PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

QUEENSLAND

FOR 1930.

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Vol. XLII., No. 1.

Proceedings of the Royal Society of Queensland.

Presidential Address.

By Professor J. P. Lowson, M.A., M.D.

(Delivered before the Royal Society of Queensland, 31st March, 1930.)

The report which has been submitted to you shows that the work of the Royal Society during the past year has been both considerable in quantity and varied in interest. The fourteen papers published cover a wide field, including work done in physics, chemistry, geology, botany, and zoology both theoretical and applied. The recently issued volume is, I think, a worthy record of the Society's work.

There is one matter not included in the report which I should like to mention. I refer to the very valuable and now completed work which has been done in the arrangement and cataloguing of the Society's library. I think the thanks of the Society are due to the librarian, Mr. Francis, and also to Mr. Hardy, for this work.

I should also like to add my thanks to those of the Society to Dr. Duhig for his generous donation to the library.

RECENT PSYCHOLOGY.

Following the example of my predecessor, Professor Parnell, who gave us last year so excellent a résumé of recent progress in physical science, I wish to put before you in this address a few of the ideas which have become centres of interest in psychology in the course of the last twenty years. This is not altogether an easy task. Psychology is the youngest of the sciences, and has but just entered on what promises to be a period of rapid and successful growth. There is at present, as always at such times, much divergence of opinion as to what must be regarded as established matter of fact, what should be held in suspense as matter of possibility or probability only, and what should be rejected in the meantime as mere speculation. Some results of psychoanalytical research, for example, which are of great interest and importance and cannot be omitted, are still regarded as matter of controversy by a number of psychologists. On this head I can only say that while, on the one hand, my account will contain no specially original features—that is, no doctrines peculiar to myself—on the other hand, I shall make no statement with which my own experience does not lead me to agree. I am aware also that part of what I have to say is not likely to make pleasant hearing. It is scarcely possible to discuss developmental psychology without risking unwitting offence to some one. But we have to recognise, in psychology as in biology generally, that Nature is independent of our human prepossessions, and that, if we wish to deal with her successfully, we must take her in the first instance as she is.

There are two topics in psychology to which I wish specially to direct your attention. The first is the fact of the continuous persistence of the past into the present in our mental life, the fact that a man's mental present, his actual present ways of thinking, feeling, and acting, are not only based upon but bound up with and to a very large extent determined by his whole mental past, by all that he has thought, felt, and done, and by all that has been done to him from birth onwards. The second topic to which I wish to direct your attention is the manner in which certain peculiarities of human sexual development interact with this persistence of the past, so as to produce important practical results.

When we consider our conscious experience, as it immediately presents itself to us, perhaps the most striking feature about it is its kaleidoscopic change: change seems to be the condition of its very existence, for without change attention and consciousness itself quickly lapse. Moment succeeds moment, event succeeds event, thought succeeds thought, and feeling follows feeling. Our mental lives have been described as consisting of an innumerable succession of states of consciousness, as they have been called, no one of which is ever exactly like those that precede or those that follow it, no one of which is ever exactly repeated. This is so obvious that the term "stream of consciousness" has long been current in psychological language to express what seems at first sight an ever-changing flow.

When the matter is considered more closely, however, we come to see that the word "stream" with its suggestion of a procession, each feature of which appears for a moment only to vanish and leave no trace, is more misleading than helpful as a description of our mental life. A close study of any particular conscious stream reveals always a very large number of constantly repeated features, ways of thinking, for instance, methods of action, peculiarities of feeling, traits of character, and the like. Of much that goes on in consciousness the old French tag turns out to be an exact description: "Plus cela change, plus c'est la même chose." The content may change but the form and purport remain the same. In order to explain these constant features we are obliged to assume the existence of some kind of unconscious organisation underlying the stream of conscious change, persisting and developing beneath it, and determining in large measure the forms which its activity takes. We may identify this organisation with brain organisation, if we choose, neglecting the fact that for the moment brain physiology can give no account of it; or we may stick to observed fact, and leave that question open for the present. In any case we should have to assume the existence of such a developing organisation underlying consciousness if we had never seen a brain at all. In the end we find it best to abandon the metaphor of a stream altogether, and introduce the concept of an organic mental structure which persists and grows in interaction with the external world, somewhat as the seedling persists and grows into the fully developed tree. We come to regard consciousness itself as the expression of activity in this organisation in interaction with the outer world from moment to moment: we note that consciousness is mainly confined to those mental activities which are in direct relation with the outer world. On the one hand we explain changes in consciousness in terms of the flux of external events and the varying needs of the mental organism; on the other hand, we explain the perpetual repetition which characterises conscious activity, the perpetual reapplication of the same ways of perceiving, thinking, feeling, and acting to differing material, by means of the persistence of the mental organisation itself and the continuity of its development. It is this latter side of the situation which I propose to discuss.

That some such persistent organisation must exist is easy to show. Everyone knows that even from the point of view of consciousness the past does not disappear completely. We know that we can reproduce in conscious memory a great deal which we have thought and felt and done in the past. This fact obviously implies that our experiences have left some sort of traces behind them, which can in some degree be re-excited so that the past lives again. It implies, in short, the existence of a more or less permanent structure of memory traces which has been woven out of our past experience, and makes possible the repetition of the past in the present.

But the persistence of the past and its repetition in the present in mental life are by no means confined to conscious memory. On the contrary, while conscious memory with its definite time reference is a highly specialised mental function, the repetition of the past in the present is a constant feature of mental organisation and mental function in general.

This fact is most obvious in relation to our intellectual development and the development of our knowledge generally. In that connection it is well recognised in introspective and experimental psychology. The psychology of perception, for instance, is one long exemplification of this fact, since the possibility of the simplest as well as the most complicated act of perception depends essentially upon a condensation of the past in the present through which the present acquires meaning for us in the light of the past. This condensation has nothing to do with conscious memory. It is immediate and irreflective. In most cases we have to consider its results to become aware that it occurs. As, for example, we glance round the room in which we are, it is by no means the room as it immediately affects our senses which we see. It is on the contrary a beautifully organised, or, as we say, integrated condensation of a vast amount of past experience of light and colour, touch and pressure, space, movement, and every other experienced possibility of sensation in such a situation as the present one. The room as we see it is in the main an imaginative product, but it certainly does not look like that to us. That is because, as we look at it, we actually see the past in the present. The pattern of stimulation which affects our senses fuses indistinguishably with perceptual patterns which come into action from within. This is of course more obvious, though not a whit more true, when the objects of which we are aware are removed from influence on our senses. No one of us in this room but is aware, without so much as once deliberately thinking of it (preconsciously aware, as we say), of the building in which he is, of the park outside, of George street, Brisbane, Australia, the whole planet, and the universe of space, so far as they are known to him as wholes. The world picture, in short, which every man carries in his head, is clearly not an affair of immediate sensation but of the imagination which the senses have trained. It sums his past experience in that respect from infancy upwards. It is the past experienced in the present.

I stress these facts in the first instance because it is not adequately recognised what a remarkable magic lantern the human mind is. The screen of consciousness on which our external experience itself appears is lit up from within as well as from without. The pictures which appear on it are thrown mainly from within, usually in response, it is true, to what is thrown from without. Normally, however, what is thrown from within in response to what is thrown from without harmonises so beautifully that we are incapable of distinguishing the inner from the outer light, and can only distinguish by inference between the present and the past components of the total picture. But in nervous breakdown, for example, where the two pictures usually clash in some respect or other, still more in insanity, where they clash irreconcilably and the inner pictures begin to get the better of the outer, the true nature of the normal situation itself begins to become apparent. Let me continue for a moment with the same image, crude though I admit it to be: it is somewhat as though what we perceive or what we think in consciousness were a consequence of a play of light streaming towards an exterior screen through a vast succession of lantern slides. It is as if from an integration of all the slides through which the light travels in response to what is given from without through the senses that the ultimate pictures result. We have also reason to think that, while these pictures may go on enriching and complicating as fresh experience comes in, yet within them something of the simpler outlines of the earlier pictures of the same series will always tend to persist. The past is never completely obliterated and the present perpetually repeats the past.

If what I have said will suffice for perception and thought, it must suffice for action also. What is true of perception and thought is naturally true of action, of what we have learned to do as of what we have learned to perceive or think. The same considerations apply in the one case as in the other and the past persists and repeats itself in action as it does in thought.

But at this point a question arises. If the image just used is not wholly wrong, if perception, thought, and action are partly the consequences of an energy streaming from within, it seems natural that this energy should flow mainly into paths already organised out of past experience; but what is the nature of the energy itself? To this question we can reply in the first instance, that whatever the intimate nature of this energy may be, observation shows that in consciousness it is correlated with, or represented by, what we call interest, that so far as mental life is concerned interest and energy are equivalent terms, and that interest in turn stands in the closest relations with the life of feeling and desire as distinguished—so far as it can be—from the life of thought and deliberate action.

An important advance in recent psychology has been the recognition of the dominant part played by feeling and desire in every mental activity without exception. Psychology, deriving, as it did, from philosophy, was for a long time chiefly occupied with the intellectual processes, which are in any case the most obvious feature of our mental life. As soon, however, as the science came into contact with problems of actual life, medical problems particularly, as it happened, it became evident that it is from feeling and desire that the energy derives on which thought and action are run, and the study of feeling and desire began to assume something like its rightful position in psychology as a whole. We now recognise that the capacity of any idea to exert any influence whatever on thought or action depends on the energy which it is capable of letting loose in the shape of feeling and desire, and further, that the kind of thought or action which follows will depend on the nature of the feelings or desires which have been excited, since it is their satisfaction which thought and action will aim at. We find that we cannot answer the question of why a man thinks and acts as he does until we have investigated how he feels about what he thinks and does; and this in turn resolves itself into a question of what the desires are which furnish the motive power to his thought and action, and how they came into being.

