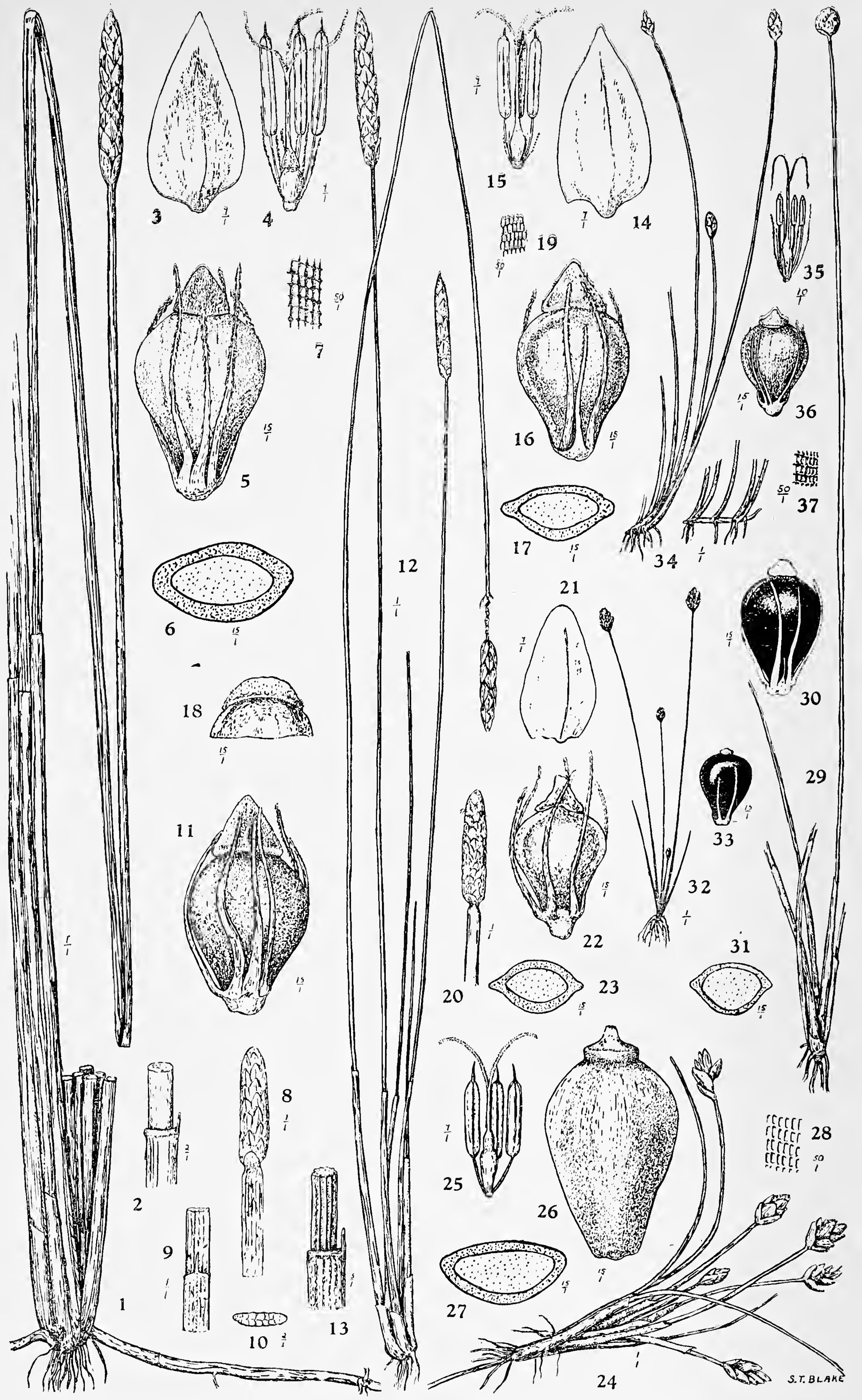
ELEOCHARIS, *Series* MUTATAE *and* ACICULARES.

Figs. 1-5, *Eleocharis sphacelata* R.Br. Figs. 6-9, *E. dulcis* (Burm. f.) Trin. Figs. 10-13, *E. equisetina* Presl. Figs. 14-19, *E. pusilla* R.Br. Figs. 20-24, *E. atricha* R.Br. (Fig. 22 x 20.)



ELEOCHARIS, *Series* TENUISSIMAE, SULCATAE, *and* MULTICAULES.

Figs. 1-4, *E. nigrescens* (Nees) Steud. Figs. 5-7, *E. caespitosissima* Baker. Figs. 8-11, *E. pachycarpa* Desv. Figs. 12-15, *E. tetraquetra Nees.* Figs. 16-22, *E. gracilis* R.Br. Figs. 23-29, *E. Dietrichiana* Boeck.



ELEOCHARIS, *Series* ACUTAE, PALUSTRIFORMES, *and* MACULOSAE.

Figs. 1-7, *E. acuta* R.Br. Figs. 8-11, *E. plana* S. T. Blake. Figs. 12-19, *E. pallens* S. T. Blake. Figs 20-23, *E. cylindrostachys* Boeck. Figs. 24-28, *E. neozelandica* C. B. Clarke. Figs. 29-31, *E. geniculata* (HBK) R. & S. Figs. 32-33, *E. atropurpurea* (Retz.) Kunth. Figs. 34-37, *E. minuta* Boeck.

New Australian Lepidoptera.

By A. Jefferis Turner, M.D., F.R.E.S.

I wish to express my thanks to Mr. Kershaw, of the National Museum, Melbourne, and Mr. Glauert, of the West Australian Museum, for the loan of specimens from these collections, and to other valued correspondents.

Fam. Larentiadae.

Gen. *Eremodorea* nov.

ἐρημοδωρεα, gift of the desert—

Tongue present. Face rough-scaled. Palpi short, ascending, not reaching middle of face, to which they are appressed; second joint shortly rough-scaled; terminal joint minute, acute. Thorax and abdomen without crests; the former slightly hairy beneath. Posterior tibiæ with middle spurs. Forewings with a large single areole; 2 from $\frac{3}{4}$, 3 from before angle, 4 from angle, 5 from well above middle, 6 from upper angle, 7 from end of areole connate with 8, 9, 10, which are stalked, 10 separating long before 8, 11 from end of areole. Hindwings with 2 from $\frac{2}{3}$, 4 from angle, 3 from midway between them, 5 from above middle of discocellulars ($\frac{3}{5}$), which are nearly straight, 6 and 7 short-stalked from upper angle, 11 anastomosing with cell from $\frac{1}{4}$ to $\frac{3}{4}$.

I know of no near ally to this genus. The neuration is similar to that of *Chætolopha*, but the palpi and wingshape are quite different. It is interesting also as coming from the dry west of Queensland. My specimen was taken at light during a period of intense drought.

Eremodorea haplopsara n. sp.

ἁπλοψαρος, simple grey—

♀. 28 mm. Head whitish-grey; face blackish. Palpi fuscous. Antennæ whitish-grey. Thorax whitish-grey, with a few fuscous scales. Abdomen fuscous. Legs fuscous, with pale rings. Forewings elongate-oval, costa moderately arched, apex rounded, termen long, oblique, gently rounded, becoming slightly sinuate towards tornus; pale grey; markings and slight irroration towards margins fuscous; a very fine irregular dentate line from $\frac{2}{5}$ costa to $\frac{1}{4}$ dorsum; a discal dot beyond middle, closely followed by a slightly darker narrow median shade; a slightly wavy subterminal line; a terminal line; cilia whitish, with narrow fuscous bars opposite veins. Hindwings very elongate, almost spathulate, termen rounded and slightly waved, but almost straight in tornal third; colour as forewings; a discal dot about middle; a strongly sinuate subterminal line; terminal line and cilia as forewings.

Queensland: Quilpie, in May; one specimen.

Anomocentris capnoxutha, n. sp.

καπνοξουθος, dark tawny—

♂. 16-17 mm. Head and thorax fuscous-brown. Palpi very small; whitish. Antennæ whitish; in male with short slender pectinations ending in tufts of long cilia. Abdomen brownish-fuscous; apices of segments whitish. Legs fuscous, with whitish rings; posterior pair whitish. Forewings broadly triangular, costa very slightly arched, apex pointed, termen slightly rounded, moderately oblique; fuscous-brown; a slender whitish line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, nearly straight; a whitish slightly waved submarginal line, indented above middle, beneath this almost touching margin, ending on tornus; cilia fuscous. Hindwings with termen strongly rounded; brownish-fuscous; cilia fuscous.

This tiny species was taken flying in the late afternoon near sunset.

Queensland: Miles and Roma, in April and May; two specimens.

Fam. STERRHIDAE.

Sterrha pulcherrima n. sp.

pulcherrimus, most beautiful—

♂. 30 mm. Head and collar brown. Palpi $1\frac{1}{2}$; fuscous. Antennæ grey; pectinations in male 3, extreme apex simple. Thorax crimson. Abdomen whitish. Legs whitish; anterior and middle pairs sprinkled with fuscous. Forewings triangular, costa straight almost to apex, apex pointed, termen straight, slightly oblique; crimson; a subdorsal spot near base and three narrow transverse fasciæ grey sprinkled with white; some orange-brown suffusion preceding first and between first and second and second and third lines; first fascia at $\frac{1}{5}$, straight, not reaching costa; second in middle with a median posterior tooth; third at $\frac{2}{3}$, slightly waved; a wavy white subterminal line with two small posterior teeth above middle; cilia whitish. Hindwings with termen rounded; white; transverse grey lines at $\frac{1}{4}$, middle, and $\frac{3}{4}$; cilia white.

West Australia: Tammin, in September; one specimen.

Fam. GEOMETRIDAE.

Chlorocoma pediobates n. sp.

πεδιοβατης, roaming the plains.

♂. 20-23 mm. Face and front of crown ochreous-brown; back of crown green; fillet white. Palpi ochreous-whitish. Antennæ grey-whitish; pectinations in male 5, apical $\frac{1}{4}$ simple. Thorax green. Abdomen green, with whitish scales on apices of segments. Legs ochreous-whitish; anterior pair fuscous. Forewings triangular, costa straight except near base and apex, apex obtusely pointed, termen almost straight, oblique; green sparsely sprinkled with minute whitish scales; a whitish subterminal line scarcely traceable; costal edge ochreous; cilia green, apices pale grey. Hindwings with termen rounded; as forewings.

Differs from *C. asemanta* Meyr., which I have not seen, in the colour of face and front of crown; from *C. dichloraria* Gn. in the absence of a pale longitudinal abdominal streak and in the green cilia.

Queensland: Miles, in May; five specimens.

Gen. *Lophothorax* nov.

λοφοθωραξ, with crested thorax—

Face not projecting. Tongue present. Palpi moderate, thickened with appressed scales, rough beneath. Antennæ in female shortly bipectinate. Thorax with a posterior crest. Posterior tibiæ with middle spurs. Forewings with 2 from $\frac{3}{4}$, 5 from well above middle, 6 from upper angle, 7, 8, 9, 10 stalked, 11 from near end of cell anastomosing with 12. Hindwings with discocellulars angled, 3 and 4 separate, 5 nearly approximated to 6, 6 and 7 separate, 12 approximated to cell to $\frac{1}{3}$, thence diverging.

Lophothorax alamphodes n. sp.

ἀλαμπωδης, dark—

♀. 28 mm. Head and thorax fuscous sprinkled with dark fuscous and whitish. Palpi $1\frac{1}{2}$; dark fuscous, base whitish beneath. Antennæ dark fuscous; pectinations in female $1\frac{1}{2}$. Abdomen grey. Legs grey; anterior pair fuscous; tibiæ and tarsi with whitish rings. Forewings triangular, costa moderately arched, apex subrectangular, termen rounded, oblique, crenulate; fuscous unevenly sprinkled with whitish; markings dark fuscous; a small ill-defined basal patch followed by a whitish suffusion; a strongly dentate line from $\frac{1}{4}$ costa to $\frac{2}{5}$ dorsum; a short linear oblique discal mark followed by a large ill-defined whitish spot; from beneath this an ill-defined dentate line to mid-dorsum; a finely denticulate line, white-edged posteriorly, from $\frac{3}{4}$ costa strongly incurved below middle to $\frac{3}{4}$ dorsum; cilia fuscous, bases barred with white. Hindwings with termen rounded, crenulate; grey; on dorsum and towards termen strigulated with whitish; cilia as forewings.

West Australia: Coorow, in October; one specimen.

Protophyta benigna n. sp.

benignus, pleasing—

♂. 60 mm. Head whitish-brown; face white. Palpi $1\frac{1}{4}$; pale grey, beneath white. Antennæ brown, apical half of stalk pale grey; pectinations in male 3. Thorax whitish-brown. Abdomen white, dorsum tinged with grey towards base. Legs white, with sparse fuscous irroration; anterior tibiæ brown; anterior and middle tarsi grey. Forewings triangular, costa straight, apex pointed, termen strongly rounded, wavy, moderately oblique; grey-whitish; a brownish basal suffusion traversed by a fine dark brown streak; a dark brown line from $\frac{1}{3}$ costa obliquely outwards for a short distance, thence acutely angled and angled again inwardly above middle, thence inwardly oblique to $\frac{1}{6}$ dorsum; a moderately broad grey-brownish fascia, its inner edge from $\frac{3}{5}$ costa to mid-dorsum, gently waved above middle, outer edge from $\frac{4}{5}$ costa, irregularly waved to $\frac{2}{3}$ dorsum; followed immediately by a broad whitish line, beyond which the terminal area is pale grey; a faint whitish subterminal line interrupted towards dorsum by two or three very short dark fuscous streaks; cilia grey-whitish, apices white. Hindwings with termen rounded, crenulate, and toothed on vein 4; colour and markings as forewings, but with no basal markings. Underside whitish; a dark fuscous discal dot on each wing followed by a wavy transverse line not reaching margins, edged posteriorly by whitish line; terminal area suffused with brown containing a dentate dark fuscous line not reaching margins, its upper end enlarged into a roundish blotch, its whole posterior edge defined by a white line; on the hindwings the postmedian line has a postmedian tooth, and the subterminal is replaced by a broad fascia.

Nearly allied to *P. castanea*, Turn., but much larger and more distinctly marked, especially distinguished by the basal markings of forewings.

Queensland: Beaudesert, in October; one specimen, which flew into the railway carriage as it was approaching the town.

Fam. OENOCHROMIDAE.

Taxeotis thegalea n. sp.

θηγαλεος, pointed—

♂♀. 27-30 mm. Head grey; face blackish. Palpi $1\frac{1}{2}$; blackish; basal $\frac{2}{3}$ of underside white sharply defined. Antennæ grey; in male slightly laminate, very shortly ciliated. Thorax, abdomen, and legs grey. Forewings triangular, costa straight to near apex, apex acutely pointed, termen slightly sinuate, oblique ; 12 anastomosing with areole (5♂) or connected with it by a short bar (3♂ 1♀) ; pale grey with very slight fuscous irroration ; markings fuscous ; a slender line from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum, often obsolete ; a minute discal dot ; a slender line perpendicular to $\frac{4}{5}$ costa, soon angled and sinuate to $\frac{3}{4}$ dorsum ; often reduced to a series of dots, followed by a second parallel dotted line, occasionally pale-edged posteriorly ; a terminal series of dots ; cilia pale grey, apices fuscous. Hindwings with termen rounded ; as forewings, but markings less distinct.

Best distinguished from *T. intermixtaria* Wlk., which it resembles, by the shorter palpi and acute apices of forewings.