This last question brings me back to my principal theme. While the persistence of the past and its repetition in the present are easily recognised in relation to our intellectual and practical activities, they are not so readily recognised in relation to our feelings and desires, that is, in relation to our emotional life and its development. A further step forward in psychology has been the recognition that our emotional present develops out of and repeats our emotional past just as present intellectual and practical capacities develop out of and repeat past ones. Just as little in the emotional as in the intellectual sphere do new feelings or new ways of feeling come into being out of nothing and without relation to the past.

This principle, once recognised, again appears natural enough. Faced with a momentary situation how are we to react emotionally if not as we have already reacted to similar situations in the past. No doubt if we can discriminate consciously in what appear to us to be essential respects between the present and past situations of the same kind our emotional response will differ accordingly, but this is, actually, far from easy in very many cases. In the first place, we respond emotionally at once before we have time to think—more correctly, we have to respond emotionally before we can think—and, in the second place, in nine cases out of ten we are unable to tell to what similarities our immediate emotional response is due. A high degree of emotional discrimination is, actually, a rare quality among human beings. This fact is most easily recognised, perhaps, in reference to our social responses. When, for example, we meet a new acquaintance, we like him, or dislike him, or experience a mixture of these feelings, as a rule immediately. But, in the first place, it is the exception for us to be able to say what exactly are the traits which have called out our immediate liking or the reverse; in the second place, suppose we can do so, it is very difficult as a rule to identify the previous experiences which have determined our feeling for these traits; and, finally, the first occasion on which our response to them was determined, which is actually the most important of all, is usually quite beyond the reach of conscious recollection. In most cases, in fact, we do not reflect much on the matter at all. We accept and follow our likes and dislikes as something natural to ourselves and not in need of explanation. Nevertheless they are invariably determined by the past, which they repeat.

This principle is of very great importance in our emotional life, and perhaps I can best make it clear by means of a simple example. Two of the fundamental social feelings are liking and dislike, love and hate. These are emotional capacities of which we all possess a share, but we must all have met persons who show an unusually marked disposition towards hate, either open or veiled in its expression, and been struck at times by the irrationality of their feeling since it plainly bears little or no relation to the real qualities of its objects. We may be tempted to explain this irrationality by reference to the inborn disposition of the persons concerned, and to suppose that hatred is natural to them. But investigation of such cases shows as a rule that their disposition to hatred is not inborn but acquired, that its irrationality in the present results from the fact that its real determinants are in the past, and that at its commencement it was justified. I select a simple illustration of this sort.

Consider the emotional development of a boy who has been led from infancy to hate his parents. A certain amount of such hatred (at least for one parent) is normal in infancy, as I shall later point out, but its persistence in force implies usually qualities in the parents—unkindness, injustice, oppression, and the like—which have themselves called it out. Now a boy's parents are in infancy the concrete embodiments of superior strength and authority; it is from their images that these ideas are abstracted first of all. This is, of course, specially true of a boy's father. We have, then, an association of these ideas with the images of the parents, an association formed in the earliest years and backed by strong feeling. Such a primary association, we find, tends to persist unconsciously throughout the whole life. We find that the boy's hatred will tend, of itself and without his conscious co-operation, to flow out subsequently to all other persons perceived as superior in strength or authority, and hence perceived at the outset, usually unconsciously, as reincarnations of his parents. He will grow up with a disposition towards hate and instinctive hostility, tending to involve all such persons, and perhaps with a morbid and misleading sensitiveness to the slightest suggestion or fancied suggestion of injustice or oppression. It is obvious that he is not likely to get on well with teachers, or employers, or authority in any form, and, since dislike and hostility on our part beget like feelings towards us in those for whom we feel them, the response he calls out is only too likely to justify his feeling from his point of view. Thus, from the point of view of its objects, his hate will be like a tree, the later hatreds branching out from the original hate, to which in most instances they will owe the greater part of their strength. Again, the better stuff he is made of, the more energy and spirit he has, the more plainly will his hostility appear, and he may get a reputation as a contumacious subject or a socially impossible person which may do him great harm.

This is a much simplified instance but we may safely generalise from it. There is no reasonable doubt that all sorts of disadvantageous peculiarities of character and feeling are acquired in this manner, as well as all sorts of advantageous qualities. We get the impression from our experience that our unconscious emotional and impulsive development is somewhat like a tree which branches out as we grow from infancy into manhood. In the tree the final form may be very different from that of the seedling from which it sprang; nevertheless every branch has sprung from a pre-existent branch, that from another, and so back to the original main stems; and every leaf which it turns to the air and light still draws nourishment from fibres that run from origin to origin down through the stem into the roots below. Within this arrangement the whole history of the tree is contained. So the developed mind of a man may be very different from that of the child he once was, but the channels through which there come unconsciously into his conscious life the energies which vivify it go back and back within the unconscious organisation of the mind, concentrating and simplifying as they go, till they reach the main sources of emotion and desire in his forgotten childhood. Within this emotional organisation his whole emotional history is contained.

The social importance of what I have said is evident. The facts of emotional development open up the possibility of a form of culture hitherto neglected. The cultivation of the intellect and the cultivation of practical capacities are ideas with which we are familiar, even if our methods are somewhat rough and ready; we are also familiar with the notion of moral education; but this last has usually taken the form of enforcing the acceptance of certain ideas and certain forms of conduct, sometimes by means of fear alone, almost always without regard to the nature of the motives which actually induce the child to accept them. Moral education has too often crippled rather than furthered emotional growth. We now recognise that a child's emotional inheritance cannot be expected to unfold and develop normally in unsuitable conditions any more than a plant will develop normally in the absence of sunlight, air, and suitable soil.

The facts of emotional development to which I have briefly referred were originally brought into sharp relief in the course of psychoanalytic work. There is nothing, however, in what I have described so far, which could not be observed or inferred apart from the method of Freudian analysis. If psychoanalysis has made an indispensable contribution here, it is in pointing out that the principle of repetition applies in a thoroughgoing manner to emotional development in general, and in insisting, consequently, on the decisive importance for future development of feeling aroused or inhibited in infancy and early childhood.

Up to this point I may hope that what I have said has not met with any strong emotional objection on the part of my audience. That is to say, you may agree or disagree, but it is unlikely that anything I have said has aroused definite repugnance, in the shape of anger, or disgust, or fear. But I have now to introduce and illustrate the specific contributions of psychoanalysis to my subject, and these, in the first place, go considerably beyond the findings of introspective and behaviouristic psychology, and, in the second place, they are not in line with common prepossessions on the subject of human nature.

In the illustration which I have used of a boy's developing disposition towards hatred, it is specially noteworthy that the secondary hatreds do not depend on a conscious recollection of the primary one. The boy does not say to himself, "This man reminds me of my father because he is in authority over me, therefore I hate him." If he did, it would tend rather to enable him to get control of his disposition to hate, since the sensible course would be to discount the resemblance and judge the person concerned on his own merits. But, as a rule, the case is quite otherwise. The feeling of hostility rises in him immediately and as it were instinctively, without any conscious reference to its original cause: it derives in fact from the past, but it appears in consciousness in apparent relation solely to the present. Thus the persistence and activity of feelings so derived has nothing to do with conscious recollection of their origin. Now in this connection a Viennese physician, Josef Breuer, discovered nearly fifty years ago a fact of great importance. Everyone knows that events in consciousness, which were accompanied by intense interest and strong feeling, are vividly impressed on conscious memory and may remain unforgotten over the whole life. Breuer's observations showed that an apparent reversal of this principle is also possible so far as conscious memory is concerned. He showed that experiences charged with strong feeling and vividly impressed may nevertheless be actively and completely excluded or "repressed" from conscious memory, so that the person concerned is quite unaware that the experiences in question ever occurred. This happens if the experiences in question either are or become too painful to be tolerated in consciousness. He showed further—and this is the important point—that such inhibited or repressed memories are not deprived of influence on the subsequent life of the individual; on the contrary, they may persist the more potently, although unconsciously, by reason of their exclusion from conscious control. Everything then goes on as if they were unconsciously remembered in their original form, unmodified by reflection. They retain their hold on the feelings of the individual and influence his subsequent emotional life in defiance of his reason, from the influence of which they are withdrawn. Breuer's original observations were later confirmed by Freud working in conjunction with him, and they have since been confirmed by numerous workers, so that they are now accepted by all competent persons.

The simplest instances which one can give of this peculiar mental situation are the morbid ideas and feelings, familiar since the war, which torment sufferers from shell-shock. Shell-shock, in its proper meaning, is a form of emotional shock. The sufferer remembers nothing of the ideas and emotions with which the explosion of the shell filled him. Yet these persist unconsciously, and the fact that they do so is evidenced by the uncontrollable re-arousal of the feelings in question in defiance of reason, and by the reappearance in consciousness of similar but now quite irrational ideas, whenever the circumstances of the man's present life are capable of forming an association with them and instigating their explosion. Thus in addition to the organised unconscious repetition of the past in the present, in so far as it is taken up into and made use of in connection with present interests, we have a form of disorganised (or dissociated) unconscious repetition in which the past persists unaltered and influences feeling and activity in defiance of reason and the present. This is far commoner than at first we might suppose.

It was this observation which, in the hands of Freud, led to the gradual development of the psychoanalytic method of mental exploration, and finally to the illumination of some of the most obscure features of our emotional development and of our mental structure generally.

Perhaps I should say a few words here on the present situation in reference to Professor Freud's work. All persons who have made use of Freud's technique (the value of which is not in dispute) have confirmed his findings so far as facts observed are concerned. The facts observed are indisputable. Differences exist only as to the interpretation which should be placed upon these facts. As to this, it must be admitted that Freud's interpretation has at first sight a disagreeable character, while the views of opposing schools, like those of Jung and Adler, appear much less repugnant. For this reason the latter views are at first the more attractive. Considerations of this kind, however—of what is pleasant, what is not—should have nothing to do with a question of fact. If we put such considerations aside, as we ought to do, Freud's interpretation seems to be that which most naturally and easily fits the facts, while the views of Jung and Adler appear more strained, containing, as they do, serious difficulties which have never been smoothed out. This situation is not affected by the circumstance that both Jung and Adler have made most valuable observations, which everyone accepts, since these observations supplement without contradicting the Freudian position. My own experience leads me to believe that the general acceptance of Freud's main position by instructed opinion is only a matter of time. It is therefore with his views that I am concerned here, but in illustrating them I must confine myself to a single central feature. In order to discuss this we must go back to earliest infancy.

According to the findings of psychoanalysis, and for that matter of common observation, the affections of a human being are in the first instance, that is in earliest infancy, directed solely towards itself. The distinction between self and the environment is not one which the infant is at first capable of making, while all things are at first appreciated simply in relation to their capacity to yield pleasure or pain in the course of the satisfaction of the infant's needs. Thus the earliest stages of emotional development are thoroughly, though unconsciously, self-centred. Following on this stage, however, as development proceeds, the beginnings of altruistic feeling appear, and the infant becomes for the first time capable of affection towards a fellow creature clearly distinguished from himself. He, or she, becomes for the first time a truly social creature. The capacity for such affection directed towards others shows itself in the first instance, naturally enough and as everyone knows, towards the persons already associated with the satisfaction of previous and existing needs, that is, normally, towards mother, or nurse, or both. Later the father normally comes to share in it.

Now, in the light of what I have already said, you will not be surprised to hear that we regard this particular step in development and the further emotional development which follows it as of very great importance. It is the first appearance of altruistic or truly social affection. Out of it will grow all the later social affections of which the child becomes capable; it will remain the prototype of these; and we find, in fact, that the character and activity of these later affections will be determined in large measure by the course which this earliest development follows in interaction with external circumstances.

But the method of psychoanalysis has revealed a further most important fact. The affection in question does not manifest itself merely in the form of those feelings of admiration, friendliness, tenderness, trust, and the like, which will be taken up into and characterise in various degrees many later social relationships; it may include all these, but, immature though it be, it resembles much more nearly the state of feeling which we know in adolescence and later life as that of being in love: that is to say, it resembles most closely those later affections which are definitely sexual. In other words, our earliest infantile attachments appear as the commencement and foundation not only of truly social feeling in the wide sense but also of normal sexuality. At their commencement these two streams of feeling are inextricably intertwined and appear to spring from a common sexual root.

That such a connection should exist is not, perhaps, very surprising, if we view it in the light of our racial history or our biological past. It is no more remarkable that our social feelings should develop post-natally in association with sexual feeling (in contradiction with the demands of adult life) than it is that our circulatory system should develop pre-natally out of a system of gill arches adapted to life in water but hopelessly out of touch with the needs of life in air. Both sets of processes are equally developmental, and in the one case as in the other we are faced, no doubt, with a partial recapitulation of the racial past.

On the other hand, that such a connection should exist and have gone so long unperceived is very remarkable, but this is partly explained by further circumstances likewise laid bare in the course of analytic investigation. We find that sexual development in Europeans goes forward not in one but in two stages. We have, first, the early infantile stage, to a feature of which I have just referred. In this stage, in which love is directed normally, as we have seen, mainly towards the parents, feelings and impulses of an unmistakably sexual although immature character first arise together with feelings of affection and tenderness. This stage, we may note also, is more or less bisexual. Now in the nature of the case the first-mentioned feelings, the sexual feelings in the narrow sense of the term, can receive no very adequate satisfaction. From the start they are doomed to relative disappointment. Not only is this the case, but among Europeans at any rate (not apparently in all races) as development, and especially ethical development, proceeds, all that is overtly sexual during this stage undergoes repression and becomes unconscious under the influence of feelings of shame, disgust, fear, and later anger, which arise in that connection to that end. This process of repression, which is usually complete about the age of five or six years, is in part, no doubt, the effect of early education, since any overt manifestations of sexuality in infancy are usually discouraged; but there is reason to believe that it is in any case organically determined, sets in, that is, in the course of development independently of education. It is obvious, then, in the first place, that this first stage of sexual development belongs to that part of our personal history, namely infancy, which is always more or less lost to conscious memory; and, in the second place, that those feelings, ideas, and associated memories, which were plainly sexual and have for that reason undergone repression, belong to those portions of our early emotional history which as a rule we *cannot* remember under ordinary circumstances. Hence it is impossible for most of us to confirm directly from personal memory, apart from psychoanalytic investigation, the existence of this early stage, while at the same time those feelings which serve the repression of it in our own minds tend to cause us to overlook or misinterpret its manifestations in our children.

This first stage of sexual development which undergoes repression is normally followed, at least in Europeans, by a stage of sexual latency, in which all the manifestations of direct sexuality are more or less completely in abeyance. This stage of latency is a somewhat variable feature; its degree and duration differ from one individual to another. It is followed again by the second stage of active advance, with which we are all acquainted, in which feelings and ideas, again of an unmistakable sexual quality, reappear in consciousness. These continue to develop, slowly at first, later more rapidly, until adolescence is reached, when, with the maturation of the genital glands, the full expansion of the sexual instinct sets in, with the rapidity and force, and, one may add, with the remarkable consequences in the intellectual and the ethical sphere, familiar to all normal persons. Thus the early stages of our sexual development are hidden from us, the later alone remaining apparent in consciousness.

We have then at least two reasons to attach importance to this particular feature of emotional development in infancy. Not only do the feelings which are called out in the course of it exert an influence on the whole of the individual's subsequent social life: the whole of his subsequent sexual life is likewise influenced.

Let me follow this development a little further. I have pointed out that an infant's first attachment is naturally to those who are already associated with the satisfaction of its needs; that is, usually, to its mother or nurse. This first attachment is irrespective of the infant's sex. A little later, however, the actual sex of the child begins to express itself, aided, no doubt, by the normal hetero-sexual preferences of the parents themselves in reference to their children. We find then, sooner or later, in the course of normal development, that the dominant feeling is for the parent of the opposite sex. In the case of boys, of course, this involves no change. In the case of girls a change is involved. It is at this point that the so-called Œdipus situation comes into being. Where one parent is predominantly loved, it is only natural that some degree of jealousy and consequent dislike should be felt for the other. For the other parent, in so far as he, or she, receives affection and consideration from the parent who is loved to the relative exclusion of the child itself —again the normal situation—comes quite naturally to be regarded as a rival whose disappearance is desired. It is in this way that the Œdipus situation comes into being and persists, until the repressions, which herald the arrival of the latent period, set in and become dominant. From this point on, the directly sexual elements in the love of the parents usually disappear from consciousness, while their sublimated representatives, affection, tenderness, and respect, usually remain.

Thus, when the second period of sexual advance sets in, the parents have vanished to all appearance from the field of sexual feeling. But we have already seen that disappearance from consciousness under repression is not equivalent to extinction. The original objects of infantile sexual feeling with the experiences associated with them persist under repression as unconscious images, after the manner of repressed mental material generally, and still retain a weaker or a stronger hold on the feelings of the individual. We find that the further development partly consists in an unconscious transference of erotic feeling from the image of the parent originally loved to persons (finally) outside the limits of the family. It follows that the earliest attachments are to persons associated in some way with the parents, though not necessarily consciously associated, since apart from this, constituted as we are, such transference could hardly take place. There must be some bridge over which energy can flow from the one image to the other. Where such transference is fairly direct, the trend of the earliest attachment often makes itself unconsciously felt both in the characteristics of the persons who exercise attraction and in the character of the attraction itself. Such persons are often older than the boy or girl who is attracted by them. That is common knowledge in the case of both sexes. Further, in the case of boys, they are often loved as queens or goddesses, rather than as mates in the true sense, and, making the necessary changes, the same is often true of the early attachments of young girls. The inhibition also, which lies on the physical side of the primary infantile attraction, often extends to some extent to these new objects of love, so that there may be something repellent, rather than attractive, in their association with that side of sexual feeling. Later on this child-like attitude is, or should be, replaced by one in which lovers meet on terms of relative equality, while the two streams of directly sexual and of sublimated feeling become once more confluent in the experience of fully developed love.

There are two points, then, in all this, which need to be grasped. The first is that the original infantile sexual attraction, unconscious under repression, tends for that very reason to retain its force and to exert an influence on the formation of all later attachments. The second point is, that full sexual development consists in attaining freedom from this compulsion and from the inhibitions which may result from it, in respect of all those feelings which, in conjunction, make up adult love.

Where such freedom is not attained, a variety of consequences may follow. For the sake of clearness as well as brevity, I will refer here only to two possible situations of the many which may arise.

Take first the situation which arises in cases where the normal process of development and detachment has failed to take place, and the individual has remained, unknown to himself or herself, at the infantile sexual level.