West Australia : Mount Barker, Collie, and Denmark, in November ; Perth and Mogumber, in October ; nine specimens.

Taxeotis lechrioschema n. sp.

λεχριοσχημος, with oblique pattern—

♂. 22-26 mm. Head and thorax grey ; face blackish. Palpi $1\frac{1}{4}$; blackish, lower surface white sharply defined. Antennæ grey-whitish ; in male slightly laminate and shortly ciliated. Abdomen grey. Legs fuscous ; posterior pair whitish-grey. Forewings rather narrow, triangular, costa straight to near apex, apex pointed, termen slightly rounded, slightly oblique ; 11 anastomosing with areole (5 ♂) ; grey faintly strigulated with fuscous, sometimes brownish-tinged ; markings dark fuscous ; a slender oblique line from $\frac{1}{3}$ dorsum not reaching costa ; a minute discal dot ; a dot on $\frac{3}{4}$ costa ; a strong double line from $\frac{2}{3}$ dorsum to apex, its outer component finely dentate, followed by a series of dots ; terminal area beyond this darker grey ; a terminal series of dots ; cilia grey, apices whitish. Hindwings with termen rounded ; a double line from mid-dorsum seldom reaching middle ; sometimes a subterminal line ; colour, terminal dots, and cilia as forewings.

A neat little species, which should be easily recognised.

West Australia : Merredin, in September ; Tammin, in October ; five specimens.

Taxeotis eutyctodes n. sp.

εὔτυκτος, well-wrought—

♂ 25-26 mm. Head whitish-ochreous anteriorly, grey posteriorly ; face ferruginous. Palpi $2\frac{1}{2}$; ferruginous sometimes with some white or whitish scales at base beneath. Antennæ grey ; in male minutely ciliated. Thorax and abdomen grey. Legs fuscous ; posterior pair sprinkled with whitish. Forewings triangular, costa straight to near apex, apex pointed, termen slightly rounded, slightly oblique ; 12 connected by a bar with areole ; a ferruginous line containing costal, median, and dorsal dots from $\frac{1}{3}$ costa to $\frac{1}{4}$ dorsum ; a discal dot ; a fuscous mark on $\frac{2}{3}$ costa from beneath which runs a ferruginous black-dotted sinuate line to $\frac{2}{3}$ dorsum, closely followed by a parallel fuscous line ; a pale subterminal line preceded by some fuscous dots ; a submarginal series of blackish dots ; cilia grey-whitish. Hindwings with termen rounded ; grey ; a transverse fuscous line from $\frac{3}{5}$ dorsum not reaching costa ; sometimes a short fuscous mark at tornus ; submarginal dots and cilia as forewings.

West Australia : Perth, in September ; four specimens.

Taxeotis xanthogramma Low.

In my revision (Proc. Lin. Soc. N.S.W. 1929, p. 489) the length of the palpi is given incorrectly. The correct length is $1\frac{1}{4}$ to $1\frac{1}{2}$.

Also from West Australia : Tammin, in September.

Taeotis maerens n. sp.

maerens, mournful—

♂♀. 25-28 mm. Head and thorax ochreous-whitish or whitish-grey; face blackish. Palpi wholly blackish. Abdomen pale grey. Legs fuscous; posterior pair pale grey. Forewings triangular, costa gently arched, apex pointed, termen rounded, oblique; 12 anastomosing with areole (7 ♂ 1♀) or connected by a bar (3♂ 1♀); grey, with a few fuscous scales; markings fuscous; sub-basal line obsolete or faintly indicated; a minute discal dot; postmedian line reduced to a series of minute dots; it arises at right angles from $\frac{4}{5}$ costa, but is soon angled and sinuate to $\frac{3}{4}$ dorsum and followed by a parallel series of dots; a series of dots on termen; cilia grey-whitish. Hindwings with termen rounded; colour and markings as forewings.

West Australia: Perth, in September and October; Margaret River, in October; Denmark, in November; nineteen specimens.

Taxeotis helicta n. sp.

ἑλικτος, twisted.—

♂. 20 mm. Head, thorax, and abdomen grey; face blackish. Palpi $1\frac{1}{4}$; blackish, base of lower surface white sharply defined. Antennæ grey; in male minutely ciliated. Legs grey-whitish sprinkled with fuscous; anterior pair fuscous. Forewings rather narrow, triangular, costa straight to near apex, apex pointed, termen rounded, oblique; 12 anastomising with areole; uniformly grey with two blackish lines; first at $\frac{1}{3}$, straight; second from $\frac{2}{3}$ costa, transverse to middle, there sharply bent inwards and strongly concave to $\frac{2}{3}$ dorsum; cilia grey, apices whitish. Hindwings with termen strongly rounded; grey; cilia grey.

West Australia: Merredin, in September; one specimen.

Taxeotis pychnomochla n. sp.

πυχνομοχλος, thickly barred—

♂. 18-20 mm. Head and thorax grey; face blackish. Palpi $1\frac{1}{2}$; blackish, basal $\frac{2}{3}$ of lower surface white sharply defined. Antennæ grey; in male minutely ciliated. Abdomen whitish-grey, with a few fuscous scales. Legs grey-whitish sprinkled with fuscous; anterior pair fuscous. Forewings triangular, costa straight to near apex, apex pointed, termen rounded, oblique; grey, with dark fuscous markings; a straight thick line from $\frac{1}{5}$ costa to $\frac{1}{3}$ dorsum; a discal dot; a line from $\frac{2}{3}$ costa to $\frac{3}{5}$ dorsum, with a small posterior tooth beneath costa, thence thicker and slightly incurved, partly edged posteriorly with white; a suffused whitish subterminal line; a terminal series of dark fuscous dots; cilia grey, apices whitish. Hindwings with termen rounded; grey; a short slender transverse fuscous line from dorsum beyond middle; terminal dots and cilia as forewings.

West Australia: Merredin, in September; Coorow in October; two specimens.

Taxeotis didymosticha n. sp.

διδυμοστυχος, twin-lined—

♂. 18 mm. Head and thorax grey; face blackish. Palpi $1\frac{1}{2}$; blackish, basal $\frac{2}{3}$ of lower surface white sharply defined. Antennæ grey; in male minutely ciliated. Abdomen missing. Legs whitish sprinkled with fuscous; anterior pair fuscous. Forewings triangular, costa straight, apex pointed, termen slightly rounded, slightly oblique; 12 connected by a bar with areole; grey, with numerous slender whitish transverse lines; costa strigulated with whitish; markings dark fuscous; an obscure double sub-basal transverse fuscous line; a discal dot; a short mark on $\frac{3}{4}$ costa, from beneath which runs a twice sinuate double line to dorsum before tornus; a terminal series of dots; cilia grey. Hindwings with termen rounded; grey; some whitish and fuscous strigulæ on dorsum; terminal dots and cilia as forewings.

West Australia: Tammin, in October; one specimen.

Taxeotis celidora n. sp.

κηλιδορος, blotched—

♀. 20 mm. Head, thorax, and abdomen pale grey; face blackish. Palpi 2; blackish, lower surface to $\frac{2}{3}$ white sharply defined. Antennæ grey. Legs grey; anterior pair fuscous. Forewings rather narrow, triangular, costa straight almost to apex, apex acutely pointed, termen sinuate, oblique; 12 anastomosing with areole; grey; a transverse blackish line at $\frac{1}{3}$; another dentate and sinuate at $\frac{2}{3}$; included area suffused with dark fuscous; second line broadly edged with fuscous posteriorly; a terminal series of dark fuscous dots; cilia grey, with fuscous points. Hindwings with termen rounded; grey; terminal dots and cilia as forewings.

West Australia: Coorow, in October; two female examples. With these I took one male (15 mm., 12 connected with areole by a bar), which differs in the absence of the broad central blotch on forewings, but is in too poor condition for description.

Gen. *Cycloprorodes* nov.

κυκλοπρωρωδης, with rounded prow—

Face with smooth rounded prominence. Tongue present. Palpi moderate, porrect rather slender, smooth-scaled except at base beneath. Antennæ in female shortly bipectinate. Thorax and abdomen rather stout; the former hairy beneath. Femora smooth. Posterior tibiæ with middle spurs. Forewings with a simple areole; 5 from middle of cell, 11 free, 10 from cell giving off 9 to anastomose with 7, 8. Hindwings with 5 from middle of cell, 6 from upper angle, 7 separate, 12 closely approximated to cell as far as middle.

In neuration this agrees with *Symphylistis* Turn., but differs in the prominent face and stouter build.

Cycloprorodes apalama n. sp.

ἀπαλαμος, sluggish—

♀. 40 mm. Head and thorax brown; face whitish ochreous, lateral margins blackish. Palpi $1\frac{1}{2}$; blackish, terminal and apices of second joints ochreous-whitish. Antennæ whitish, pectinations fuscous. Abdomen whitish-ochreous. Legs whitish-ochreous, with slight fuscous irroration. Forewings elongate-triangular, costa gently arched, apex rectangular, termen rounded, oblique; brown sprinkled and strigulated with fuscous; a small fuscous discal spot beyond middle; a thick dark fuscous line with dentate posterior edge from apex to tornus; terminal area beyond this pale brown; cilia pale brown. Hindwings with termen rounded; whitish; terminal area suffused with fuscous; cilia whitish.

South Australia: Adelaide, in May; one specimen received from Mr. J. O. Wilson.

Dichromodes mesoporphyra n. sp.

μεσοπορφυρος, purple in the middle—

♂. 20 mm. ♀. 28 mm. Head and thorax reddish-ochreous. Palpi 2; blackish, basal half beneath white sharply defined. Antennæ fuscous; pectinations in male 3. Abdomen pale grey. Legs fuscous, with whitish rings. Forewings triangular, costa straight almost to apex, apex rounded, termen rounded, slightly oblique; reddish-ochreous; a broad median reddish-purple band containing a minute fuscous discal dot; its anterior edge partly whitish, from $\frac{1}{4}$ costa to $\frac{2}{5}$ dorsum, with subcostal, median, and subdorsal posterior teeth; posterior edge curved, denticulate, bordered with whitish, from $\frac{3}{4}$ costa to $\frac{4}{5}$ dorsum; an interrupted reddish-purple subterminal shade; an interrupted fuscous terminal line; cilia grey. Hindwings with termen rounded; grey; an ill-defined darker shade from $\frac{4}{5}$ dorsum to midcosta; terminal line and cilia as forewings.

The sexes are similar. In my revision I was mistaken in ascribing the female to *D. rufula* Prout. Actually it is a very distinct species.

West Australia: Northampton, in October; Cunderdin, in November; two specimens.

Dichromodes rufilinea n. sp.

rufilineus, reddish-lined—

♂♀. 22-26 mm. Head and thorax fuscous. Palpi $2\frac{1}{2}$; blackish basal half beneath white sharply defined. Antennæ fuscous. Abdomen and legs grey. Forewings triangular, costa slightly arched, apex pointed, termen nearly straight, oblique; dark grey with fuscous markings; a faint curved, sub-basal line; antemedian from $\frac{1}{3}$ costa to mid-dorsum, straight, with two posterior teeth, one above and one below middle; a small oval pale centred discal spot; postmedian from $\frac{2}{3}$ costa to $\frac{3}{4}$ dorsum, edged posteriorly by a pale line; immediately beyond this a subterminal fascia with a median rectangular projection and excavations above and below, inner edge of fascia below middle suffused with reddish; cilia grey, with whitish points and apices. Hindwings with termen rounded; grey; cilia grey.

West Australia: Merredin, in September; two specimens.

Dichromodes subrufa n. sp.

subrufus, somewhat reddish—

♂♀. 23-24 mm. Head and thorax fuscous. Palpi $1\frac{1}{2}$; grey with a few white scales at base beneath. Antennæ fuscous; pectinations in male 4. Abdomen grey. Legs grey; anterior pair fuscous, with whitish rings. Forewings triangular, costa slightly arched, apex pointed, termen slightly rounded, slightly oblique; grey; markings fuscous mixed with pale reddish; a moderate dark basal patch containing two pale transverse lines; median band fuscous, narrow; anterior edge from $\frac{2}{5}$ costa to mid-dorsum, nearly straight; posterior from $\frac{3}{5}$ costa to $\frac{3}{4}$ dorsum, slightly angled outwards in middle, narrowly whitish-edged posteriorly; a median discal dot; a fine irregularly denticulate subterminal line; a submarginal shade with a rectangular median projection posteriorly, excavated above and beneath, posteriorly narrowly edged with whitish; an obscure series of terminal dots; cilia whitish. Hindwings with termen rounded; grey; darker towards termen; cilia grey.

West Australia: Coorow, in October; two specimens.

Dichromodes phœoxesta n. sp.

φαιοξεστος, darkly polished—

♂♀. 28-30 mm. Head and thorax fuscous. Palpi 2½; blackish, basal half beneath white sharply defined. Antennæ fuscous; pectinations in male 6. Abdomen grey. Legs fuscous, with whitish rings; posterior pair grey. Forewings triangular, costa slightly arched, apex pointed, termen slightly rounded, slightly oblique, crenulate; glossy fuscous; an obscure dentate dark line at $\frac{1}{3}$; a dark fuscous discal dot; postmedian line obscure, denticulate, from $\frac{2}{3}$ costa sinuate to $\frac{2}{3}$ dorsum, edged whitish posteriorly, towards dorsum double; following this some slender dark streaks on veins; a very obscure whitish subterminal line; an interrupted dark terminal line; cilia fuscous, with whitish points. Hindwings with termen rounded; grey; slight fuscous marks on and before tornus; terminal edge fuscous; cilia grey, apices whitish.

West Australia: Merredin, in September; five specimens.

Dichromodes typhistis n. sp.

τυφιστις, smoky—

♀. 26-28 mm. Head grey. Palpi 2½; grey, with some white scales above and sharply white at base beneath. Antennæ fuscous. Thorax dark fuscous; patagia and tegulæ grey. Abdomen grey. Legs fuscous, with whitish rings; posterior pair grey. Forewings triangular, costa slightly arched, apex pointed, termen rounded, slightly oblique; grey, with sparse fuscous irroration and obscure darker markings; two slender transverse lines near base; antemedian at $\frac{1}{3}$, dentate, very obscure; a short transverse linear discal mark; postmedian fuscous posteriorly edged with whitish, very obscure; subterminal faintly marked, sinuate, denticulate; a fine whitish subterminal line; a terminal series of triangular dots; cilia grey, apices whitish. Hindwings with termen rounded; grey, darker towards termen; cilia grey.

South Australia: Mount Lofty Ranges, in November; type received from Mr. J. O. Wilson, West Australia; Mogumber, in October; two specimens.

Dichromodes capnoporphyra n. sp.

καπνοπορφυρος, dark purple—

♀. 24-26 mm. Head and thorax fuscous. Palpi 1½; wholly fuscous. Antennæ fuscous. Abdomen grey. Legs with whitish rings, fuscous; posterior pair grey. Forewings triangular; costa straight to near apex, apex obtusely pointed, termen rounded, slightly oblique; fuscous, purple-tinged, with darker markings; two slender transverse sub-basal lines; a slender antemedian line at $\frac{1}{4}$; a linear transverse median discal mark; postmedian slender from $\frac{3}{5}$ costa, obliquely outwards, bent inwards in middle to $\frac{3}{4}$ dorsum; a terminal series of dots; cilia ochreous-whitish, with a fuscous median line. Hindwings with termen rounded; grey; sometimes a small fuscous discal mark; cilia as forewings.