Assuming that the person concerned is otherwise normal the situation is somewhat as follows. He, or she, has passed through the first or infantile stage of sexual development. Repression has ensued and the recollection of this stage has been obliterated from conscious memory. But a liberation of feeling from the now unconscious images of the parents, as they were known or imagined to be in infancy, has failed to take place. In the unconscious they are still loved or hated as they formerly were. As physical and mental growth proceeds and the sources of sexual feeling develop also, all direct sexual feeling tends to be sucked under—so far as its application to real persons in the real world is concerned—by the attraction exerted by these primary unconscious images and to come under the inhibition beneath which they lie. It is clear that such an unconscious fixation (as it is often termed) of the love impulses to such a degree must have important results in consciousness itself. These results will be both positive and negative: positive in so far as feeling will tend to be determined towards the actual parent concerned who is the living representative of the unconscious image; negative, in so far as there will be a failure to show feeling where a normal person would show it.

Let us take positively determined feeling first. Powerfully inhibited as it is, this can usually only show itself in a more or less desexualised or sublimated manner. There may be a more than ordinary degree of tenderness, respect, and the like, for the parent involved, combined too often with an abnormal degree of submission to the parent's authority, and dependence on the parent's protection—for the satisfaction of infantile love lies in being loved more than in loving. The person concerned may be all too satisfied with life in the parental home, and very unwilling to leave it and face life on his or her own account. All this is often accepted as evidence of exceptional filial feeling, and may even be considered praiseworthy by the thoughtless. It is on the negative side, in the gap in conscious feeling, that the sexual nature of the unconscious source of this attitude comes plainly to light. The individual fails to fall normally in love in adolescence or early maturity. Marriage is shunned, or entered upon from loveless motives, often with much resulting unhappiness. Lastly, when sexual relations in marriage are attempted, psychical impotence or frigidity, in the male or female respectively, is found to result. It results because the sexual act itself and the feelings normally associated with it, the most direct possible manifestation of sexuality, cannot escape from the effects of the inhibition which their close though unconscious association with the image of the loved parent necessarily involves.

You will note that I have chosen an extreme example. Naturally, all degrees between such a complete unconscious fixation of the sexual feelings and the normal situation of practical freedom are actually found in practice. If, indeed, by the term "normal situation" we meant the average situation of human beings in general, we should have to say that the normal situation lay somewhere in between these two extremes—nearer health of course. For while complete impotence in men is relatively rare, degrees of relative impotence are common; and frigidity in women is certainly much commoner, while marked degrees of partial frigidity are commoner still. Both conditions are the cause of a very great deal of married unhappiness. You must not suppose, however, that either impotence or frigidity is determined solely in all cases in the way just described. Other factors may condition it, but the factor just mentioned is one of the most important and is sometimes the sole cause.

Let me now briefly describe another possible, not uncommon, and equally unfortunate result, in cases where a strong infantile fixation exists, but the repression is not so strong as to inhibit physical sexuality altogether.

It is, we must remember, to the image of the parent, as he or she was known or perhaps imagined in infancy, not to the parent who exists in real present life, sometimes a very disappointing person, that the desires of the individual are unconsciously bound. For instance, the unconscious image of the mother may be from the child's point of view the embodiment of all beauty, tenderness, and help. From this there may arise in some persons an endless search for the "ideal" mate in real life, and it is in this way that what is sometimes called the "Don Juanism" of the sexual life of some men takes origin, since Don Juan is the classic literary example of the male type. These unhappy persons pass from one love affair to another seeking satisfaction which perpetually eludes them, and leaving unhappiness behind them, as each new object of desire proves somehow inexplicably wanting. It is the forgotten ideal of their infancy whom they unconsciously seek, and hence they can never arrive.

By an error of judgment, not uncommon on this side of human nature, such persons are often described, in literature for example, as love heroes and the like. Their numerous love affairs are regarded as evidence of their unusual capacity for this emotion. But the truth is that they are cripples. Their love affairs are evidence of their weakness, their inability to love, not of their strength.

Such reversals of judgment are not uncommon in analysis. Thus, in the case previously discussed, the filial feeling which is shown is often regarded by its bearer and only too often by the parent in question as a virtue, while from our point of view it is a weakness and a heavy disadvantage.

I should like to conclude these illustrations with the briefest reference to a peculiarity of male sexuality which is so common that it is sometimes accepted as a normal feature. I refer to a positive dissociation in feeling between direct sexual attraction on the one hand, and tenderness, esteem, sympathy, and the other components of fully developed love on the other, so that these two groups of feelings tend to be mutually exclusive. In the extreme case, for instance, we get a man who is attracted physically by women whom he cannot respect, while women whom he can respect may call out affection and admiration but not direct sexual feeling—a disastrous situation, minor degrees of which, however, are common. While the infantile determinants of this situation are, as a matter of fact, somewhat complicated, it is not difficult to see in a general way, in the light of what I have already said, how naturally, though unfortunately, such a split in feeling tends to come about.

In discussing our emotional development and a few of the practical consequences of the course which it follows, the main stress in what I have said has fallen on the sensual side of sexual feeling. The reason for this is, that it is with failure to develop on this side of human feeling and with its effects that practice makes us most familiar. I was desirous also that this aspect of the matter, which is fundamental from a biological standpoint, should be placed in a clear light. But I should be sorry if I misled you into thinking that we regard the sublimated sexual feelings, or any of our higher feelings, as in any way of less importance than the directly sexual ones. That is not the case. It seems to me plain on the surface of the social situation that these feelings are of the last importance for the future of our civilisation and our culture. It should not be necessary to say that the fact that some of the most important of these feelings are unconsciously interlocked with directly sexual feeling does not diminish by one iota their value to us and to the future of mankind. That fact, on the contrary, affords a powerful motive for the unbiassed psychological and physiological study of the sexual instincts. I need not say, either, that we are quite unable to share any view, however it may describe itself, which attributes a degraded character to functions which are the foundation of life and love in human beings.

I should like to conclude this paper with two illustrations from life, the first of which may serve to show us how powerful, the second how lasting, our infantile affections and longings are, immature though they be. The first illustration is taken from the life of Gustav Theodor Fechner, the second from Leo Tolstoi.

Gustav Theodor Fechner,[1] professor of physics at the university of Leipzig, was a man of outstanding intellectual and emotional power. Born in 1801, he passed his medical examinations at the age of twenty-one. Poor as he was, he decided, instead of practising, to devote himself to physical science. Up to the age of thirty-eight, for seventeen years therefore, his life was passed in unremitting and, unfortunately, unremunerative intellectual toil. His publications during this period were little short of monumental, and at the same time his scientific work, consisting of experimental researches in his own and in allied sciences, was excellent. Some of it is classical. At the age of thirty-eight, as a consequence, it was thought, of continuous strain, overwork, poverty, and an eye trouble brought on, or supposed to be brought on, by his observations on visual after-images (a classic piece of investigation), he suffered a terrific nervous breakdown which lasted three years and cut him off entirely from active work. So inexplicable and so malignant did his sufferings appear, that when after three years he began to get well, both he and others regarded his recovery as a sort of divine

[1] I abridge this account of Fechner from William James (A Pluralistic Universe, p. 145 *et seq.*), using James's words as far as possible. Comments are, of course, mine.

miracle. It was, in fact, his religious and cosmological faiths which saved him, and thenceforward one great aim with him was to work out and communicate these faiths to the world.

What, then, were the faiths with which he emerged from this experience? They were very remarkable ones.

"The original sin of our thinking, according to Fechner," says James,[1] "is our inveterate habit of regarding the spiritual not as a rule but as the exception in nature. Instead of believing our life to be fed at the breasts of the greater life, our individuality to be sustained by the greater individuality, which must necessarily have more consciousness and more independence than all that it brings forth (note the character of these metaphors), we habitually treat all that lies outside us as so much slag and ashes of life only; or, if we believe in a divine spirit, we fancy him on the one side as bodiless, and nature as soulless on the other. The flowers wither at the breath of such a doctrine; the stars turn into stone; our own body grows unworthy of our spirit; the book of nature turns into a volume on mechanics; and God becomes a thin nest of abstractions." To Fechner this doctrine came to seem incredible.

For Fechner nature and the whole universe became alive and conscious of its life. The vaster orders of mind go with the vaster orders of body. The whole earth is alive and conscious as a vast yet unitary spirit. Just as in ourselves the eye sees and the ear hears, the eye knows nothing of the ear nor the ear of the eye, yet our consciousness, which includes them both, sees and hears at once through each of them, so the earth. Her consciousness includes all our experiences, and not only ours but those of every animal and plant that breathes her atmosphere. And beyond the earth comes the whole solar system, and so from synthesis to synthesis and height to height until an absolutely universal consciousness is reached, the consciousness of God.

I regret that I have no space in which to repeat some of the arguments by which Fechner supports this conclusion. They are much more interesting and remarkable than might be supposed. However, my present interest is different.

"In his system," says James, "the supreme God marks only a sort of limit of enclosure of the worlds above man." (One comes ultimately, no doubt, to something which includes everything.) The object of Fechner's passionate belief is the earth soul. The Earth is our special human guardian angel; we can pray to the Earth as men pray to their saints. The thought of the perfections of her life moves him as nothing else can. "Think of her beauty, sky-blue and sunlit over one half, the other bathed in starry night, reflecting the heavens from all her waters, myriads of lights and shadows in the folds of her mountains and windings of her valleys, she would be a spectacle of rainbow glory, could we only see her as she is. Green would be her dominant colour, but the

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[1] A Pluralistic Universe, p. 150 *et seq.*

blue atmosphere and the clouds would enfold her as a bride is enfolded in her veil—a veil the vaporous and transparent folds of which the Earth, through her ministers the winds, never tires of laying and folding about herself anew. Yes! The Earth is our great common guardian angel, who watches over all our interests combined."