West Australia: Mogumber, in October; two specimens.

Enchocrana lacista Turn.

In one female and in a male from Coorow vein 12 of the hindwings anastomoses with the cell. Antennal pectinations in male 6.

Enchocrana oxystoma n. sp.

ὀξυστομος, sharp-toothed—

♀. 28 mm. Head fuscous sprinkled with whitish; frontal process long, slender, acutely pointed. Palpi 2; fuscous sprinkled with whitish. Antennæ fuscous; pectinations in female 3. Thorax and abdomen fuscous. Legs fuscous, with whitish rings. Forewings elongate-triangular, costa very long, straight, apex acute, termen long, strongly rounded, strongly oblique; fuscous, with very slender fuscous lines; antemedian at $\frac{1}{4}$, outwardly oblique; postmedian from $\frac{4}{5}$ costa to $\frac{3}{4}$ dorsum, slightly sinuate; a terminal line; cilia fuscous, with whitish bars between crenulations. Hindwings with termen not rounded, toothed on veins 3 and 6; as forewings, but lines scarcely traceable.

In the hindwings 12 anastomoses with the cell.

West Australia: Coorow, in October; one specimen.

Lissomma thrasyschema n. sp.

θρασυσχημος, boldly patterned—

♀. 34 mm. Head blackish sprinkled with whitish; face with a rounded prominence, from which springs a down-curved beak-like chitinous process. Palpi $1\frac{1}{2}$; blackish sprinkled with whitish. Antennæ fuscous; in female simple. Thorax with a posterior crest; blackish sprinkled with whitish. (Abdomen missing.) Legs blackish, with whitish rings; posterior tibiæ with middle spurs. Forewings elongate-triangular, costa straight almost to apex, apex acute, termen rounded, oblique, dentate; white partly suffused with blackish, appearing grey; markings blackish; costal and median basal spots, the latter with acute posterior tooth; a sinuate sub-basal transverse line; antemedian at $\frac{1}{3}$, irregularly dentate; several streaks on veins in median area; a large transversely oval pale-centred discal spot; postmedian from $\frac{4}{5}$ costa to $\frac{2}{3}$ dorsum, irregularly dentate, a sharp posterior tooth beneath costa and an anterior tooth above dorsum; edged posteriorly with white; a wavy subterminal line from costa before apex to tornus, edged posteriorly with white; a series of interneural streaks running into termen, on which is a dark line; cilia grey. Hindwings with termen scarcely rounded, dentate; basal half white, with a small fuscous discal mark; posterior half grey, with two irregular blackish postmedian lines, the second edged white; an incomplete white-edged subterminal line, cilia barred with blackish on apices of dentations.

I formerly separated *Dinocephalus* Prout from *Lissomma* Warr. by the absence of middle spurs, but the affinities of this species are with the former genus, which should, I think, be merged in the latter.

West Australia: Yanchep, in September; one specimen.

Gen. *Nycticleptes* nov.

νυκτικλεπτης, prowling by night—

Face with moderate rounded projection. Tongue strongly developed. Palpi moderately long, porrect; second joint thickened above and beneath with rough hairs; terminal joint short and very stout, apex obtusely rounded; Thorax and abdomen stout; thorax hairy above and beneath with a small basal dorsal crest; abdomen smooth-scaled. Coxæ and femora hairy; tibiæ with spurs short; posterior with middle spurs. Forewings with cell $\frac{1}{2}$; 2 from $\frac{4}{5}$, 3 from angle, 4 from shortly above, 5 from well above middle ($\frac{2}{5}$), 6 from upper angle, 7, 8, 9 stalked from shortly before angle, 10 from cell, approximated to 8, 9 beyond 7 but not connected, 11 from $\frac{3}{4}$, free. Hindwings with cell not quite $\frac{1}{2}$; 2 from $\frac{3}{4}$, 3 from near angle, 4 from angle, 5, 6, 7 closely approximated at origin, 12 closely approximated to cell from $\frac{1}{3}$ to $\frac{2}{3}$, thence diverging.

It is likely that in other examples 10 may be connected with 8, 9 forming a long narrow areole. The structure of the antennæ is not known. The genus is near *Hypographa*, differing in 11 of forewings being free, and the close approximation of 5 and 6 of the hindwings.

Nycticleptes lechriodesma n. sp.

λεχριοδεσμος, obliquely banded—

♂. 50 mm. Head, palpi, thorax, and abdomen fuscous. (Antennæ missing.) Legs fuscous, with whitish rings. Forewings triangular, costa and termen long, dorsum comparatively short, costa straight, apex acute, termen rounded, sinuate beneath apex, shortly dentate; fuscous; a broad subterminal fuscous-whitish fascia from apex to tornus, anterior edge nearly straight, posterior edge slightly curved, crenulate; cilia fuscous. Hindwings with termen strongly toothed on veins 4 and 6; colour as forewings, with a similar but broader subterminal band.

South Australia: Purnong, near Murray Bridge; type in National Museum, Melbourne.

Oenochroma celidophora n. sp.

κηλιδοφορα, blotched—

♂♀. 32-36 mm. Head and thorax pale grey. Palpi $1\frac{1}{2}$; pale grey. Antennæ grey; pectinations in male 10. Abdomen whitish-grey. Legs whitish sprinkled with grey; tarsi grey; anterior tibiæ with a terminal hook. Forewings elongate-triangular, costa straight to beyond middle, thence slightly incurved, apex acute, termen sinuate, slightly oblique; pale grey, with a few fuscous scales; an oblique suffused grey line from $\frac{3}{5}$ costa to $\frac{3}{5}$ dorsum, a slightly sinuate line of minute fuscous dots from costa near apex to $\frac{2}{3}$ dorsum; cilia grey, apices whitish. Hindwings with termen slightly rounded; as forewings, but subterminal dots not developed. Underside whitish, with a large oval dark fuscous blotch above tornus in forewings only, and slender subterminal dotted lines on both wings.

Best differentiated from *O. subustaria* Wlk. by the markings on underside.

West Australia: Coorow, in October; six specimens.

Fam. NOCTUIDAE.

Graphiphora ctenota n. sp.

κτενωτος, pectinated—

♂. 34 mm. Head reddish-brown; lower edge of face whitish-ochreous. Palpi $2\frac{1}{2}$; whitish-ochreous, outer surface of second joint dark fuscous edged beneath with brown. Antennæ grey; pectinations in male 3 (apices broken off). Thorax reddish-brown; tegulæ except apices whitish-ochreous. Abdomen grey; beneath whitish, with lateral blackish spots. Legs fuscous, partly tinged brownish, with whitish rings. Forewings elongate-triangular, costa nearly straight, apex rectangular, termen straight, rounded beneath, not oblique; pale ochreous-brown, with blackish markings and strigulæ; these strigulæ are most developed on costal and dorsal margins, with one larger in mid-disc at $\frac{1}{3}$; orbicular obsolete; reniform narrow, subcrescentric; an interrupted line from $\frac{2}{3}$ costa, outwardly curved, bent inwards to $\frac{2}{3}$ dorsum ; slight indications of a subterminal line ; cilia pale brownish. Hindwings with termen rounded ; fuscous, paler, towards base ; cilia ochreous-grey-whitish, with a fuscous median line.

If it were not for the male antennæ, this might be mistaken for an aberration of *G. compta* Wlk.

New South Wales : Scone, in October ; one specimen received from Mr. H. T. Nicholas.

Gen. *Thoracolopha* nov.

θωρακολοφος, with crested thorax.

Face not prominent. Palpi ascending, not reaching beyond middle of face ; second joint thickened with appressed scales ; terminal joint very short or minute, obtuse. Antennæ of male very shortly ciliated. Thorax clothed with scales ; with a posterior crest and large tegulæ. Abdomen without crest. Posterior tibiæ hairy ; middle spurs present. Neuration normal.

Though reluctant to make a new genus, I am unable to place the three following species in any previously described. Of Australian genera, they appear nearest to *Syntheta* Turn., but differ in the much shorter palpi, the larger tegulæ, and the origin of the obsolescent vein 5 of the hindwings from the middle of cell. Type *T. pissonephra.*

Thoracolopha pissonephra n. sp.

πισσονεφρος, with black reniform.

♂♀. 27-30 mm. Head blackish or whitish-ochreous. Palpi blackish, apices whitish. Antennæ blackish ; ciliations in male $\frac{1}{2}$. Thorax blackish ; patagia sometimes edged with grey, or sometimes patagia and centre ochreous-whitish. Abdomen fuscous. Legs fuscous, with ochreous-whitish rings. Forewings elongate-triangular, costa straight, apex rounded-rectangular, termen slightly rounded, not oblique ; fuscous-grey ; costa strigulated with blackish and ochreous-whitish ; sometimes a white median sub-basal dot ; orbicular small, circular, outlined with white ; reniform large, black, triangular, the posterior inferior angle produced ; a transverse dentate fuscous line between stigmata ; a blackish subterminal shade beneath costa ; some dark fuscous streaks ending in pale terminal dots ; cilia fuscous. Hindwings with termen rounded ; grey ; a fuscous discal dot and terminal line ; cilia grey, apices fuscous.

West Australia : Albany, in November ; Margaret River, in October ; Perth ; Narrogin ; six specimens.

Thoracolopha plæsiospila n. sp.

πλαισιοσπιλος, square-spotted—

♂. 23 mm. Head brownish-fuscous. Palpi with minute terminal joint ; ochreous-whitish, external surface of second joint except apex dark fuscous. Antennæ fuscous ; ciliations in male less than $\frac{1}{2}$. Thorax with a strong posterior crest ; brownish-fuscous. (Abdomen missing.) Legs dark fuscous, with whitish rings ; posterior pair mostly whitish. Forewings elongate-triangular, costa nearly straight, apex subrectangular, termen slightly rounded, scarcely oblique ; pale fuscous reddish-tinged ; markings blackish ; a whitish costal dot near base, a second at $\frac{1}{2}$, a third in middle, and five more between this and apex ; a fine transverse line from $\frac{1}{3}$ costa to $\frac{2}{5}$ dorsum, sharply indented above dorsum ; a large somewhat quadrangular reniform connected by a wavy line with mid-dorsum ; beyond this is a paler area traversed by a fine line, which starts from a midcostal dot and is bent twice quadrangularly well beyond reniform and again beneath it, whence it proceeds direct to dorsum at $\frac{3}{4}$; a terminal series of spots edged anteriorly with reddish ; cilia fuscous, apices whitish. Hindwings with termen slightly sinuate ; whitish, with grey discal dot and terminal suffusion ; cilia whitish, bases grey.

Queensland : Cunnamulla, in April ; one specimen.

Thoracolopha alychnodes n. sp.

ἀλυχνωδης, dark—

♂. 26 mm. Head, thorax, and abdomen fuscous ; thorax with a strong posterior crest. Palpi with terminal joint very short, obtuse ; dark fuscous, terminal and apex of second joint ochreous-whitish. Antennæ fuscous ; ciliations in male about $\frac{1}{2}$. Legs dark fuscous, with whitish rings ; posterior pair mostly whitish. Forewings elongate-triangular, costa gently arched, termen slightly rounded, slightly oblique ; fuscous-grey ; a whitish costal dot near base, a second at $\frac{1}{4}$, a third at middle, and two more beyond this ; an obscure double very strongly dentate dark fuscous line at $\frac{1}{4}$; reniform scarcely indicated by a pale dot ; a very fine wavy dark line starting from a dot on midcosta, quadrangularly bent well beyond and beneath reniform, thence to $\frac{2}{3}$ dorsum ; cilia fuscous, apices paler. Hindwings with termen rounded ; whitish-grey ; cilia whitish, with a grey sub-basal line.

Queensland : Gayndah, in October ; one specimen.

Caradrina stigmatucha n. sp.

στιγματουχος, well branded—

♀. 28 mm. Head and thorax grey sprinkled with whitish. Palpi grey sprinkled with whitish ; base and inner surface white. Antennæ black finely annulated with whitish. Abdomen ochreous-whitish. Legs whitish sprinkled with fuscous ; anterior pair dark fuscous, with whitish rings. Forewings triangular, costa straight, termen gently rounded, not oblique ; grey sprinkled with white and fuscous, appearing light grey ; a short fuscous mark from base of costa, edged posteriorly white ; a fine shortly dentate line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum, indented above dorsum ; interrupting this, a round white orbicular spot with grey centre ; a fuscous shade from costa before middle to mid-dorsum ; immediately beyond this an 8-shaped white reniform with two grey centres ; postmedian double, partly filled in with white and with some white dots beyond, from $\frac{3}{4}$ costa to tornus, sinuate, with a sharp tooth above tornus ; a grey subterminal shade, well defined posteriorly, with quadrangular projections above and below middle ; a terminal series of fuscous lunules edged with white ; cilia grey, with narrow whitish bars. Hindwings with termen slightly rounded ; pale grey ; cilia whitish, with a pale grey sub-basal line.

Queensland : Roma, in April ; one specimen.

Gen. *Thaumasiodes* nov.

θαυμασιωδης, marvellous—

Tongue present. Palpi moderate, upturned ; second joint moderately thickened ; terminal joint very short, obtuse. Abdomen with prominent crests on sixth and seventh segments. Posterior tibiæ smooth ; all spurs present and long. Forewings without areole ; 7, 8, 9, 10 stalked, 3 and 4 separate. Hindwings with 3 and 4 stalked, 6 and 7 connate, 12 anastomosing with cell near base.

Allied to *Arœoptera* Hmps., from which it differs in the strong abdominal crests and separation of 3 and 4 of the hindwings.

Thaumasiodes eurymitra n. sp.

ευρυμιτρος, broadly girdled—

♀. 12 mm. Head white. Palpi dark fuscous. Antennæ fuscous ; basal joint white. Thorax with anterior half white, posterior half fuscous. Abdomen fuscous ; base, crests, and underside whitish. Legs fuscous ; posterior pair white. Forewings elongate-triangular, costa almost straight, apex pointed, termen rounded, strongly oblique ; grey, greenish-tinged ; markings blackish partly outlined with white ; a broad antemedian fascia, inner edge from $\frac{1}{4}$ costa to dorsum near base, outer edge from midcosta to mid-dorsum with a small acute tooth beneath costa and another below middle ; a curved dentate line edged white posteriorly from $\frac{2}{3}$ costa to below middle of disc ; a short white indented line from costa near apex ; rather large apical and subapical fuscous spots ; cilia pale grey, bases barred with fuscous. Hindwings with termen rounded ; colour and antemedian band as forewings.

North Queensland : Lake Barrine, in September ; one specimen.

Gen *Eremobates* nov.

ἐρημοβατης, roaming the desert—

Tongue present. Face with strong conical rounded protuberance. Antennæ in male shortly ciliated. Palpi rather long, porrect, thickened with appressed scales ; terminal joint short, obtuse. Thorax with strong posterior crest. Abdomen with small basal crest. Legs smooth ; posterior tibiæ with middle spurs. Forewings with areole ; 2 from $\frac{3}{4}$, 3 and 4 approximated from angle, 5 from slightly above, 6 from upper angle, 7 connate with 8, 9 from areole, 10 separate, 11 from cell. Hindwings with cell less than $\frac{1}{2}$; 2 from $\frac{2}{3}$, 3 and 4 connate from angle, 5 from below middle parallel to 4, 6 and 7 connate from upper angle, 12 anastomosing with cell near base, thence diverging.

Not near any other genus, though structurally it approaches *Tarache.*

Eremobates dolera n. sp.

δολερος, deceitful—

♂. 28 mm. Head and thorax brown. Palpi $1\frac{1}{4}$; brown. Antennæ grey ; ciliations in male $\frac{1}{2}$. Abdomen ochreous-grey-whitish. Legs fuscous, with whitish rings ; posterior pair whitish-ochreous. Forewings triangular, costa straight, apex rounded, termen slightly rounded, slightly oblique ; basal area dark brown ; a broad median band, anteriorly dark brown, posteriorly suffused with pale grey, edged by whitish-ochreous lines, anterior from $\frac{1}{3}$ costa to mid-dorsum, posterior from $\frac{2}{3}$ costa to dorsum near tornus, with a strong obtuse median tooth ; terminal area suffused pale grey ; a terminal series of dark fuscous dots ; cilia grey. Hindwings with termen rounded ; a faint antemedian fuscous discal dot ; a terminal fuscous band, broad at apex, narrowing suddenly above tornus ; cilia grey-whitish.

Superficially this species is very suggestive of the *Larentiadœ.*

Central Australia : Tennant's Creek ; type in National Museum, Melbourne.

Selepa picilinea n. sp.

picilineus, with pitch-black lines—

♀. 28 mm. Head, palpi, antennæ, and thorax grey. Abdomen ochreous-whitish, crest on basal segment represented by a small grey disc. Legs whitish; anterior pair grey. Forewings rather broadly sub-oval, costa strongly arched, apex rounded-rectangular, termen gently rounded, oblique; light grey, with blackish markings; antemedian line double from $\frac{1}{3}$ costa to $\frac{2}{5}$ dorsum slightly outwardly curved, indented above dorsum; postmedian from $\frac{2}{3}$ costa to $\frac{4}{5}$ dorsum, obtusely bent in middle, posteriorly edged with white; a broad oblique suffusion connects middle of first with origin of second line; in this is a white discal dot; three or four costal dots beyond this; faint indication of a subterminal line; a terminal series of triangular dots; cilia grey. Hindwings with termen rounded, slightly waved; whitish suffused with grey towards termen; cilia whitish.

Queensland: Rockhampton in May; one specimen.

Calathusa hemicapna n. sp.

ἐμικαπνος, half dusky—

♀. 27 mm. Head and palpi grey. Antennæ fuscous. Thorax dark fuscous, with a few whitish scales, patagia broadly grey. Abdomen pale grey. Legs fuscous; posterior pair whitish. Forewings narrowly triangular, costa gently arched, apex rounded, termen obliquely rounded; basal area and costal half broadly dark fuscous; remainder of disc whitish, with dark fuscous irroration and markings; a fine dentate transverse line from $\frac{3}{5}$ costa, becoming outwardly oblique at its upper end; an oblique series of four dots between veins follows this; a broad sinuous line from before tornus; a submarginal series of dots between veins; cilia grey, bases barred with fuscous.

Queensland: Roma, in April; one specimen.

Calathusa phæoneura n. sp.

φαιονευρος, dark-veined—

♀. 28 mm. Head and thorax fuscous sprinkled with whitish. Palpi grey. Antennæ fuscous. Abdomen whitish-ochreous, with a few reddish scales. Legs whitish; anterior pair grey, with whitish rings. Forewings narrowly triangular, costa moderately arched, apex rounded, termen obliquely rounded; grey, with dark fuscous markings and some patchy whitish suffusion; an outwardly curved line from before $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum; an outwardly oblique line from before $\frac{2}{3}$ costa, rather sharply angled in middle, again angled and thence transverse to $\frac{2}{3}$ dorsum; terminal area partly suffused with white, traversed by fine interrupted streaks on veins; a submarginal series of dots between veins; cilia whitish, with grey bars. Hindwings with termen slightly sinuate; grey-whitish suffused with grey towards apex; cilia whitish.

Queensland: Yelarbon, near Inglewood, in November; one specimen.

Diatenes acrocausta n. sp.

ἀκροκαυστος, scorched at the apex—

♀. 32 mm. Head and thorax whitish-brown, with few scattered blackish scales. Palpi 3, second joint long, expanded antero-posteriorly towards apex, terminal joint short, obtuse; pale brownish. Antennæ fuscous. Abdomen sprinkled with whitish and towards base with pale ochreous.

Legs fuscous, with brown-whitish rings. Forewings triangular, costa nearly straight, apex rectangular, termen straight, rounded beneath, scarcely oblique ; whitish-brown ; a suffused interrupted brown costal streak to $\frac{3}{5}$; an incompletely developed double dentate sub-basal fuscous transverse line ; reniform small, quadrangular, pale centred with brown outline ; a triangular dark fuscous apical blotch bounded by a straight line from $\frac{3}{5}$ costa to midtermen ; in it three pale costal dots and a large oval apical brown spot ; a very fine parallel dark fuscous line precedes blotch, which is traversed by a fine fuscous subterminal line prolonged by a series of dots to $\frac{3}{4}$ dorsum ; a submarginal series of pale dots ; cilia fuscous, on apex whitish-brown, below middle grey. Hindwings with termen strongly rounded ; grey, paler towards base ; cilia grey. Underside of hindwings with a fuscous spot at $\frac{1}{3}$, and curved transverse postmedian and subterminal lines.

North Queensland : Kuranda, in June ; one specimen.

Gen. *Alophosoma* Turn.

The conical frons has an apical circular depression partly hidden by a tuft of scales above it.

Alophosoma cana n. sp.

canus, whitish-grey—

♂. 35 mm. ♀. 40 mm. Head and palpi grey. Antennæ grey ; in male bipectinate, pectinations 3. Thorax grey mixed with whitish. Abdomen ochreous-grey-whitish. Legs whitish-grey. Forewings elongate-triangular, costa straight, slightly arched before apex, apex rounded-rectangular ; termen slightly rounded, slightly oblique ; grey largely suffused with whitish ; a whitish basal patch edged by a fine fuscous line, very strongly toothed in middle, indented above and beneath ; fine fuscous streaks on veins ; a fine curved wavy fuscous line from $\frac{2}{3}$ costa to before tornus, indented above dorsum ; two spots above tornus and several interneural streaks between these and costa fuscous ; cilia whitish, with grey bars. Hindwings with termen rounded ; in male white narrowly suffused grey on apex and termen ; in female grey except near base and dorsum ; cilia white.

North Queensland : Georgetown ; two specimens in rather poor condition.

Prorocopis mitotypa n. sp.

μιτοτυπος, thread-marked—

♂. 28 mm. Head and thorax grey sprinkled with whitish. Palpi grey, bases whitish. Antennæ grey ; cilia in male $\frac{2}{3}$ with slightly longer bristles. Abdomen ochreous-whitish ; basal crest fuscous. Legs grey ; posterior pair whitish. Forewings narrowly triangular, costa rather strongly arched, apex obtusely pointed, termen slightly rounded, slightly oblique ; grey ; markings formed by extremely slender fuscous lines ; a sub-basal line acutely toothed above middle ; a double wavy line from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum ; orbicular shortly before this, small, circular, and slenderly outlined ; reniform large ; postmedian obsolete at costa, outwardly curved to well below middle, thence curved upwards and touching reniform, curved again downwards, indented, ending on $\frac{3}{5}$ dorsum ; subterminal pale ; irregularly dentate, partly fuscous-edged ; a crenulate submarginal line ; cilia grey. Hindwings with termen slightly sinuate ; white, slightly suffused with grey on termen ; cilia white.

Central Australia : Mount Liebig ; one specimen received from Mr. J. O. Wilson.

Ophyx dochmotoma n. sp.

δοχμοτομος, obliquely divided—

♂. 40 mm. Head, thorax, and abdomen grey. Palpi with second joint reaching vertex, thickened with loosely appressed scales, terminal joint $\frac{1}{2}$, stout, obtuse; blackish, extreme base white, apex of terminal joint whitish. Antennæ grey; in male shortly ciliated ($\frac{1}{2}$) with longer bristles. Legs grey, with whitish rings; knees of anterior pair blackish. Forewings elongate-triangular, costa almost straight but slightly sinuate, apex pointed, termen gently rounded, slightly crenulate, strongly oblique; grey; extreme costal edge whitish in central portion; indications of a slender fuscous dentate antemedian line; reniform dotlike, pale, with fuscous outline; a fine, almost straight ochreous-whitish line from $\frac{5}{6}$ costa to $\frac{3}{4}$ dorsum bounding a narrow obscure fuscous fascia with dentate posterior edge; a crenulate fuscous terminal line; cilia grey. Hindwings with termen rounded; colour, terminal band, and cilia as forewings; in male the dorsal half of cell is occupied by a finely corrugated scaleless area, which is prolonged for a short distance between veins 5 and 6; 6 and 7 are separate at origin.

Queensland: Noosa, in May; one specimen.

Gen. *Chorizomena* nov.

χωριζομενος, remote, isolated—

Tongue well developed. Palpi very slender, smooth, porrect, not reaching beyond face. Face smooth. Thorax and abdomen slender, not hairy. Legs smooth; posterior tibiæ without middle spurs. Forewings with 2 from middle of cell, 4 from angle, 3 from midway between, 5 from shortly above angle, discocellular incurved, cell $\frac{2}{5}$, areole very large and projecting beyond cell to $\frac{3}{5}$, 6 from near base of areole, 7 from near its apex, 8 and 9 stalked, 10 from areole very near them, 11 from middle of cell, running close to areole but not connected. Hindwings with dorsum long; 2 from $\frac{2}{3}$, 4 from angle, 3 from midway between, 5 approximated at origin to 4, 6 from upper angle, 7 from before middle of cell, strongly curved and closely approximated to 12, but not connected.

The species described below has the wing-shape of one of the *Terpna* group of the *Geometridæ*. Structurally, it is certainly one of the *Noctuidæ*, but with curious modifications of the neuration, especially of the hindwings. I do not know any related genera.

Chorizomena nivosa n. sp.

nivosus, snow-white—

♀. 30 mm. Head and thorax white. Palpi pale fuscous. Antennæ grey, towards base white. Abdomen white; terminal segments greyish; tuft white. Forewings triangular, termen nearly straight, slightly oblique; white with fuscous dots; a dot on $\frac{1}{3}$ dorsum, and another in disc above it; a pair of subcostal dots at $\frac{1}{3}$ arranged transversely, a postmedian line of dots, indented beneath costa and slightly angled outwards in middle, followed closely by a fine interrupted line; a subterminal series indented above middle, cilia white. Hindwings with dorsum long, termen rounded; colour and markings as forewings, but without antemedian dots; postmedian and subterminal lines converging towards dorsum. Underside white without markings.

North Queensland: Cooktown (Endeavour River); type in National Museum, Melbourne.

Artigisa microsticta n. sp.

μικροστικτος, minutely speckled—

♂. 22-25 mm. Head and thorax brownish-fuscous. Palpi very long, obliquely ascending, second joint exceeding vertex, terminal joint $\frac{1}{3}$, stout, obtusely pointed ; brown, at base fuscous, terminal joint pale at base and apex. Antennæ fuscous ; with tufts of long cilia (3). Abdomen fuscous-brown ; tuft fuscous. Legs fuscous, with whitish rings. Forewings triangular, costa very slightly arched, apex subrectangular, termen rounded, oblique, slightly crenulate ; brownish-fuscous ; stigmata obscure, blackish ; orbicular round or dotlike ; reniform obliquely elongate, constricted in middle, sometimes partly obsolete ; a wedge-shaped whitish-ochreous costal mark at about $\frac{2}{3}$, bisected by a fine minutely dentate fuscous line to $\frac{3}{4}$ dorsum, on its edges minute whitish-ochreous specks ; a submarginal series of blackish dots, each preceded and followed by a whitish-ochreous dot ; cilia fuscous, with some reddish-purple scales. Hindwings with termen slightly rounded, dentate ; as forewings.

North Queensland : Ravenshoe and Millaa Millaa (3,000 feet), in September, November, and December. Queensland : Montville (1,500 feet), near Nambour, in September. Four specimens.

Gen. *Philogethes* nov.

φιλογηθης, cheerful—

Head with frontal tuft. Tongue strong. Palpi very long, porrect ; second joint extremely long, thickened with rough scales, with a ridge of long rough scales on upper surface throughout ; terminal joint short, acute. Antennæ in male shortly ciliated. Forewings with areole present ; 2 from middle, 3, 4, 5 approximated from angle, 6 from upper angle, 7 connate with 8, 9, 10 from areole, 11 from beyond middle, anastomosing shortly with areole. Hindwings with 2 from $\frac{2}{3}$, 3 and 4 stalked, 5 from well above angle ($\frac{1}{3}$), 6 and 7 connate, 12 anastomosing with cell near base.

Probably allied to *Hypenodes* Gn., which has lost the areole in the forewing.

Philogethes metableta n. sp.

μεταβλητος, variable—

♂. 18-20 mm. Head whitish ; face sometimes fuscous. Palpi fuscous, lower half of external surface sometimes brown-whitish. Antennæ brown-whitish, towards base annulated with dark fuscous ; ciliations in male less than 1. Thorax brown-whitish ; bases of tegulæ dark fuscous. Abdomen brown-whitish ; sometimes with a pair of dark fuscous dots on second segment, or some dorsal suffusion on terminal segment. Legs brownish-whitish, with some fuscous scales ; apices of tibiæ fuscous. Forewings elongate-triangular, costa straight to near apex, apex round-pointed, termen wavy, strongly angled on vein 4, incurved between this and apex ; brown-whitish, with fuscous markings ; a short streak on costa from base ; a line from costa near base to base of dorsum ; a straight, slightly dentate line from $\frac{1}{4}$ costa to $\frac{1}{4}$ dorsum ; a similar line from before midcosta to $\frac{1}{3}$ dorsum, followed by a narrow fuscous suffusion more or less complete ; two dots above middle transversely placed follow this ; a fine, strongly sinuate, slightly dentate line from beyond midcosta to beyond mid-dorsum ; a sinuate subterminal line sometimes preceded by three ferruginous dots ; a submarginal series of dots ; in one example a quadrangular blotch between subterminal line and termen, from which a strong line cutting subterminal runs to dorsum ; a fine terminal line ; cilia brown-whitish, on excavation fuscous. Hindwings with termen slightly rounded, irregularly dentate; two approximated antemedian lines, between which is a discal dot; a series of dots from tornus, closely followed by a line, neither reaching costa; between them two discal dots; submarginal dots and cilia as forewings.

North Queensland: Kuranda, in May; Lake Barrine, in September; Ravenshoe, in January; three specimens. I have seen another from Eungella.

Fam. LYMANTRIADÆ.

Lœlia turneri Collenette.

Collenette. Ann. Mag. Nat. Hist. (10) xiii., p. 216—

This species probably came from New Guinea and should not be included in our Australian list without verification.

Dr. G. A. Waterhouse has informed me that specimens in the British Museum *ex* Coll. Oberthur and labelled "Kuranda. F. P. Dodd" were actually captured in New Guinea.

Fam. ANTHELIDÆ.

Anthela glauerti n. sp.

♂. 30-32 mm. Head, thorax, palpi, antennæ, abdomen, and legs brownish-fuscous; palpi 1; antennal pectinations 6. Forewings triangular, costa straight almost to apex, apex pointed, termen rounded, slightly oblique; brownish-fuscous; whitish discal spots at $\frac{1}{3}$ and $\frac{2}{3}$; cilia concolorous. Hindwings with termen rounded; colour as forewings; a median whitish spot, which is more distinct on underside.

North-west Australia: Yalbalgo; two specimens received from the West Australian Museum.