"On a certain spring morning," says Fechner, "I went out to walk. The fields were green, the birds sang, the dew glistened, the smoke was rising, here and there a man appeared; a light as of transfiguration lay on all things. It was only a little bit of the Earth; it was only one moment of her existence; and yet, as my look embraced her more and more, it seemed to me not only so beautiful an idea, but so true and clear a fact, that she is an angel—an angel so rich and fresh and flower-like, and yet going her round in the skies so firmly and so at one with herself, turning her whole living face to heaven and carrying me with her into that heaven, that I asked myself how the opinions of men could ever have spun themselves away from life so far as to deem the earth only a dry clod. . . . But such an experience passes for fantastic. The earth is a globular body, and what more she may be one can find in mineralogical cabinets."

I should be sorry to spoil with comment what I have just read. It is not difficult to see who it is who has returned in the person of Cybele, the Earth Goddess. The dear companion, the divine mother, is Fechner's once more, and with this tremendous sublimation he passed out of suffering and misery into happiness and health. After that he could and did work as hard as ever, but there were no more breakdowns.

My second citation is from the diary of Tolstoi in his old age. "I go over," he writes in his private diary, "all the people I have loved; not one is suitable to whom I can come close. If I could be little and snuggle up to my mother, as I imagine her to myself! Yes, yes! Mother whom I called to when I could not speak; yes, she, my highest imagination of pure love, not cold divine love, but earthly, warm, motherly. It is to that that my battered weary soul is drawn. You, mother, you caress me. All this is senseless, but it is all true." Tolstoi's mother died when he was two years old.

A Geological Reconnaissance of the Linville-Nanango District.

By E. C. Tommerup, B.Sc., A.A.C.I.

One Geological Map.

(*Communicated by Dr. W. H. Bryan to the Royal Society of Queensland, 28th April, 1930.*)

Contents.

I.—INTRODUCTION.

The following paper is an abridged* description of studies made on the geology of a large area situated between Linville and Nanango, Queensland. The information was gathered during numerous traverses made by the writer when stationed in the district on forestry work.

Little geological work has been done in the district, but considerable assistance can be derived from various reports on some scattered mining "shows" associated with the edges of the granitic intrusions. The nearest systematic surveys south of the area are those carried out by Reid,[12] Reid and Morton,[13] and Hill[20] on the country between Esk and Ipswich. It is probable that the Esk series of shales and conglomerates form a continuous belt from Esk to Linville, and that the Esk andesitic stage forms a practically continuous strip from east of Esk to beyond Goomeri in the north.[13] [15]

The writer has attempted to correlate and classify the various rock formations of the district, but does not regard the classification as either

* A contour map of the area, together with a more complete account of the area with details of actual outcrops, portion numbers, descriptions of rock specimens, and other important though minor details, has been deposited in typescript form in the library of the Society, and will, it is hoped, be found useful by future workers.

complete or final. He hopes, however, that this paper will serve as a basis for further work, and that it will assist in the geological mapping of Queensland.

II.—THE BRISBANE SCHISTS.

What are regarded as outcrops of the Brisbane Schists appear north of the area at Wondai and Manumbar,[15] and in the south near Crow's Nest,[12] whilst east of the area Brisbane Schists form a huge belt.[17] An outcrop of typical light-brown hard schistose shales of this series occurs along Rocky Creek where the Yarraman-Nanango road crosses it; they strike N.N.W. and dip 80° E. In the creek bed jasper pebbles are found some of which carry radiolarian casts. On Por. 292 Cooyar, serpentine rock may be seen in an old shaft. Outcrops of typical and almost vertical N.N.W.-striking schists are to be seen close to Yarraman township, on the Upper Yarraman road. A considerable extent of slates, hard sandstones, and quartzites outcrop to the north and east of Nanango, and these also appear to belong to this formation though Rands[1] regarded them as belonging to the Gympie Series.

III.—THE GYMPIE SERIES.

A number of patches of massive, jointed, hard, fine-grained, dark-coloured, bluish grey to black metamorphosed slates of somewhat doubtful age outcrop in various places in the district, frequently associated with granite intrusions. Usually no dip or strike is discernible. Fine quartz veins may be seen in this rock, which is regarded as belonging to the Gympie Series on account of lithological similarity with outcrops in other parts of the district[3 18] which contain fossils.

A typical outcrop is seen close to Benarkin railway station. Further outcrops have been described by Ball[3 11 21] from the neighbourhood of Taromeo. Mr. Ball's work has been incorporated in the accompanying map.

Several patches of these slaty rocks may be observed between Benarkin and Yarraman Creek. They strike roughly N.W. and are practically vertical. Their positions are given on the map.

IV.—THE ESK SERIES, ANDESITIC STAGE.

I have to report the find of the Goomeri Volcanics farther to the south than mapped by Mr. Reid in his report.[15] Typical andesitic agglomerates and intrusive andesites are to be seen near Marbletop east of Nanango, and on adjacent lands. The following is Mr. A. K. Denmead's description of a microslide of a specimen taken from near the boundary between R. 456 and the northern end of R. 299 Avoca:—

"A fine-grained rock exhibiting a pronounced fluidal structure under the microscope. The groundmass consists of rods and needles of plagioclase, epidote, magnetite, and chlorite in a more or less devitrified glass. There are phenocrysts of plagioclase felspar, more or less decomposed, and of hornblende partially or entirely converted to a mass of chlorite and epidote. Name: andesite."

The whole of this area is made up of intrusive andesites and masses of andesitic agglomerates (or perhaps tuffs) which occur on top of the Brisbane Range and in the beds of Burnettine Creek below. Probably the western boundary of the series passes through Por. 279 Coolabunia, and west of Paradise Creek in R. 299 Avoca (51v). It will be noticed that an imaginary extension of this boundary line leads roughly along the Blackbutt Range for about eight miles. There is thus the possibility that this range is a fault scarp. There is much evidence of faulting showing in the railway cuttings between Benarkin and Linville.

The writer was able to follow the andesite series continuously south from Goomeri to the head of the Brisbane River and beyond Mount Stanley at least as far as the junction of Avoca Creek with the Brisbane River. This series covers a wide area and consists of massive andesitic agglomerates and intrusives with perhaps tuffs, &c. The agglomerate is perhaps the most common type, and along the road from Goomeri to Mount Stanley down the Brsbane River (west branch) it consists mainly of angular fragments of andesitic rock embedded in a matrix of what appears in the hand specimen to be lava and perhaps also consolidated tuffaceous material.

On the east branch of the Brisbane River a few miles below Mount Gibbarnee, the agglomerate consists of pebbles from very small up to boulder size embedded in a matrix of andesitic (?) lava. The pebbles are sometimes pinkish, due probably to oxidation, but many are of grey andesite which exhibits phenocrysts of plagioclase and pyroxene set in a fine-grained groundmass. Occasional pebbles of milky quartz and chert also occur. Along the west branch the series is seen forming cliffs in several places, and disjointed and irregular bedding may be seen. There does not seem to be any definite dip or strike, but joint planes are numerous. Nevertheless one can sometimes make out a general N. and S. trend and a general dip of 50-60° E.N.E. can be observed on T.R. 59v.

Rands[1] and Jackson[8] have visited Gooroomjam Creek,[23] which rises in the Brisbane Range near the eastern edge of the andesite belt. These geologists studied the ore-bodies which exist there and described the country rock as fine-grained diorite. Recently the area has been mapped by McGrath and Jennings,[24] and their reports indicate that generally speaking the rock on the western side of Bunya Creek on R. 154 Gallangowan is a porphyritic hornblende andesite, whilst that on the eastern side is a more typically textured andesite. This distinction also holds for the northern end of R. 329 Avoca. Near the head-waters of Gooroomjam Creek there are granodioritic intrusions in massive diorites. In short, this locality seems to have been a centre of disturbance, on the edge of the andesitic belt.

V.—THE ESK SERIES, SHALE STAGE.

The next series of rocks to receive consideration comprises a number of outcrops of shale and conglomerate situated as follows:—

(A) A large outcrop in the vicinity of Tarong. This series consists of coarse conglomerates and shales. The pebbles are made up of rhyolite, chert, &c.: some large (12 in. diam.), but usually about 3 in. diam. and smaller. In some places a slight secondary pressure or chemical metamorphism has produced a gritty textured quartzite.

(B) An outcrop of grey shale and conglomerate occurs on Por. 25 Cooyar, and dips 15° E.N.E.

(C) On T.R. 369 Cooyar, at the head of Oaky Creek, conglomerates very similar to those seen near Tarong outcrop. They are definitely overlaid by basalt on the eastern corner of the reserve. The Spring Creek gorge near-by, which is a couple of hundred feet deep, is cut entirely in basalt. The relationship of this conglomerate bed to the granite was not determined, but the conglomerate is almost certainly younger.

(D) A patch of conglomerate and shales occurs on Upper Yarraman Creek, accompanied by a small seam of steam coal in Por. 84v. The seam is said to be about 6 in. thick and is accompanied by fossils. An analysis of a sample of this coal gave the following results:—

	Per cent.
Moisture at 100° C.	5·1
Volatile matter	26·3
Fixed carbon	55·2
Ash (grey colour)	13·4
	100·0

The conglomerates exposed in the gully consist of numerous pebbles of typical Brsbane Schist, of typical black slates like those regarded as Gympie Series, of sandstone, banded cherts, milky quartz, rhyolite, &c., set in a sandy or mudstone matrix. The conglomerate beds are mingled with layers of grits, sandstones, and shales, and exhibit current bedding. Much secondary red ferruginous staining has been produced by percolating waters. Mr. Ball[21] has also examined this locality and he quotes dips of 10 to 15° N.N.W. on Yarraman Creek.