Anthela decolor n. sp.

decolor, faintly coloured—

♀. 46-48 mm. Head, palpi, antennæ, thorax, abdomen, and legs ochreous-grey-whitish; palpi 1. Forewings triangular, costa straight, apex pointed, slightly produced, termen sinuate, not oblique; ochreous-grey-whitish; markings slightly darker grey; a line from $\frac{1}{4}$ costa to $\frac{2}{5}$ dorsum; a sinuate subterminal fascia; a narrow terminal fascia on costal half of termen; cilia whitish. Hindwings with termen rounded; colour as forewings; fascia median.

North-west Australia: Yalbalgo; two specimens received from the West Australian Museum.

Anthela virescens n. sp.

virescens, partly green—

♂. 40-45 mm. Head, thorax, and abdomen reddish-brown. Palpi $1\frac{1}{2}$; reddish-brown, towards apex pale ochreous. Antennæ white; pectinations in male 8, fuscous. Legs fuscous; tarsi and outer surface of tibiæ whitish; a white dot on apices of middle and posterior tibiæ. Forewings broadly triangular, costa slightly arched, apex rectangular, termen rounded, not oblique; fuscous-purple; a moderate basal patch suffused with green, its posterior edge dentate; a nearly straight green line from $\frac{4}{5}$ costa to $\frac{3}{5}$ dorsum; beyond this terminal area more or less suffused with green, with a green subterminal line preceded by a series of fuscous dots and partly edged posteriorly with fuscous; a circular discal spot fuscous with whitish centre; cilia fuscous-purple, apices reddish. Hindwings with termen rounded; fuscous-reddish; a sub-basal median fuscous dot; a straight fuscous transverse line at $\frac{4}{5}$; beyond this as forewings. Underside reddish, with whitish-centred discal spot and transverse fuscous line on forewing beyond and on hindwing before middle.

New South Wales: Tooloom, in March; two specimens received from Mr. E. J. Dumigan.

Fam. Lasiocampidæ.

Porela arida Wlk.

I am now satisfied that *P. delineata* Wlk. is a synonym of this species, which is variable.

Fam. Pyraustidæ.

Diathrausta metallosticha n. sp.

μεταλλοστιχος, with metallic lines—

♀. 18 mm. Head white. Palpi grey; base and extreme apex white. Antennæ grey. Thorax white; apices of tegulæ yellowish. Abdomen whitish; base of dorsum yellowish. Legs whitish; anterior pair with dark fuscous rings. Forewings narrowly triangular, costa almost straight, apex round-pointed, termen slightly rounded, oblique; white; a broad grey costal streak ceasing abruptly before apex; an orange-yellow streak edged with fuscous from $\frac{1}{4}$ dorsum very obliquely outwards to middle of disc; a narrow orange-yellow terminal band edged with fuscous anteriorly connected by an orange-yellow fuscous-edged line with costal streak beyond middle; in the terminal band is a silvery streak from apex ceasing abruptly in a broad end above tornus; cilia pale grey with three blackish bars above tornus, on apex yellowish. Hindwings with apex rounded, termen nearly straight; basal area white, defined by a wavy fuscous median line; terminal area yellow; a silvery submarginal line interrupted and not reaching tornus; five blackish dots on middle part of termen; cilia silvery white.

North Queensland: Chillagoe, in September; one specimen.

Margaronia eurytalis.

Glyphodes eurytusalis Wlk. Cat. Brit. Mus. xvii., p. 503. Hmps. Moths Ind. iv., p. 355.

Glyphodes opalalis Hmps. Ill. Het. viii., p. 135. Pl. 155, f. 20.

This handsome species has not previously been recorded from Australia.

North Queensland; Cape York in October; Kuranda in September; Lake Barrine, near Atherton, in September; four specimens. Also from Borneo, Ceylon, India, and Loyalty Islands.

Gen. *Macrobela* nov.

μακροβελος, with long palpi—

Tongue well developed. Face with a short acute anterior projection. Labial palpi straight, porrect, very long ($3\frac{1}{2}$–4), with rough projecting scales at base beneath; otherwise smooth-scaled; terminal joint $\frac{1}{4}$, stout, obtusely pointed. Maxillary palpi short, stout, obtuse, not dilated. Antennæ smooth; ciliations minute in both sexes. Posterior tibiæ with outer spurs $\frac{1}{2}$. Forewings with 4 and 5 connate, 8, 9, 10 stalked. Hindwings with 5 approximated to 4 at origin, 7 anastomosing with 12 for half its length.

I place this next *Sceliodes*, from which it differs in the longer labial palpi, stouter maxillary palpi, and stalking of vein 10 of forewing.

Macrobela phæophasma n. sp.

φαιοφασμα, a dusky spectre—

♀. 24-32 mm. Head and thorax grey. Palpi grey-brown. Antennæ grey. Abdomen grey-brown, with lateral fringes of whitish scales. Legs white. Forewings triangular, costa straight to $\frac{3}{4}$, thence arched, apex acute, termen slightly bowed on vein 4, slightly oblique; grey; costal edge whitish; a triangular, thinly scaled, translucent whitish area, from costa beyond middle reaching more than half across disc, indented anteriorly; cilia whitish. Hindwings with termen nearly straight; grey, with a faintly darker postmedian line; cilia grey.

North Queensland: Kuranda, in December; Ravenshoe, in January (F. P. Dodd); two specimens received from Mr. Geo. Lyell, who has the type.

Myriostephes eucosmeta n. sp.

εὐκοσμητος, very neat—

♂. 14-16 mm. Head and thorax greyish-ochreous. Labial palpi $2\frac{1}{2}$, terminal joint minute; ochreous-fuscous. Antennæ with joints strongly dilated and angular at apices; ciliations in male $\frac{1}{2}$; grey. (Abdomen missing.) Legs ochreous-whitish; anterior pair fuscous. Forewings elongate-triangular, costa straight to near apex, apex pointed, termen nearly straight, slightly oblique; greyish-ochreous; two slender fuscous transverse lines; first from $\frac{1}{3}$ costa to $\frac{1}{4}$ dorsum, angled beneath costa, thence straight; second from $\frac{3}{4}$ costa to $\frac{3}{5}$ dorsum, edged with whitish posteriorly, curved outwards in upper half, thence straight; a white median subcostal discal dot; cilia fuscous, with a darker basal line and three whitish bars, on tornus, above vein 2, and above vein 6. Hindwings with termen rounded; ochreous-whitish; a faint postmedian fuscous line; cilia whitish.

Victoria: Beaconsfield (Wandin), in November; two specimens received from Mr. Geo. Lyell, who has the type.

Fam. COSSIDÆ.

Culama crepera n. sp.

creper, dark—

♂. 52 mm. Head pale brown; face dark fuscous. Palpi with second joint long, reaching beyond face; terminal joint $\frac{1}{4}$; fuscous. Antennæ dark fuscous; pectinations in male 3. Thorax dark fuscous, patagia and central area pale brown. Abdomen dark fuscous, towards apex grey. Legs fuscous. Forewings suboblong, costa moderately arched, apex rounded, termen obliquely rounded; dark fuscous, with fine blackish lines and strigulæ partly edged with brown; an incomplete sub-basal line; a curved line from $\frac{1}{6}$ costa to $\frac{1}{3}$ dorsum, transverse wavy postmedian and subterminal lines; cilia fuscous. Hindwings with termen gently rounded; whitish, margins suffused with whitish; cilia fuscous.

West Australia: Coorow, in October; one specimen.

Artificial Ripening of Oranges.

By L. S. BAGSTER, D.Sc., A.A.C.I., and MADOLINE V. CONNAH, M.Sc.

(*Read before the Royal Society of Queensland, 28th November, 1938.*)

Artificial ripening of fruits by means of treatment with ethylene gas is a well-known commercial process, and in recent years has been the subject of considerable investigation.

It has been shown that with fruit such as the banana, apple, pineapple, ethylene treatment causes actual ripening of the pulp as well as hastening the colouring of the skin. It has been suggested by Lynch (1935) that ethylene acts as a coenzyme to an oxidase system such as is known to be present in both the skin and pulp of such fruits. This suggestion is supported by the fact that the skin of citrus fruits, such as the orange and lemon, which are known to contain an oxidase system is affected by the process, whereas the pulp which contains no oxidase system is not affected.

Egana and Acerati (1935) investigated very thoroughly this process with regard to oranges of various types. They found that the orange may acquire colour by this process, but it is necessary for it to have begun its natural change of colour. It is impossible by this method to colour a completely green orange, whereas the banana can be coloured by ethylene at any stage of maturity. With regard to the actual pulp, no change due to ethylene treatment was observed in the citric acid, glucose, or invert sugar content.

It was therefore thought of interest to study the effect of ethylene on the enzyme catalase which is present in the orange pulp, and also its effect on the ascorbic acid content of oranges. The investigation covered the fruit from one particular tree throughout the season. The tree was a well-grown 10-year-old plant about 6 ft. high and of approximately 6 ft. spread. It was grown in an open position in brown loam soil.

The ethylene treatment used was that of Egana, namely—temperature 18–20° C., humidity 75–80°, concentration of ethylene 2 in 1000. The ripening cupboard was swept out every eight hours with fresh air and then recharged with ethylene. The treatment requires about four days.

The catalase was estimated as oxygen liberated in one hour by 1 c.c. of 30% hydrogen peroxide in 3 c.c. water added to 10 c.c. juice mixed with approximately 3 grs. calcium carbonate in 40 c.c. of M/5 potassium hydrogen phosphate—M/5 sodium hydroxide buffer which gave pH 7. A vessel containing a strong solution of sodium hydroxide was used to absorb the carbon dioxide liberated, and it was ascertained that all this had been absorbed before the peroxide was added.

For estimation of ascorbic acid 5 c.c. of a solution of 2·6 dichlorindophenol and 0·5 c.c. glacial acetic acid were titrated against the orange juice. The dye solution was standardised by means of freshly prepared ascorbic acid solution which was itself standardised by titration against 0·01 N iodine.

The fruit was cut with a stainless knife, squeezed on glass, filtered through a porcelain sieve, and used immediately.

Experiments showed that grinding the juice with fine silver sand reduced the catalase but had no appreciable effect on the ascorbic acid content.

The results are shown in the accompanying tables.

No. of Orange.	Colour.	Taste.	Catalase (as O_2 at N.T.P. from 10 c.c. juice.)	Ascorbic Acid (mgr. in 10 c.c. juice.)
Batch 1 (29-3-38)—				
A_1	I	1	1·5	5·65
A_2	I	2	8·1	5·71
A_3	I	2	3·3	6·48
B_1	III	2	0·0	5·68
B_2	II	2	2·0	6·58
B_3	II	2	0·9	5·81
C_1	III	1	10·1	6·25
C_2	IV	3	6·7	6·58
C_3	IV	4	3·4	5·95
Batch 2 (4-4-38)—				
B_1	II	4	4·4	5·22
B_2	II	3	4·6	5·63
B_3	II	3	0·0	5·83
C_1	IV	4	8·4	6·50
C_2	IV	3	5·8	5·96
C_3	IV	3	0·2	5·83
Batch 3 (11-4-38)—				
B_1	II	3	2·7	6·54
B_2	II	3	1·5	7·52
C_1	IV	4	2·4	6·24
C_2	IV	4	0·5	5·55
Batch 4 (18-4-38)—				
B_1	II	4	3·5	6·05
B_2	III	3	5·0	6·41
B_3	III	3	5·1	6·05
C_1	III	4	20·6	5·42
C_2	V	3	6·4	5·78
C_3	III	3	3·7	5·84
Batch 5 (26-4-38)—				
A_1	I	3	1·6	5·18
B_1	II	2	8·4	4·87
B_2	II	2	6·0	5·40
C_1	IV	3	5·8	6·17
C_2	IV	3	4·8	6·45
Batch 6 (29-4-38)—				
B_1	III	4	12·4	5·51
B_2	II	4	4·6	5·04
C_1	IV	4	7·2	5·31
C_2	IV	4	8·3	4·99
C_3	IV	4	13·2	5·61

No. of Orange.	Colour.	Taste.	Catalase (as O_2 at N.T.P. from 10 c.c. juice.)	Ascorbic Acid (mgr. in 10 c.c. juice.)
Batch 7 (5-5-38)—				
A_1	I	1	1·9	5·56
A_2	I	1	0·0	5·56
B_1	III	4	6·7	5·32
B_2	II	3	15·7	4·63
C_1	IV	3	6·9	5·14
*C_2	IV	3	14·2	4·73
Batch 8 (12-5-38)—				
A_1	I	1	0·0	5·09
A_2	II	1	0·4	5·09
B_1	III	4	13·7	5·67
B_2	III	4	10·9	4·84
C_1	IV	4	11·5	5·22
C_2	V	4	6·0	5·28
Batch 9 (16-5-38)—				
B_1	III	4	7·8	5·57
B_2	III	3	0·0	5·44
C_1	III	4	11·4	5·13
C_2	IV	3	3·4	5·44
C_3	III	4	1·1	5·78
Batch 10 (19-5-38)—				
A_1	I	1	0·9	5·71
A_2	I	1	0·0	4·87
B_1	IV	..	7·6	5·34
B_2	III	4	9·22	4·83
*C_1	V	4	14·2	5·20
C_2	V	4	4·9	5·93
Batch 12 (30-5-38)—				
B_1	III	4	7·4	5·31
B_2	III	3	0·0	6·08
*C_1	V	4	9·6	5·02
*C_2	V	3	11·4	5·63
Batch 13 (6-6-38)—				
B_1	III	4	24·1	5·23
B_2	III	3	3·6	5·71
C_1	IV	3	6·05	4·94
C_2	V	3	13·5	5·71

No. of Orange.	Colour.	Taste.	Catalase (as O_2 at N.T.P. from 10 c.c. juice.)	Ascorbic Acid (mgr. in 10 c.c. juice.)
Batch 14 (17-6-38)—				
B_1	III	..	1·5	5·32
C_1	V	5	24·7	5·66
C_2	V	5	4·7	4·77
Batch 15 (29-6-38)—				
	V	Judged not	completely ri	pe.
Batch 16 (6-7-38)—				
D_1	V	5	10·5	4·57
Batch 17 (17-7-38)—				
D_1	V	5	2·1	4·75
Batch 18 (25-7-38)—				
D_1	V	6	6·8	5·90
D_2	V	6	1·7	6·81
Batch 19 (8-8-38)—				
D_1	V	6	5·0	5·20
D_2	V	6	0·9	9·42
Batch 20 (17-8-38)—				
D_1	V	6	5·4	7·70
D_2	V	6	8·4	7·38
Batch 21 (20-8-38)—				
D_1	V	6	3·7	8·02
D_2	V	6	2·2	6·76
Batch 22 (5-9-38)—				
D_1	V	6	3·2	6·52
D_2	V	6	1·7	7·64
Batch 23 (11-9-38)—				
D_1	V	4	5·9	5·92
D_2	V	6	6·6	6·13

EXPLANATION OF SYMBOLS USED IN TABLE.

A, green oranges tested the same day as picked; B, partly ripened when picked, untreated, but kept for test with group C; C, partly coloured when picked, treated with ethylene; D, ripened on the tree, tested the same day as picked. *Colour*: I, green; II, yellowish-green; III, greenish yellow; IV, pale yellow; V, orange. *Taste*: 1, very sour, extremely unpleasant to taste and completely inedible; 2, sour, edible but definitely unpleasant; 3, fairly sour, juice palatable with sugar; 4, slightly sour, quite edible but faint sourness underlying the sweetish taste; 5, sweetish, no trace of sourness but not yet fully ripened, poor flavour; 6, sweet to definitely ripe and fully flavoured.

Samples C for treatment with ethylene in each experiment were selected to correspond closely in size and colour with corresponding check samples B. The colour given to these in the tables is that after ethylene treatment.

Although the results are rather irregular, certain conclusions seem fairly definite—

1. The catalase content of completely green oranges was very low and showed an increase as the fruit ripened until the oranges became really ripe, when it was decreased again, but did not become as low as in the completely green oranges.
2. The ethylene treatment had apparently no effect on the catalase content.
3. The ascorbic acid content varied but little throughout the season, but showed a slight tendency to increase as the oranges became really ripe.
4. The ethylene treatment produced no definite change in ascorbic acid content. Oranges marked thus * had a slight but definite unpleasant "musty" flavour after treatment with ethylene. Apart from this the treatment seemed to have no effect on the taste.

This work was carried out by aid of a grant from funds provided to the University of Queensland by the Commonwealth Government through the Council for Scientific and Industrial Research.

The authors are indebted to Miss N. McGinn, who carried out some of the later experimental work.

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The Metamorphic Complexes of the D'Aguilar Range and New Caledonia.

By H. I. JENSEN, D.Sc.

(*Read before the Royal Society of Queensland, 28th November,* 1938.)

In every branch of natural history one of the most interesting studies is parallelism in development. It has been the privilege of the author to study two metamorphic complexes far removed from one another and of very different ages, which, nevertheless, show numerous points of similarity, namely, the Mount Panie complex of Northern New Caledonia and the D'Aguilar Range of Southern Queensland.

In Southern Queensland we have a belt of metamorphic rocks, the Brisbane schists, stretching more or less uninterruptedly from the New South Wales border to Gladstone, where they run out to sea. The occasional breaks in the continuity of outcrop are due to cappings of Triassic sandstone, and volcanics, like the Brisbane tuffs at and near Brisbane, and the andesitic and rhyolitic tuffs probably of early Triassic (Esk series) age at Palmwoods and Yandina, to cappings of Tertiary basalt at Bald Hills and the Blackall Range, and to Tertiary sandstone about Strathpine.

Queensland geologists have divided the Brisbane schists into strata referable to the Silurian and Devonian, the older lying in general east of the younger. The western strip, containing serpentines, is regarded as Devonian, largely on account of analogy with the New South Wales serpentine belt. The serpentine belt stretches from Pine Mountain, near Ipswich, north through Kilcoy and Kilkivan.

The most intensely metamorphic area in the whole of the Brisbane schist belt is the portion of the D'Aguilar Range lying between Terror's Creek and Mount Mee, on the eastern flank, and the summit of that part of the D'Aguilar Range and east of the serpentine belt. These rocks are mineralogically comparable to the oldest Archæan of South Australia. They comprise mica schists, micaceous phyllite, slate, granulite, epidote schist, chlorite schist, with dykes and bosses, and perhaps altered lava flows, turned into glaucophane schist, glaucophanite, glaucophane epidote rock, hornblende schist, epidote actinolite topaz schist, etc. These altered igneous rocks are schistose through stress, and have also been broken up into lenticular bodies by faulting and squeeze. Rocks described by me (1906) include cyanite-rutile granulite, granulitic mica schist, muscovite granulite, greenstone, ortho-gneiss, hornblende schist, epidote-actinolite schist, epidote-cordierite-delessite schist, albite-chlorite schist, glaucophane rock, epidiorite, and glaucophane-epidote rock. In addition to the commoner rock-forming minerals like quartz, orthoclase, albite, microcline, hornblende, uralite, muscovite, biotite, and to the minor constituents, apatite, magnetite, ilmenite, the following were determined in these rocks:—Labradorite, anorthite, actinolite, glaucophane, epidote, zoisite, cordierite, sillimanite, talc, tremolite, chlorite, delessite, topaz, anthophyllite, rutile, cyanite, sericite, etc., etc.

Most of these minerals have a smaller molecular volume than that calculated from the molecular volumes of the oxides composing them, and they belong to Grubenmann's "Middle Zone" schists—that is, schists formed in a portion of the earth's crust which has been loaded with sediments sufficient to lower it into a position where heat and pressure have caused extensive chemical changes and recrystallisation, but not complete fusion and recrystallisation. The greenstones, epidiorites, hornblende schists, glaucophane rocks, and actinolite schists are all derived from igneous rocks like flows, tuffs, dykes and bosses of basic magma. The mica schists and slates are altered marls and shales. The granulites may be altered sandstones and tuffs, while the gneisses constitute altered granite.

Miss G. A. Joplin, B.Sc., Ph.D., examined a collection of schistose rocks made by the writer in northern New Caledonia. They included glaucophane-lawsonite rocks, glaucophane epidote schists, glaucophane garnet schists, glaucophane-muscovite-quartz schist, chlorite-albite-epidote-garnet schist, chlorite schist with sphene and epidote, garnet schist, chloritoid schist, quartz schist, and actinolite schist. The minerals of these schists again belong mostly to Grubemann's "Middle Zone," and here, as in the Queensland area, we are dealing with a complex of altered igneous (volcanic and hypabyssal) and sedimentary rocks.

Thus the Panie Massif of north-eastern New Caledonia and the D'Aguilar Range of Southern Queensland are petrologically similar, and of similar rock genesis, but, as will be seen below, the New Caledonia complex is probably much the younger.

The next very interesting point of similarity is the existence of a belt of serpentine to the west of each of these complexes of metamorphic rocks, but whereas in Queensland the serpentines are considered to be Devonian, in New Caledonia they are of very late Cretaceous or of early Tertiary age. They intrude all the Mesozoic rocks from Triassic to Cretaceous. In New Caledonia we have rocks as late as Cretaceous, altered to schist, tilted at very high angles, or even vertical. Such recent schists abound in the Dombea district, and also west of Koumac, between that village and the Diahot River. The schistose Mesozoic rocks are in general east of the serpentine belt, but west of that belt the Mesozoics range from very highly altered, steeply inclined rocks, by every gradation to unaltered and but gently folded sedimentaries.

Taking the schists, we find that those west of the Diahot River have been developed mainly through thrust and pressure. Sericitisation, talc formation, and chlorite development are noticeable in those of sedimentary formation, and the lavas are extensively chloritised. Occasionally a patch is more intensely altered, showing development of mica and glaucophane.

However, east of the Diahot River the schists are predominantly recrystallised. They are completely crystalloblastic, and embrace both homoblastic and heteroblastic structures, and helicitic structure often shows. There are granoblastic quartzites and eclogites, lepidoblastic mica schists and glaucophane schists, nematoblastic amphibolites, poikiloblastic greenstones, diablastic glaucophane rocks with kelyphitic structure, and metamorphosed trachytes with porphyroblastic structure.

There is good reason to believe that these rocks represent the same series as those west of the Diahot, but more intensely metamorphosed. This intense metamorphism is due to the rocks of the region being depressed in a deep synclinal trough, and afterwards brought up on the back of the peridotite intrusion that arose from the depths to the east. Both the depression into the "Middle Zone" and the superposition on a great hot igneous intrusion added intense heat to pressure as an agent of metamorphism and recrystallisation.

There seems every reason to think that most of the serpentines of Eastern Australia are Devonian. In the D'Aguilar Range they lie west of the intensely metamorphic region of Terror's Creek and Mount Mee. Perhaps in this case, too, the serpentines have been thrust up from a deep to the east, now long since re-elevated or filled in, and in all probability here, as in New Caledonia, the intensely metamorphosed rocks are derived from rocks immediately preceding the Serpentine (peridotite) extrusion, in this case earlier Devonian and Silurian.

By combined chemical and petrological investigation it could be determined if the glaucophane schists and the associated rocks of Mount Mee represent an extremely metamorphosed phase of rocks in the Brisbane schist series.

The presence of chrome is common to the New Caledonia and D'Aguilar serpentines, and the absence of nickel in the Queensland series is a matter of geological age. In all probability the Queensland serpentines contained nickel for several periods after the peridotite extrusion. In New Caledonia the serpentine masses are largely peridotite undergoing decomposition into serpentine. As the olivine is serpentinised the nickel in it rises in solution to the surface, where it is deposited in a lateritic crust. Most of the New Caledonia nickel mines are just such superficial crusts of nickeliferous laterite. After a mine is worked out (that is, exhausted by surface scraping) it is left twenty or thirty years for the nickel to rise again, and the "mining" is renewed. This rise of nickel to the surface continues till all the peridotite is serpentinised. In the Queensland area the nickel, once present, has all been removed by erosion.

Chemical analysis shows traces of nickel in the Mount Mee glaucophane schists, pointing to that metal having been originally present in the region.

REFERENCE:

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The Royal Society of Queensland.

Report of Council for 1938.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its report for the year 1937.

Fifteen original papers were accepted for publication in the Proceedings, and most of them were actually read at ordinary meetings of the Society.

During the year the following lectures were delivered:—"A Scientist Abroad" by Dr. J. V. Duhig; "Interaction of Radiation with Living Matter" by Dr. H. C. Webster; "Modern Methods of Museum Display" by Mr. Frank Tose; "New Laboratories of the Division of Forest Products, C.S.I.R., Its Equipment and Activities" by Mr. S. Clarke, B.E.; "Co-operative Pasture Plant Improvement Investigations in Queensland" by Mr. C. S. Christian, B.Ag.Sc.; "Plant Introduction Investigations in Queenland" by Mr. T. B. Paltridge, B.Sc.

One meeting was devoted to a series of short addresses on Phosphorus, the speakers being Dr. W. H. Bryan, Dr. M. White, Dr. A. W. Turner, and Dr. J. V. Duhig.

Exhibits were tabled by the following members:—Professor H. C. Richards, Drs. Whitehouse, Vickery, Duhig, Herbert, and Marks, and Messrs. Blake, Riddle, and Ogilvie.

Your Council takes this opportunity of thanking those who assisted in the above phases of the Society's work; those who provided the numerous exhibits which were displayed for the interest of members; the University of Queensland for housing the library, and providing accommodation for meetings; and the Assistant Librarian of the University, Miss McIver, for superintending the lending of periodicals from the library.

During the year the library was shifted to the new Library Building. Unfortunately, however, it has not yet been possible to arrange the periodicals on the shelves.

The membership roll consists of 5 honorary life members, 6 life members, 3 corresponding members, 193 ordinary members, and 3 associate members. During the year there were 3 resignations and 16 new members were elected.

There were ten meetings of the Council during the year, the attendance being as follows:—L. S. Bagster, 8; E. W. Bick, 9; J. V. Duhig, 7; D. A. Herbert, 10; J. S. Just, 6; H. A. Longman, 0; J. K. Murray, 3; F. A. Perkins, 9; H. C. Richards, 5; A. R. Riddle, 8; H. R. Seddon, 4; J. H. Smith, 7; F. W. Whitehouse, 8.

In terms of Rule 19, Mr. J. S. Just, Senior Member of the Council, automatically retires, but will be eligible for re-election in 1939.

THE ROYAL SOCIETY OF QUEENSLAND.

Cr. STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDED 31ST DECEMBER, 1937. Dr.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
Balance in Commonwealth Bank, 31st December, 1936	152	12	2	Government Printer, Abstracts and Report	12	1	0
Subscriptions	145	8	6	Government Printer, Stationery	4	13	5
Sales, Reprints, and Volumes	3	5	4	Government Printer, Volume of Proceedings	152	6	10
Commonwealth Loan Interest	3	9	10	Assistance in Library	4	0	0
Savings Bank Interest	3	12	2	State Government Insurance, (Library)	1	1	7
Refreshments Account, Collections	1	19	8	Hon. Secretary, Postages	9	0	0
				Hon. Librarian, Postages	1	0	0
				Hon. Treasurer, Postages and Duty	1	0	0
				Commonwealth $3\frac{3}{4}$ Loan (50) £	49	12	6
				Lanternist	1	0	0
				Refreshment Account, Crockery and Utensils	4	2	3
				Refreshments and Service	2	16	1
				Refund of £1 1s. banked in error, 1936	1	1	0
				Balance in Commonwealth Bank	66	13	0
	£310	7	8		£310	7	8

Audited and found correct.

A. J. M. STONEY, B.E.E., Hon. Auditor.

4th March, 1938.

E. W. BICK, Hon. Treasurer.

Abstract of Proceedings, 28th March, 1938.

The Annual Meeting of the Society was held on Monday, 28th March, at 8 p.m., in the Geology Lecture Theatre of the University, with the President, Professor L. S. Bagster, in the chair. About sixty members and friends were present. Apologies were received from Messrs. J. J. C. Bradfield, C. S. Fraser, and C. T. White.

The minutes of the previous annual meeting were read and confirmed. Miss J. Griffiths, B.Sc., and Mr. D. J. W. Smith, B.Sc., were proposed for Ordinary Membership by Mr. F. A. Perkins and Dr. R. Hamlyn Harris. The Annual Report and Balance-sheet were adopted. In moving the adoption of the Report Dr. W. H. Bryan suggested that a list of the papers read during the year should, in future, be inserted in the report after the list of lectures given. Mr. H. Tryon asked that some account be given of the library activities.

The following officers were elected for 1938:—President, Professor H. C. Richards; Vice-Presidents, Professor L. S. Bagster and Mr. H. A. Longman; Honorary Secretary, Miss D. Hill; Honorary Treasurer, Mr. E. W. Bick; Honorary Librarian, Mr. F. A. Perkins; Editor, Dr. D. A. Herbert; Associate Editor, Mr. J. H. Smith; Members of Council, Professor J. V. Duhig, Mr. A. R. Riddle, Dr. M White, Dr. F. W. Whitehouse. The President then delivered his retiring address on "Alchemy—Ancient and Modern."

Starting with old Greek philosophy chemical history first began at Alexandria. The Greek idea of a common constitution of matter was there adopted and attempts first made to transform matter, chiefly base metals, to gold. From Alexandria in the early years of the Christian era such knowledge as had been gained was transferred to workers supported by the then flourishing rulers of Arabia. These early workers, though failing in their primary object, in the course of their attempts developed methods of procedure and discovered many new materials and compounds. At the revival of learning in Europe, Arab knowledge was acquired, and, for a long period, until the civil war in England, the alchemist flourished; though still believing in transmutation, he gradually turned his attention to the application of his discoveries to medicinal use and carried on his experiments in a spirit of inquiry.

It was Robert Boyle, an Irishman, at Oxford in the reign of Charles II., who finally demonstrated that what we call the chemical elements were to be regarded as unchangeable, a theory accepted without question till the end of last century, when Thomson, at Cambridge, showed that all atoms contained a common constituent, the electron, which could be removed by a suitable electric discharge. The discovery of radioactivity a little later was the beginning of a new scientific era.

Rutherford, Thomson's successor at Cambridge, was able to show that during the radioactive process large atoms were actually breaking up, forming smaller ones. It had been shown that one of the radium radiations, the alpha particle, was actually the essential portion of the gas helium without the electrons that ordinary atoms carry. Rutherford was able by studying the passage of alpha particles through matter to show that atoms possessed a nucleus compound of particles much heavier than the electrons; that hydrogen, the simplest element, had one such particle or proton, and that the alpha particle had four. The proton from hydrogen can be set free in the electric discharge. It has been shown in the last few years that by bombarding atoms with fast-moving protons or by alpha particles changes can be produced in the atomic nucleus. The products are actually synthetic elements with new properties. Some of them are actually radioactive and their existence can be easily shown by electrical methods. One, radio-sodium has already been produced in quantity and shown to be as active as the small quantity of radium used for many cancer treatments. Another, radio-phosphorus, has the chemical properties of ordinary phosphorus except that of radioactivity. This has been fed to rats which later were killed. The radio-phosphorus could readily be estimated by its radioactivity, and the history of the ordinary phosphorus from its chemical properties will be the same. In this way it has been found that the phosphorus, even in the bones, changes every few weeks, new phosphorus atoms replacing old ones.