(E) Very similar conglomerate beds are seen near Kooralgin; these dip at 25° S.E. This outcrop is also overlaid by a large outcrop of basalt in Por. 153 which appears to be intrusive in this locality.

(F) Mr. K. P. McGrath,[24] has mapped an area of fossiliferous conglomeratic shales along Moonarumbi Creek in R. 245 Monsildale which are probably assignable to the Esk Series. Conglomerates are also to be found farther south.[25]

(G) Jack[2] mentions conglomerates below basalt on Por. 5v Burrandowan.

On lithological grounds the writer regards all these outcrops as belonging to the Esk Shales (Ipswich basal conglomerate stage).[20]

Esk shales outcrop on the southerly slope of the Blackbutt Range and are seen along the Linville-Benarkin railway and along the main road.[3] An examination of the railway cuttings revealed that there was much evidence of faulting in this locality, the dips varying considerably over short distances: 10° E. to 60° E. being approximate limits, with a general strike N.N.W. The beds are conglomeratic with pebbles of chert, rhyolite, and what appear to be fragments of Brisbane Schist and Gympie Slates, but no granitic or basic rocks. Fossiliferous beds are present. Numerous interbedded dark greywackes occur, notably between the 75-78 mile posts. Some are narrow bands, others thick, the variation ranging from 10 to 150 ft. These greywackes can be regarded as sandstones composed of quartz, felspar, rock fragments, and other detritus from some weathered basic rock. Typical Esk shales and conglomerates outcrop at several points along the Brisbane Valley railway south of Linville.

A specimen of a basic rock from part of the (?) Esk Series, collected near Burnt Hill Forestry Barracks (position marked on map with an asterisk), was sectioned and described for me by Mr. Denmead as follows:—"A clastic rock composed largely of fragments of andesite and of some fine-grain sedimentary rock (slate or shale); partially kaolinised felspar crystals are numerous. Very scarce angular quartz fragments also occur. The few ferro-magnesian minerals are very decomposed and are now represented by leaves and irregular masses of chlorite which occur interstitially. A few iron-ore fragments are present. The groundmass is not clearly defined. The rock is an andesitic tuff."

VI.—IGNEOUS ROCKS.

The igneous rocks of the area are rather complex and not easily correlated. Three main types can be distinguished, and are indicated on the map—

(A) A series of grey granodiorites which are younger than the intruded Gympie Series but older than the overlying Esk beds.

(B) A series of andesitic rocks which, to avoid confusion, are termed porphyrites, though some outcrops are perhaps not precisely true to label. These rocks are apparently closely associated with the granodiorites.

(C) The basalts, which outcrop along the Cooyar Range and elsewhere, and which are younger than the Esk Shale Series.

(A) The Granodiorites.

These rocks usually contain a sufficiency of quartz, though Mr. Ball[3] quotes syenite from the foot of Mount Mellera and from other localities. Associated with the granites, too, are small flows of trachytes and rhyolites. The Taromeo, Nanango, and other areas have been mineralised and several shafts have been operated in the past for ores of copper, silver, gold, and other metals which are found in close proximity to the granite outcrops.

Numerous outcrops of granodioritic rocks are found in the area, and all those so far described* are marked in on the accompanying map.

* A fuller description of the outcrops will be found in the original typescript of this paper deposited in the Society's library.

Those described from the Nanango Goldfield,[1, 8] Taromeo district [3 11 21] Gooroomjam Creek,[8 24] Mount Monsildale,[7 25] Jumna Creek,[2] Kunioon,[19] and Dattu Dattu,[9 10] are taken from literature; the remainder are personal observations.

In several localities where the granites intrude the (?) Gympie Series an interesting type of contact breccia is found in the granitic aureole. Examples may be seen on the Gilla-Kooralgin road and old Yarraman-Nanango stock route. The contact zones are marked by outcrops of laminated sericitised rhyolites associated with peculiar volcanic agglomerate consisting mainly of a dark felsite containing much quartz, small phenocrysts of felspars, traces of mica and ferro-magnesian minerals and xenoliths of other associated rocks. On Cooyar Creek in Por. 42v fluxion structure is clearly seen in felsite associated with altered andesites. The same phenomenon is described from other localities.[3 4 5 8] Evidently the punching magma distends and cuts the country rock and produces a crush breccia which is then indurated and a kind of volcanic agglomerate is formed. (*cf.* Tyrrell, "Principles of Petrology," p. 20.)

(B) The Porphyrites.

In numerous places in the area the granodiorites apparently pass continuously into porphyrites. These junctions, however, need special investigation. Miss D. Hill (personal communication) has examined the junction of the granite and the porphyrite at Cooyar Creek crossing, and considers that the granite is intrusive into the porphyrite. The porphyrite outcrop is fairly typical of those in the district, and consists of phenocrysts of plagioclase undergoing saussuritization; small phenocrysts of chloritised amphibole and small crystals of pyrite may also be observed. Similar material outcrops in Por. 42 Cooyar and at Din Din (C. and W.R. 54 Cooyar). At 83¼ m. on the Linville-Benarkin railway a basalt containing felspar, olivine, ilmenite, secondary quartz, epidote, and pyrite may be seen associated with a granitic intrusion.

(C) The Basalts.

Ball[3] describes a fayalite basalt from Mount Mellera near Taromeo; he regards the mountain as the site of an extinct volcano, and notices that "the lava flows have not passed over the Ipswich beds but abut against their edges as against a cliff (but probably they are of later age than the Ipswich)."

The Cooyar Range basalts (or andesites) are fairly typical in that they weather to give a red loam soil, and also because they contain, in some localities, numerous inclusions of foreign rocks, and when this agglomerate weathers it exhibits a curious "puddingstone" appearance, patchy white xenoliths standing out in contrast to the weathering matrix proper, which is of a ferruginous red hue. This basalt extends all along the Cooyar Range and for some miles on either side. It overlies the conglomerate beds regarded as Esk Series and also overlies granite. It peters out towards Nanango. It is probably contemporaneous in age with the Mount Mellera basalt, with the Tingoora and Boat Mountain basalts,[15] and with the Main Range basalts—that is, with the Upper Tertiary basalts of Professor Richards.[22] Specimens from cliff boulders from R. 510 (1v) at the head of Cooyar Creek proved to be basaltic glass or tachylite, associated with which is an ironstone rock of a slag-like appearance. From the nature and position of this outcrop it seems probable that the junction of the Great Dividing Range, Bunya Mountains, and Cooyar Range is the seat of a Tertiary centre of vulcanicity. (*See* Harker, "Petrology for Students," p. 207.)

The Bunya Mountains appear to be composed entirely of basalt. Jack[2] describes basalt from the mountains at the heads of the Boyne River, Jumna and Ironpot Creeks. He mentions, too, that sedimentary strata occur interbedded with the basalt flows on the slopes leading up from Jimbour to the Bunyas.

On part of S.F.R. 316 a somewhat curious agglomeratic rock exists; in the hand specimen fragments of chert, slate, &c., may be seen set in a dark groundmass, and the rock is not unlike specimens from the Esk andesitic stage. A sample of this rock selected from the western end of Por. 53v was sectioned for me by Mr. A. K. Denmead, M.Sc., and his report on it is very interesting:—

"A medium-grained rock of even texture with the following minerals in order of abundance:—

1. Felspar usually much kaolinised, where recognisable belonging to the plagioclase group. Occurs in sub-idiomorphic to extremely irregular individuals. One or two individuals of fresh potash felspar (microcline) occur in the section. The felspar constitutes about one-third of the rock.
2. Augite in irregular individuals with a maximum length of one millimetre, colourless to pale green—about one-tenth of the rock.
3. Hornblende in small brown grains somewhat less abundant than augite.
4. Quartz usually large angular grains 35-40 individuals in the section (which is one inch square).
5. Chlorite occurs as interstitial material and as a decomposition product of ferro-magnesian minerals (olivine?).
6. Biotite occurs sparingly.
7. Magnetite.
8. Ilmenite altering to—
9. Leucoxene.
10. Pyrite very sparingly.
11. In addition to the foregoing there are fragments of slate.

"The rock has evidently been derived from a basic or intermediate rock and fragments of quartz and slate have been added. It is not a tuff, for there is no ashy material. It possibly could, however, have been derived from a tuff by a process of natural elutriation."

It will be noticed that this outcrop is bounded on the east by a granite porphyrite complex, on the north and south by rhyolite, and about a mile or so to the west by Brisbane Schists. One hesitates to offer an explanation as to the relationships of this rock to the others in the district; suffice it to state that examples of it occur in numerous places along the andesite-granite boundary from S.F.R. 316 to Yarraman railway yard, where it shows jointing, probably due to faulting. It should, perhaps, be considered as part of the porphyrites.

SUMMARY AND CONCLUSIONS.

It is customary to give a set of conclusions at the close of a paper such as this; but the writer fears that the facts which he has to offer are too incomplete to suggest any reliable hypotheses which would correlate all the rocks of the district. Even the geological boundaries on the accompanying map are largely interpolated. However, a brief discussion of the rock sequence may prove useful to future workers.