A vote of thanks to the retiring President, moved by Mr. H. Tryon and Professor J. V. Duhig, was carried by acclamation.

Abstract of Proceedings, 26th April, 1938.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University on Tuesday, 26th April, at 8 p.m., with the President, Professor Richards, in the chair. About forty members and visitors were present, and apologies were received from Professor Bagster and Mr. J. R. Kemp. The minutes of the previous meeting were read and confirmed. Miss J. Griffiths, B.Sc., and Mr. D. J. W. Smith, B.Sc., were unanimously elected members of the Society.

Dr. F. Berry Smith exhibited cultures on saturated saline media of typical chromogenic bacteria isolated from solar salts, and photomicrographs of spore masses or fruiting bodies of a Myxococcus constituting the principal chromogene of one sample of Australian crude salt of marine origin.

The main business of the evening was an account of the work of the Science Students Association's Expedition to Moreton Bay, illustrated by lantern slides, a cine film, maps, and specimens. The typed reports of the work of all sections were tabled. Dr. Dorothy Hill, leader of the expedition, said that it was made possible by the activities of Mr. J. P. Callaghan, president of the Association. The Expedition was away a fortnight. The "Cambria," lent by Mr. T. L. Jones, formed a movable sea station, and all the apparatus was lent by the Great Barrier Reef Committee, the Queensland Museum, and the various University Departments. The University Union gave financial help. The two aims of this Student expedition were to awaken realisation of the numerous research problems of the Bay in as many sciences as possible, and to set a high standard of accuracy in research. The party completed a topographical, geological, physiographical, biological, and botanical survey of the Bird and Goat Islands bank.

Dr. Hill summarised the results of the parties engaged in physical investigations. The topographical surveyors made a map contoured at 2-foot intervals of the bank, which was found to be a fringing coral reef, built up about the coarse Triassic sandstone which outcrops at the south end of Goat I. The reef above Mean Low Water Level is dead. At its highest point it is 5 feet above M.L.W., indicating a recent slight change in sea level. Living corals are fairly common on the bank below M.L.W., except to the north. The raised reef contains 21 species, a different assemblage from the living corals, of which 13 species were collected. All are species of wide geographic distribution. Like many of the reefs of the Great Barrier, the Bird-Goat reef carries a sand cay (Bird I.) at its leeward end. The shape and position of the cay and the distribution of boulder, sand, and mud veneers result from the interaction on the bank of the north and south tidal currents and the waves caused by the prevailing S.E. winds and the storms. Analyses made by Mr. Hines on the sediments suggest that much of Bird I. sand is dune sand, carried by the flood tides, the remainder, and the sand and mud veneers, being fragments of animal skeletons and detritus from the Goat I. sandstone. The only soil found is in the mangrove swamps. An interesting meteorological curve was that recorded by the barograph, showing the approach and departure of a cyclone.

Mr. Callaghan gave the results of the hydrographic work, in the absence of Mr. N. Hancox, chemist to the expedition. Temperature, salinity, Hydrogen-ion concentration, and oxygen saturation were determined, and attempts were made to measure the dissolved organic matter, silicates, phosphates, and nitrates, of a series of water samples taken from the surface and at depth at different stages of the tide and times of day. The maximum temperature was 29°C. and the minimum 26·6°C. The average salinity was 34·6 per cent.; it decreased remarkably after the cyclonic rains. The oxygen saturation varied between 90 and 100 per cent. A larger series of results is necessary for analyses of the dawn and sunset variations, and of those due to the state of the tides.

Dr. Joyce Laing reported on the zoological work. Zoological collections were made zonally. The littoral zone of Bird and Goat Islands was found to harbour a rich and interesting fauna, which varied considerably in its composition in different localities. At high-water level around the island there was very little life, just below this level, in the sandy flats of Bird Island was an interesting community consisting chiefly of burrowing Crustacea and worms, while in the rocky zone round Goat Island, molluscs were dominant. Near low water the population was much more dense and more uniform around the two islands, most animal phyla being represented. Gastropods and crabs were the commonest animals; Echinoids, Hydroids, Polyzoa, and Nemertines were apparently absent.

The one visit made to the extensive sand flats round the Myora oyster bank showed that the sand community there was remarkably different from that of Bird Island.

Six plankton hauls were made during the expedition, one horizontal and three vertical hauls from the "Cambria," and two surface tows from the tender. Crustacean larvæ dominated five of the catches. The sixth and best catch was that obtained in the surface tow made at night. This was enriched by very numerous Mysids and a few other Crustacea, creatures which are benthic during the day but which rise to the surface at night.

Mr. S. T. Blake said that botanical work in some form or other was carried out on Stradbroke Island, Goat and Bird Islands, and the surrounding waters, and in the waters off Peel Island. Some difficulty was experienced in drying specimens, due partly to the salty atmosphere, partly to weather conditions. Ecological work was carried out in conjunction with collecting specimens. Forty-two collections were made, embracing 24 algæ and 19 vascular plants. Of the latter, one represents an interesting new genus of the Restiaceæ, while two represent new species of the Cyperaceæ. The Algæ will have to be sent abroad for determination. A list of the plants on Goat Island was drawn up, an account of the vegetation both terrestrial and marine has been written, and a map showing the distribution of the several vegetation types and also the area occupied by the chief trees, &c., has been prepared.

Mr. T. B. Stephens reported on the photography. He demonstrated the value of an aquarium and car head lights for lateral under water photography, and advocated a glass-bottomed boat with adjustable shade for vertical under-water work. He considered that colour photography is now sufficiently advanced to be freely used on such expeditions, for both stills and cine films, and for cine work advised prearrangement and rehearsal of sequences. Future expeditions might well examine the possibilities of micro-photography in stills and with the cine camera.

In moving a vote of thanks to the speakers, Mr. H. A. Longman and Mr. C. T. White welcomed this successful student enthusiasm for the scientific study of the Bay, and hoped the expedition would be the fore-runner of much work. Professor Richards congratulated the expedition on having surmounted all its difficulties, on prosecuting its work with the right attitude towards scientific research, and on completing its work by its written reports. The vote was carried by acclamation.

Mr. J. F. Bailey drew the attention of the meeting to the Press announcement that the Clarke Medal of the Royal Society of New South Wales had been awarded to Professor H. C. Richards, and the meeting congratulated its President on his new honour.

Abstract of Proceedings, 6th June, 1938.

The Ordinary Monthly Meeting of the Society was held on Monday, 6th June, at 8 p.m., in the Department of Geology of the University. In the absence of Professor Richards, Mr. H. A. Longman occupied the chair. About thirty members and friends were present. Apologies were received from Drs. Bryan, Marks, and Whitehouse. The minutes of the previous meeting were read and confirmed. In tribute to the memory of the late Mr. J. F. Bailey, sometime President of the Society, the meeting stood in silence for one minute. Mr. K. Jackson was proposed for ordinary membership of the Society by Miss D. Hill and Mr. Watkins.

The main business of the evening was a series of exhibits. Professor L. S. Bagster demonstrated two Polaroids and their reaction on light passed through sugar solutions.

Mr. J. S. Just exhibited a piece of the first paper insulated 11,000 volt electric power cable manufactured. The cable was laid in London during 1890 and made possible electric power stations of to-day It was taken out of service during 1933 after forty years of continuous use.

Mr. S. T. Blake exhibited a series of plants collected in Cape York Peninsula, some being new records for Queensland and others rediscoveries of species collected either by Banks and Solander in 1770 or by Robert Brown in 1802.

Mr. S. B. Watkins exhibited (1) Basalt from Coulson's Creek, Spicer's Gap Area, collected at the site of the coal seam, carrying chabazite, a little natrolite and purple tinged fluorite. Fluorite in basalt is very rare. (2) Silver selenide sent in by a student of the correspondence course in geology and mineralogy from the vicinity of Cloncurry. (3) Enoggera granite from Kerr's granite quarry, Waterworks road, Ashgrove, on the right-hand side in the major granite mass. The specimen was composed for the greater part of decomposed felspars with radiating patches of needle-shaped crystals of tourmaline. Embedded between the needles of tourmaline was pyrites which in some cases climbed right up between the crystals indicating that this pyritical phase followed the tourmaline phase. A small patch of pink mineral suggested thulite. (4) Fossil wood showing perfect cellular structure. (5) A pine model of a laccolite wherein white ants were operating. These white ants were distinct in character from the normal white ants. They tunnelled in the wood and on reaching its surface worked sideways leaving a thin layer of wood forming a ceiling, thus obscuring the activities from the outside. They produced a fine sawdust and ate the wood away cleanly. As a result of a visit from Mr. A. Berry of the Termite Exterminators Pty. Ltd., the species was identified as Cryptotermes.

Dr. T. G. H. Jones showed a specimen of azulene and commented on its properties.

Dr. D. A. Herbert exhibited an albino mango.

Mr. H. A. Longman exhibited two Ring-tailed opossums from Mount Spurgeon, via Mount Carbide, Cape York Peninsula. One of these had been presented to the Queensland Museum in July, 1937, by Mr. J. McNamara, and the other had been recently collected by Dr. G. Neuhauser. He considered that these represented the type of Ring-tail collected by Banks on the Endeavour River in 1770, and described in 1785, as *peregrinus* by Boddaert. Although this name had been loosely applied at one time to southern common Ring-tails, these were more correctly designated as *Pseudochirus laniginosus* Gould. The new specimens from Mount Spurgeon were not closely allied to the *laniginosus* group, but their cranial characters showed them to be related to *Ps. herbertensis*. This was anticipated by Oldfield Thomas when writing of these marsupials in 1923, and describing a sub-species of the Common Ring-tail from North Queensland.

A cast of the Cohuna Skull was also exhibited and its principal characters were outlined.

The exhibits were commented on by Messrs. H. Tryon, J. H. Smith, F. G. de V. Gipps, and a vote of thanks to the exhibitors was moved by Mr J. H. Smith, seconded by M. F. Koumans, a visiting Dutch scientist, and carried by acclamation.

Abstract of Proceedings, 27th June, 1938.

The Ordinary Monthly Meeting of the Society was held in the Geology Theatre of the University on Monday, 27th June, at 8 p.m., with the President in the Chair. About fifty members and friends were present. Apologies were received from Professor J. K. Murray and Mr. R. Roe. The minutes of the previous meeting were read and confirmed. The President referred with regret to the death of Dr. W. N. Robertson, Vice-Chancellor of the University, and the loss the Society had sustained thereby. Mr. K. Jackson was unanimously elected a member of the Society. The Secretary read a letter from the Royal Society of New South Wales asking for nominations for the Walter Burfitt Prize for 1938, and an invitation to members from the Chancellor and Senate of the University to attend the John Thomson Lecture for 1938.

On behalf of the Royal Society of New South Wales, the Senior Vice-President, Professor L. S. Bagster, presented to Professor H. C. Richards the Clarke Memorial Medal for outstanding services to Australian geology. Professor Bagster referred to the distinguished services W. B. Clarke had himself rendered to Australian geology, and said that Professor Richards' work for science in general and geology in particular was indeed outstanding. Mr. L. C. Ball, Chief Government Geologist, spoke of Professor Richards' important contributions to geology, especially his petrological work and the number of very able graduates in petrology who had come from his department. Dr. W. H. Bryan spoke of his great work as Chairman of the Great Barrier Reef Committee. Professor Richards responded, and the meeting congratulated its President on his award.

Mr. F. N. Lahey read a paper "Essential Oils from the Queensland Flora, Part XIV., Eucalyptus conglomerata" by F. N. Lahey and T. G. H. Jones. The paper recorded the isolation of a previously unknown chemical substance. A paper "1—α Phellandrene and its Monohydrochloride Part 1" by N. C. Hancox and T. G. H. Jones was tabled.

Professor H. J. Wilkinson gave a lantern lecture on the "Aborigines of Central Australia." He outlined the work done by scientific expeditions of which he was a member, in particular the work of the physical anthropologists and the physiologists. One of the most interesting discoveries was the physiological mechanism which enables the natives to withstand the extreme cold of the desert night. The different types of natives were shown on the screen and many interesting slides were shown of the gathering of food and its preparation for cooking and eating. Native pictorial art and the crafts of implement-making were described and records of native songs were played. The lecturer also showed slides of corrobborees and the preparations for corrobborees, and discussed the future of the aborigine.

A vote of thanks to the lecturer was moved by Mr. Longman and carried by acclamation.

Abstract of Proceedings, 25th July, 1938.

The Ordinary Monthly Meeting of the Society was held in the Geology Theatre of the University on Monday, 25th July, at 8 p.m., with the President in the Chair. About fifty members and friends, including representatives of the National Parks Association, were present. Apologies were received from Professor Duhig and Dr. Bryan. The minutes of the previous meeting were read and confirmed. The

President referred with regret to the deaths of Mr. C. A. Lambert and Mr. T. Rimmer, M.Sc. Mr. G. W. Sims was nominated for ordinary membership by Mr. S. B. Watkins and Mr. A. R. Riddle.

Mr. A. R. Riddle exhibited a recently devised apparatus for fluorescent work with ultra violet rays, and showed its application in the detection of oranges susceptible to mould. This apparatus, now being used by C.S.I.R. for such work, has the advantage of being portable (weight 36 lb.).

The main business of the evening was a symposium on "The Conservation of the Natural Flora and Fauna of Queensland." In opening the discussion Dr. F. W. Whitehouse spoke about aspects of soil erosion, generally, and their local effects. Soil is formed in any locality at a definite but very slow rate. Protective surfaces are developed on the soil—leached upper horizons and vegetative cover. But there is locally a definite rate of weathering in virgin country. Thus an equilibrium is established and a definite thickness of soil maintained. If this equilibrium is disturbed, by removal of the protective covering or by the acceleration of natural weathering, the soil is depleted. A change of climate may cause this; so will the removal of vegetation by human agency. Ringbarking is listed officially in this State as an "improvement" to property; but indiscriminate and thoughtless ringbarking can and does seriously denude the soil cover. Pasture depletion by overstocking is another obvious means of accelerating soil erosion. The effect is cumulative; for depletion of soil by plant removal will make the surface less useful to grow plants.

Other effects that follow are rapid run-off after rain, making both floods and droughts more prevalent, and the silting of waterholes.

There is evidence in Queensland that some of these effects, from which we very obviously suffer, are due to natural agencies (possibly climatic fluctuations); but much of it is man-made. It is a duty that we owe to future generations to check this erosion, whether caused by natural or human agencies; to check thoughtless removal of protective soil cover; to increase the surface vegetation by a policy of plant-improvement; to adopt farming and pastoral methods that lead to a minimum of soil depletion; and to remedy where possible the erosive damage that already has been done. Some methods that have been employed for attaining these objectives were outlined.