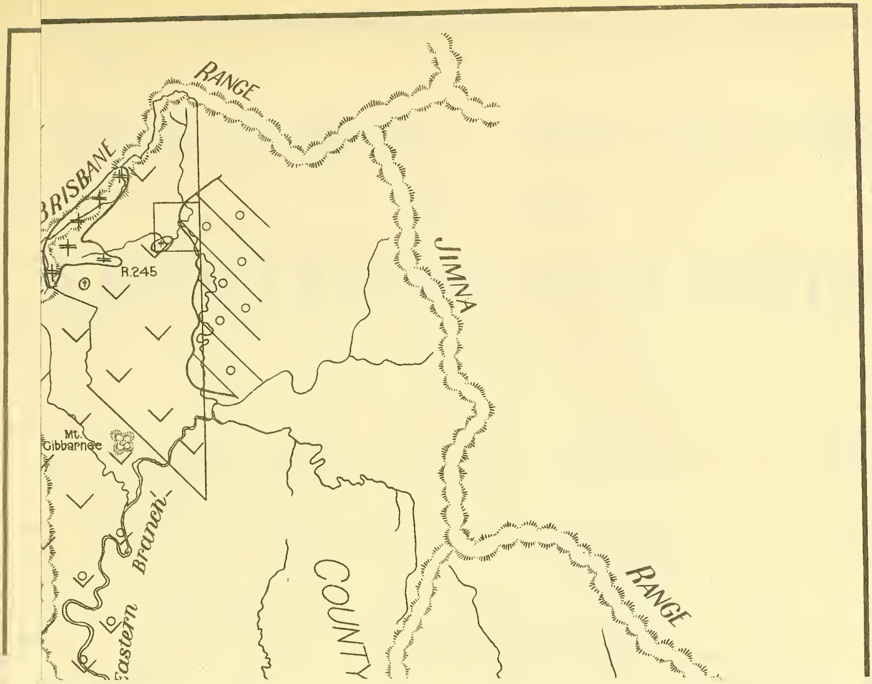
The oldest rocks in South Queensland are the Brisbane Schists, which form a practically continuous block to the east of a line joining Pine Mountain to Kilkivan. An outcrop of this series occurs between Yarraman and Wondai.

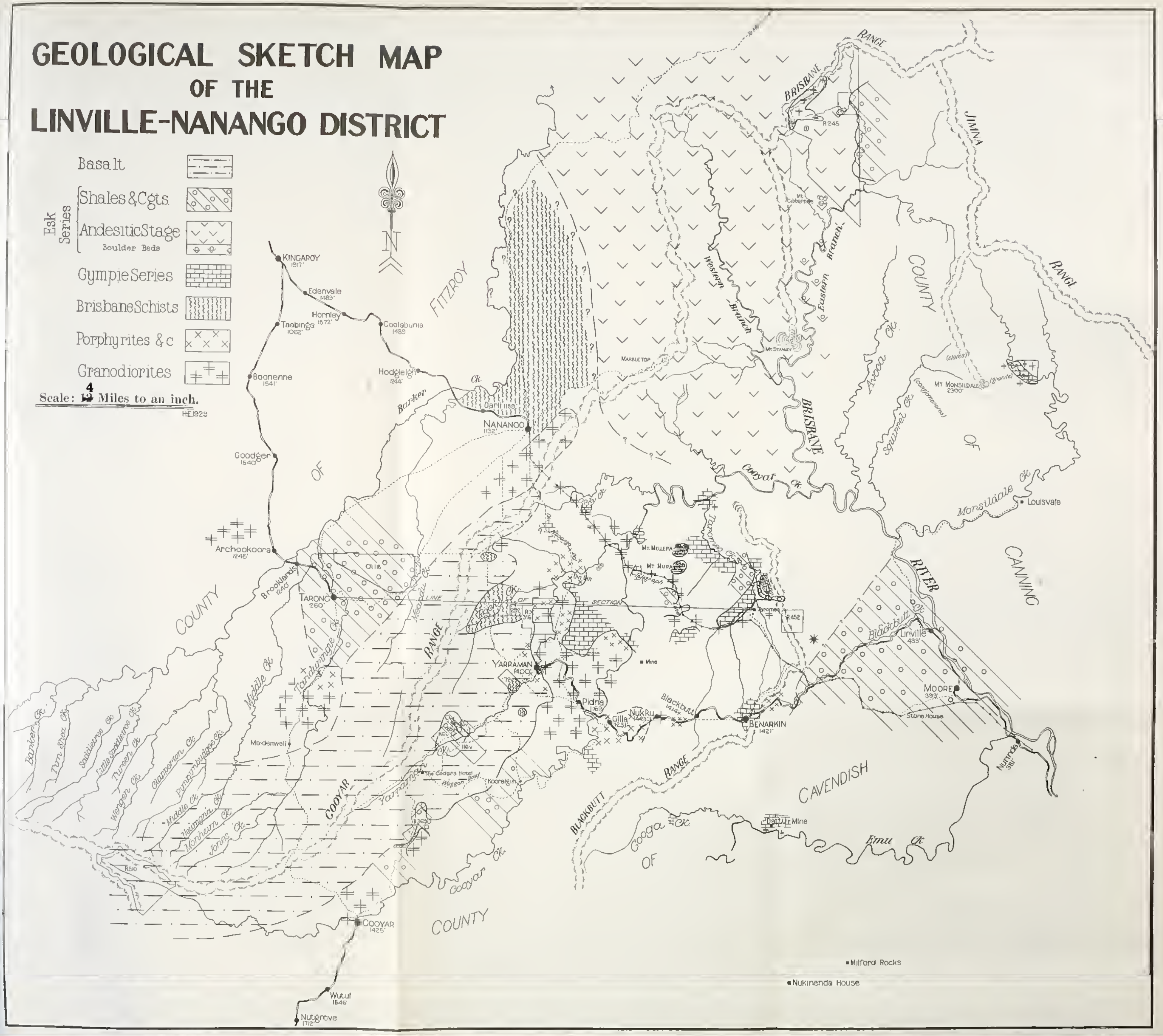
Between Yarraman and Esk there are several outcrops of slates which probably belong to the Gympie Series; whether they are deposited *in situ* or are faulted into their present position is not clear.

The age and meaning of the porphyrite intrusions is not clear; they seem to be older than the granodiorites, and might possibly be related to the massive Esk andesitic stage farther east.

There is doubtless some significance in the fact that the Esk conglomerate beds of the district contain numerous pebbles of milky quartz, jaspers, Brisbane Schist, Gympie Slates, rhyolite, &c., but very few, if any, basic pebbles, with the notable exception of some interbedded greywackes. The conglomerates overlie the granitic intrusions but are overlaid by the (?) Tertiary Cooyar Basalts.

It gives me pleasure to express my gratitude to Miss D. Hill, M.Sc., for references to literature and for helpful criticism; to Dr. W. H. Bryan for encouragement and advice; to Mr. L. C. Ball, B.E., for kind permission to utilise his unpublished sketch-maps of the district; to Mr. A. K. Denmead, M.Sc., for very considerable petrographic and other assistance; to Mr. E. H. F. Swain for his consent to use information from forest surveys; to Mr. F. E. Connah, F.I.C., for the analysis of the coal sample from Por. 84v; and to Mr. C. Woods and Mr. H. Everist for aid in drafting the map and section.


RANGE
BRISBANE
R.245
JIMNA
Mt.
Gibbarnee
Eastern
Branch
COUNTY
RANGE


GEOLOGICAL SKETCH MAP
OF THE
LINVILLE-NANANGO DISTRICT
Basalt
Esk Series
Shales & Cgts.
Andesitic Stage
Boulder Beds
Gympie Series
Brisbane Schists
Porphyrites &c
Granodiorites
Scale: 4 Miles to an inch.
H.E.1929
N
KINGAROY 1917'
Edenvale 1489'
Hornley 1572'
Taabinga 1062'
Coolabunia 1489
Boonenne 1541'
Hodgleigh 1244'
Barker Ck.
NANANGO 1132'
Goodger 1540'
Archookoora 1246'
Brooklands 1240'
TARONG 1260'
FITZROY
OF
COUNTY
RANGE
LINE OF SECTION
YARRAMAN 1400'
Pidna 1169'
Gilla 1231'
Nukku 1440'
Blackbutt 1414'
BENARKIN 1421'
Linville 433'
MOORE 393'
Stone House
Nunnda 381'
Maidenwell
Mine
MT. MELLERA
MT MURA
Taromeo
R452
CR 118
R510
The Cedars Hotel
Kooralgin
COOYAR RANGE
Cooyar Ck.
COOYAR 1425'
Wutul 1646'
Nutgrove 1712'
COUNTY
Milford Rocks
Nukinenda House
BLACKBUTT RANGE
CAVENDISH
OF
Googa Ck.
Emu Ck.
Dal Ur Mine
CANNING
COUNTY OF
RIVER
BRISBANE
Blackbutt Ck.
Monsildale Ck.
Louisvale
MT MONSILDALE 2300'
Squirrel Ck.
Avoca Ck.
JIMNA
RANGE
BRISBANE RANGE
R245
MT. GIBBERNE
Western Branch
Eastern Branch
MT STANLEY
MARBLETOP
Cooyar Ck.
Middle Ck.
Tandurringe Ck.
Barkers Ck.
Tun Shea Ck.
Saddletree Ck.
Little Saddletree Ck.
Thureen Ck.
Wengen Ck.
Clapperton Ck.
Pimpimbudgee Ck.
Middle Ck.
Yelumgnia Ck.
Monheim Ck.
Jones Ck.
Yarraman Ck.
Meandu Ck.

BIBLIOGRAPHY.