Dr. D. A. Herbert in dealing with the Conservation of the Native Flora pointed out that though in Australia the aboriginal population was never agricultural, it had left its mark on the vegetation. Periodical firing in many areas destroyed forests and replaced them with a pseudo-climax grassland. The balds of the Bunya Mountains, now grass covered and abutting on dense rain forests, formerly bore trees, the roots of which may still be discovered in the soil. No forests have grown there within living memory. It is evident that the blacks had profoundly modified parts of Australia by firing, but they did not do so to the same extent as more civilized peoples elsewhere. In Gippsland what were grasslands when the white settlers arrived have, with the control of fires, become tree-clothed. In regions of similar climate in Africa, America, and Asia the development of forests is much more sparse. Many people are amazed at the comparative luxuriance and wealth of species in the forests of the Kalgoorlie area, which is a natural forest development that must have been paralleled elsewhere before man destroyed it. Already the cutting of the trees for mine props round Coolgardie and Kalgoorlie is very largely eliminating the difference between the goldfields country and similar areas overseas.

The primaeval forests are singularly deficient in food plants, and grass for introduced animals cannot thrive in forests. Forest must give way in part to grassland and to agriculture. Agricultural plants are almost entirely importations. Native grasses are valuable, but many introductions are even more desirable in selected regions. We must avoid the idea that because a plant is native it is thoroughly desirable and should have undue precedence over an importation. Our domestic animals are importations, and their requirments are different from those of marsupials. We, by our coming, have created an utterly new set of conditions for the native plants. The control of grazing areas depends partly on establishing a reasonable balance between the grazing stock and the pasture plants, so that neither get out of hand, and partly on a search for plants which are more suitable for grazing. This search is being carried out in two directions by Commonwealth and State scientists and by private workers.

First, work such as that of Mr. Christian is aimed at the improvement of native pasture plants and introduced fodder plants that are already here. Secondly, plants are being introduced from other countries and tested for Australian conditions.

The forester, like the pastoralist, is mainly concerned with the commercial aspect of his plants. In Queensland hoop and kauri, maple, white beech, silky oak, cypress, and other native trees are receiving very special attention, but exotics are also being exploited, notably at Beerwah. The exploitation of the native species ensures their perpetuation and affords an example of the truth that the best qualification for survival of an animal or a plant is to be useful to man. Therein lies the future of many of our native species, not only in Australia but overseas.

There are, however, thousands of plants of no commercial value. They are useless for food or timber, of no decorative value, and not even dignified by a common name. But they have their allotted place in nature. Some of them are of great scientific interest because of anatomical or chemical peculiarities, or because of the light they shed on the past history of the flora. Without them the delicate balance of the plant community would be upset. We might almost regard the Queensland flora as a great organism sprawled across the State, and any part of it, be it the humblest species, is an essential member. So many of the native species are restricted to this State, and this State only, that it is our duty to see that they are preserved. That is the object of our national parks. They are areas where the plants and their dependent animals can live in their natural undisturbed balance.

After referring to the interest of seeing the fearless and abundant wild life in unspoiled natural habitat in the Yellowstone Park, U.S.A., Dr. E. O. Marks pointed out that it is the duty of the present generation as life tenants to hand on to future generations areas of country in its natural state and thus to preserve from extinction the peculiar Australian fauna and flora. National Parks should be called Nature Sanctuaries. Though their most important objects are sentimental and scientific, they have as recreation and tourist resorts a commercial value which will far exceed that of any contained natural products. While appreciating what has been done already by the Queensland

Government in reserving national parks, the present area constitutes only 0·1 per cent. of the State and is not sufficient. There should be reserved areas of every type of country to preserve examples of each characteristic assemblage of animals and plants.

Mr. H. A. Longman remarked that our obligations to protect our unique Australian fauna are not only national but international, for the intelligentsia of the world are interested in distinctive marsupials and birds. Queensland with its variety of environments has the richest fauna of any Australian State. Because of the inevitable changes resulting from white settlement, the natural environment of many species is being destroyed and their persistence threatened. The introduction of such mammals as the fox, the rabbit and the domestic cat (the last now being often seen in a wild state) was an additional menace. The bringing in of such birds as the sparrow, the Indian dove and the starling was also a mistake.

The Government had wisely proclaimed no less than 313 sanctuaries in Queensland, and the latest Fauna Protection Act was an excellent measure. Most of our native birds and many of the rarer marsupials were now adequately protected. The world-famous Koala was now protected for all time. The Government's legislation should be more thoroughly supported by the people. Some so-called sportsmen seemed to think it fair to evade the law in out-of-the-way places. The pernicious pea-rifle should be entirely prohibited. The work of the Nature Lovers' League and the issue this year of thousands of certificates to children was a pleasant feature.

Although certain dominant species of marsupials, such as the "scrub wallaby" were very numerous in places, several other species were in danger of extinction. The so-called "rat-kangaroo" and the beautiful "hare-wallaby" were rarely seen to-day. Fortunately the platypus, which has been strictly protected for years, was now common in some coastal streams.

Certain species of birds such as the "paradise parrot" and the western "flock pigeon" were evidently in danger of extinction.

Over 120 years ago Byron declaimed that "Man marks the earth with ruin" and the words were still more true to-day. But the intelligentsia of the world were now recognising how great are our obligations to preserve and protect harmless creatures of the wild in inviolable sanctuaries.

Mr. Romeo Lahey, President of the National Parks Association, gave an outline of its work, and its immediate programme for the conservaton of the fauna and flora of Queensland.

A vote of thanks to the speakers was moved by Mr. C. T. White and Mr. F. A. Perkins.

Abstract of Proceedings, 29th August, 1938.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University on Monday, 29th August, 1938, at 8 p.m., with the President in the Chair. About twenty-five members and friends were present, and apologies were received from Dr. W. H. Bryan, Mr. C. T. White and Dr. F. W. Whitehouse. The minutes of the previous meeting were confirmed. Mr. G. W. Sims was elected an ordinary member, and Mr. C. W. Ball, B.Sc., was nominated for ordinary membership by Dr. F. W. Whitehouse and Dr. W. H. Bryan.

Professor H. R. Seddon, D.V.Sc., delivered a lecture on "The Spread of Three-Day Sickness in Cattle in Australia in 1936-37." The disease first appeared in Northern Australia, in the autumn of 1936, and spread west and south-east until early in 1937. It was confined to cattle, and those affected had fever one day, stiffness and lameness on the second day, recovering on the third day; the mortality rate is low, and an attack gives immunity for at least a year. The causative agent is a filterable virus, carried possibly by an insect, which may be in part wind-born. Likelihood of another epidemic is small until the present immune cattle-population is replaced by a new generation. The danger of introduction of other stock diseases from the near east was stressed.

Mr. F. A. Perkins, in moving a vote of thanks, said that if the vector were a wind-born insect it could be deduced, by an analysis of the insect fauna, to be any or all of the sandflies and mosquitoes. Mr. J. H. Smith, in seconding the vote of thanks, which was carried by acclamation, added to the entomological analysis.

Abstract of Proceedings, 26th September, 1938.

The Ordinary Monthly Meeting of the Society was held in the Geology Theatre of the University on Monday, 26th September, at 8 p.m., with the President in the Chair. About thirty members and friends were present and apologies were received from Mr. H. A. Longman and Mr. R. Roe. Mr. C. W. Ball, B.Sc., was declared an Ordinary Member, and Mr. F. B. Coleman, of the Department of Agriculture and Stock, was proposed for Ordinary Membership by Dr. M. White and Miss Hill. The President congratulated Mr. C. T. White on his appointment as Commonwealth liaison officer at Kew, and welcomed Mr. W. W. Bryan on his return from the United States.

Mr. C. T. White exhibited a series of specimens of *Acacia linifolia* and *Acacia fimbriata.* The latter is very common in South Eastern Queensland and is usually known as Brisbane Golden Wattle. The exhibitor stated that he had separated two varieties from the type and had under review an allied and undescribed species. These will be described in the next "Contributions to the Queensland Flora."

Dr. F. W. Whitehouse showed (*a*) two very large spiral concretions, each about 5 ft. long, from the Lower Cretaceous of the Blackall district, and comparable to that described Whitehouse 1934, *Mem. Qld. Mus.* X, p. 203; (*b*) a collection of Lower Cretaceous fossils, mainly molluscs, converted into precious opal, from Lightning Ridge and Whitecliffs, New South Wales, and Stuart's Range, South Australia.

Dr. D. A. Herbert exhibited fruits of a hybrid raspberry, the parents of which were the native *Rubus rosaefolius* and the introduced *R. ellipticus.*

Dr. W. H. Bryan read a paper, "The Red Earth Residuals and their Significance in South-Eastern Queensland," of which the following is the author's summary:—"Evidence is brought forward to show that there exists in South-Eastern Queensland a series of soils, namely the Red Earths, that cannot be explained in terms of the existing soil-forming processes, but appear to have been inherited from an earlier wetter climate. It is shown too that the Red Earths have a restricted distribution and are associated with the dissected plateau remnants of an old erosion surface. The suggestion is made that these Red Earth

Residuals represent a definite epoch in the late Tertiary (probably Pliocene) history of South-Eastern Queensland, and that they may conveniently be used as a datum to which earlier and later events may be referred. Moreover the combination of Red Earth soils with dissected plateau topography is so striking that it should be possible to use it as a basis of correlation. Although no attempt has been made as yet at precise correlation, a number of occurrences are cited from Australia and elsewhere, that resemble more or less closely the Red Earth Residuals, and some of which may ultimately prove to be equivalent formations.'' The paper was followed by a discussion in which Dr. Marks, Professor Bagster, Dr. Whitehouse, Mr. Bennett, and Mr. Blake took part.

Special Meeting.

A Special Meeting of the Society was held in the Lecture Theatre of the Department of Geology of the University at 8 p.m., on Monday, 10th October, with the President in the Chair. About fifty members and guests were present. Mr. T. J. Marshall, M.Agr.Sc., of the Soils Division of C.S.I.R., returning from the University of California, spoke on ''Recent Trends in the Investigation of Soils.'' He reviewed the advances he had noted during his absence abroad, in the determination of the crystalline components of the clay fraction, in the chemistry, physics, moisture content, microbiology, texture, structure and consistence of soils, and spoke of methods of soil survey and soil conservation in the United States. A discussion followed in which Messrs. Wells, Ball, Vallance, Christian, and Gurney took part, and a vote of thanks to the lecturer was moved by Professor Murray, seconded by Dr. Bryan, and carried by acclamation.

Abstract of Proceedings, 31st October, 1938.

The Ordinary Monthly Meeting of the Society was held in the Lecture Theatre of the Department of Geology of the University on Monday, 31st October, at 8 p.m., with the President in the Chair. About thirty-five members were present, and apologies were received from Dr. J. J. C. Bradfield, Dr. W. H. Bryan, Prof. E. J. Goddard, and Prof. H. R. Seddon. The minutes of the previous meeting were read and confirmed. Mr. F. B. Coleman was unanimously elected a member.

The main business of the evening was a discussion, ''Homotaxy and the Australian Flora and Fauna.''

Opening the discussion, Dr. F. W. Whitehouse said that the chief purpose of the evening was to examine certain oft-repeated statements about the Australian fauna and flora—chiefly that it is ''primitive.'' Reviewing palæontological evidence, he pointed out that often in earlier periods (the Jurassic, for instance) faunas and floras world-wide were very similar. Sometimes (for example, in the Cretaceous) there were more marked differences, and rarely (notably in the Permian) there were world-wide contrasts more pronounced than at present. The biological differences of the continents to-day seem to be more marked than what the palæontologist would regard as usual. The Australian fauna and flora particularly is distinct. He reviewed a number of possible theories to account for this (differences of climate, differences of facies, isolation, &c.), including an extension of Huxley's suggestion (1862) that, due to the time taken in migration, similar faunas in different parts of the world might be of different ages (''homotaxial'' with one another and not contemporaneous). He asked the biologists contributing to the discussion whether the present-day Australian life forms are a primitive group or whether this so-called primitive aspect has been overstressed.

Dr. D. A. Herbert pointed out that the statement that the Australian flora is primitive and represents a survival of floras elsewhere extinct was without foundation. An analysis of the plant population shows that the families dominant in Australia are for the most part the families dominant in other large land masses. There is no greater concentration of what are usually considered to be earlier types of flowering plants. Dying out of ancient types has left relics in Australia, but the same is true for Asia, Africa, Europe, and America. The main differences between the floras of Australia and adjacent countries lie in the adaptations to climate. Certain peculiar Australian types—*Eucalyptus,* phyllodineous Acacias and Casuarinas, for example—have developed under climatic conditions not duplicated in Asia and New Zealand. Any comparison of floras must be made on similar climatic zones, as it is not possible to compare vegetation of a dry zone in one country with that of a wet zone in another and draw valid conclusions. A comparison of the temperate rain forests of Australia, New Zealand, and South America shows a remarkable resemblance, as does also a comparison of alpine floras of Australia, New Zealand, and Malaysia. Using such climatic units, it is apparent that the vegetation of Australia is not as peculiarly Australian as would be deduced from a brief examination of the flora as a whole. Most of the peculiar Australian types are plants of the open forest which are specialised and not primitive.

Mr. F. A. Perkins said that a study of the insecta has little value in any attempt to prove or disprove that the flora and fauna is the same in all parts of the earth at the same time. The fossil record is incomplete and even misleading for the following reasons:—(*a*) Only about 11,000 fossil insects have been recorded in spite of the fact that well over half a million species of living insects have been described. (*b*) Usually, except in the comparatively recent amber fossils of Miocene age, only the wings have been preserved, and consequently insect palæontology is mainly a study of venation. (*c*) Most of the fossil wings are those of aquatic insects. Naturally, such insects are more liable to be preserved, as most fossil insects are found in shales and similar rocks. Forest insects were probably as numerous in the past as they are to-day, and yet very few have been preserved as fossils. Using the Order Mecoptera as an example, the present-day American fauna was compared with the Lower Permian of Kansas, and the living Australian fauna with the Permian and Triassic of Eastern Australia. In both countries the present-day fauna is comparatively more closely related to the fossil fauna than to one another. In any attempt to compare the insecta fauna of the two countries at any one time the Mecoptera would be of little value.

Mr. H. A. Longman said that Huxley invented the word homotaxis to "get rid of a number of pitfalls," and there was definite need to-day for the severely-critical attitude shown in his addresses given in 1862 and 1870. The associated problems were too complex to be concisely stated. There were still difficulties over lineal relationships of mammals and over the significance of supposed primitive characters. He thought that the marsupials of Australia, both living and extinct, should not be regarded as merely a survival of primitive Mesozoic mammals. Our marsupials had exhibited surprising radial development, and there were many specialised forms. As outlined in a paper, "The Uniqueness of Australian Fossil Marsupials" (A.A.A.S. Rep., 1924), he thought that these were radically autochthonous and that their evolution had mainly taken place here. Among the Dasyuridæ and Phascolomyidæ there were interesting illustrations of species surviving in certain localities, whilst closely-allied forms were only found elsewhere in Australia as fossils. Reference was made to W. D. Matthew's important paper on "Climate and Evolution" (1915).

Mr. Longman also suggested that the Australian Aborigines were the changed descendants of a Neanderthal type of man (as first noted by Huxley), although not strictly homotaxial and obviously not contemporaneous.

Mr. F. Bennett, Miss Hill, Mr. C. T. White, and Mr. S. T. Blake contributed to the discussion which followed, and a vote of thanks moved by Mr. C. T. White and seconded by Mr. S. B. Watkins was carried by acclamation.

Publications are being received from the following Institutions, Societies, etc., and are hereby gratefully acknowledged:—

ALGERIA—
Societe de Geographie et d'Archaeologie d'Oran.

ARGENTINE—
Universidad Nacional de la Plata.

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Commonwealth Bureau of Census and Statistics, Canberra.
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