1. Queensland Geological Survey Pub. No. 29, 1886 .. RANDS: Report on Nanango Goldfield.
2. Queensland Geological Survey Pub. No. 114, 1896 .. JACK: Notes on Bunya Range.
3. Queensland Geological Survey Pub. No. 159, 1900 .. BALL: Report on Taromeo District.
4. Queensland Government Mining Journal, 1901, p. 466 .. JACKSON: Rising and North Star Mines.
5. Queensland Government Mining Journal, 1901, p. 468 .. JACKSON: Great Pyramid Mine.
6. Queensland Government Mining Journal, 1901, p. 469 .. JACKSON: Milford Rocks Gold Area.
7. Queensland Government Mining Journal, 1901, p. 530 .. JACKSON: Silver-lead at Monsildale.
8. Queensland Geological Survey Pub. 169, 1901 .. JACKSON: Mines at the heads of the Brisbane River.
9. Queensland Government Mining Journal, 1903, p. 188 .. CAMERON: Dattu Dattu Mine.
10. Queensland Government Mining Journal, 1906, p. 467 .. BALL: Dattu Dattu Mine.
11. Queensland Government Mining Journal, 1912, p. 111 .. BALL: Mines near Taromeo.
12. Queensland Government Mining Journal, Dec. 1922, p. 462 .. REID: Coal in West Moreton.
13. Queensland Government Mining Journal, Jan. 1923, p. 7 .. REID AND MORETON: Geology of Esk.
14. Proceedings, Royal Society of Queensland, 1924, p. 44 .. RICHARDS AND BRYAN: Geology of Silverwood.
15. Queensland Government Mining Journal, Mar. 1925, p. 87 .. REID: Murgon-Goomeri District.
16. Proceedings, Royal Society of Queensland, 1924, p. 134 .. RICHARDS AND BRYAN: Radiolaria in Brisbane Schists.
17. Proceedings, Royal Society of Queensland, 1927, p. 71 .. DENMEAD: Brisbane Schists.
18. Proceedings, Royal Society of Queensland, Sept. 1926, p. xiv. .. RICHARDS AND BRYAN: Permo-Carb. Fossils on Cressbrook Creek.
19. Queensland Government Mining Journal, Mar. 1929, p. 101 .. DENMEAD: Kaolin No. 14.
20. Proceedings, Royal Society of Queensland, 1929, p. 162 .. HILL: Esk Shale Series.
21. Unpublished sketch-maps to accompany (3) above .. BALL.
22. Proceedings, Royal Society of Queensland, 1916, p. 194 .. RICHARDS: Volcanics of South-eastern Queensland.
23. Quarterly Journal Geological Society, 1872, p. 300 .. DAINTREE.
24. Queensland Forest Service Files: Reports on survey of S.F.R. 154 Gallangowan, 245 Monsildale, and 329 Avoca .. Forest Assistants MCGRATH AND JENNINGS, 1929.
25. The plan of S.F.R. 343 Monsildale, 1915, Cg. 806, mentions "conglomerates slate, granite" in different places which are marked on map herewith.

The Development of the Esk Series between Esk and Linville.

With reference to the Possible Occurrence of Workable Coal.

By Dorothy Hill, M.Sc., Research Scholar, University of Queensland.

Two Geological Maps.

(*Read before the Royal Society of Queensland, 28th April, 1930.*)

Table of Contents.

I.—INTRODUCTION AND ACKNOWLEDGMENTS.

This work was carried out by the author while holding the Scholarship for the Encouragement of Original Research of the University of Queensland, field expenses being defrayed by a grant from the Commonwealth Council for Scientific and Industrial Research, the latter being made so that the possibilities of coal in the Brisbane Valley might be explored. The country dealt with extends from Kipper Creek and Bellevue on the south to Avoca Vale and the heads of Sheep Station Creek on the north. The average width is 20 miles, and the length 38 miles, making a total area of 760 square miles. Half of this area (about 380 square miles) has been examined in some detail during the ten weeks' fieldwork, but the other half, on the east of the Brisbane River, has only been touched upon, as may be judged from the few geological data appearing on that half of the map.

The method of working was on horseback from private homes and hotels, one eminently suitable for the district, which is closely settled;

while for the outlying Happy Creek area a car camp was arranged, from which the work was again done on horseback.

In investigating the possible occurrence of coalfields the following method was adopted:—A study was made of the tectonic structures of the area, of which previously little had been known; and, concurrently with this, the lithology of the different types of sediments was examined with a view to determining the conditions of deposition of each. From the knowledge thus gained, localities favourable for the occurrence of coal were deduced. The localities thus determined were then examined in as much detail as time permitted for traces of coal.

These investigations forced one to the conclusion that conditions are distinctly unfavourable for the occurrence of a large field of coal, but it is possible that small occurrences capable of allowing small collieries to supply part of the needs of the Brisbane Valley, including those of the railway line, may be found in some of the synclinal areas. But, apart from this rather negative economic value of the investigations, it is believed that the data collected during the course of the work have more than justified the time and money spent in the field, for they form a very important addition to the knowledge of the tectonic and volcanic geology of our Triassic deposits.

The hospitality and cordiality of the people in the Brisbane Valley made the work very pleasant. In particular I wish to thank Mr. and Mrs. T. J. Coleman of Toogoolawah, Mr. and Mrs. B. G. White of Moorabool, Mr. and Mrs. George Graham of Ettswold, Mrs. Moore and Miss Moore of Colinton, Mrs. J. H. McConnel and Miss Ursula McConnel of Cressbrook, Miss Gardner of Dingyarra, Mr. Marson and Mr. Launder of Toogoolawah, and Mr. and Mrs. R. Whyte of Happy Creek. Their generous hospitality and ready assistance made the fieldwork seem like a pleasant holiday amongst friends; and it was with regret that the last field excursion was completed.

Mr. C. C. Morton, of the Geological Survey of Queensland, most kindly made available to me his unpublished reconnaissance maps of the area between Esk and Ottaba, and the Great Moreton Fault Area; while the Rev. C. H. Massey and Dr. Bryan have given me dip readings along the main road from Esk to Benarkin. Dr. Bryan also read the manuscript and suggested many improvements.

II.—PREVIOUS WORK.

(A) Bibliography.

In published work on the Brisbane Valley, short references only to the Mesozoic rocks may be found, since the chief object of the reports has been to deal with mineral occurrences in the Palæozoic rocks.

(1) 1885. C. Stutchbury: 15th Report, N.S.W.L.A. Papers, vol. 1, p. 1185. This describes traverses made from Kilcoy down the valley of the Stanley River, and from Kilcoy west to Colinton, from Colinton through Balfour's (Wallaby) and Jeromeo (Taromeo) Creeks to Bonera

(Boonara) and Boubyjan. Unfortunately this report is not of much assistance owing to the rather indefinite usage of the terms "porphyry" and "trap" and to the difficulty of placing exactly its localities. But Stutchbury seems to have been the first to recognise the important felspar porphyry series intruding the Mesozoic Coal Measures. . .

(2) 1892. R. L. Jack and R. Etheridge: G.S.Q.P. 63, "The Geology and Palæontology of Queensland and New Guinea." In this the only references to the area under discussion are to "Colinton" and "Kilcoy Range above Cressbrook," both as fossil plant localities.

(3) 1901. L. C. Ball's Annual Report, A.R.G.S. for 1900; G.S.Q.P. 159. The report has notes on a journey from Esk to Taromeo over the Blackbutt Range, mentioning "trachyte (?) tuffs and (?) sheets" in the Mesozoic Coal Measures on Wallaby Creek and on the climb up the range.

(4) 1901. C. F. V. Jackson: "Mines near Esk," Q.G.M.J., pp. 466, 468, 469, and 530. This refers to Palæozoic rocks only.

(5) 1903. W. E. Cameron: "The Dattu Dattu Mine," Q.G.M.J., p. 188. This also refers to Palæozoic rocks only.

(6) 1906. L. C. Ball: "The Upper Brisbane Valley," Q.G.M.J., p. 470. This contains a short reference to coaly outcrops in the Trias-Jura at the head of Wallaby Creek, and on the Esk-Nanango road.

(7) 1912. L. C. Ball: "Mines in the Parish of Taromeo," Q.G.M.J., p. 111. Here Trias-Jura rocks are described lying unconformably on Permo-Carboniferous sediments near Taromeo Station.

(8) 1912. E. O. Marks: "Prospects of Coal at Esk," Q.G.M.J., p. 322. Dr. Marks reports unfavourably on certain indications of coal near Esk.

(9) 1912. E. O. Marks: "On the Geological Age of South-eastern Queensland Volcanic Rocks," P.R.S.Q., p. 139. A Mesozoic age is advocated for certain trachytes near Esk.

(10) 1916. H. C. Richards: "Volcanic Rocks of South-eastern Queensland," P.R.S.Q., vol. 27, No. 7. Places the trachytes above (Marks, 1912 (9)) into the Tertiary.

(11) 1918. A. B. Walkom: "The Geology of the Lower Mesozoic Rocks of Queensland," Proc. Linn. Soc. N.S.W., vol. xliii. A short reference is here made (p. 55) to the belt of rocks between Esk and Cooyar Creek as Walloon.

(12) 1923. J. H. Reid and C. C. Morton: "The Geology of the Country between Esk and Ipswich," Q.G.M.J., p. 7. They define the Esk Series from its occurrence south of Esk, as follows:—

$$\text{Esk Series} = \begin{cases} \text{Esk Trachytes.} \\ \text{Esk Shales and Bellevue Conglomerates.} \\ \text{Andesitic Stage.} \end{cases}$$

(13) 1926. H. C. Richards: "Volcanic Activity in Queensland," A.A.A.S., 1924, p. 285-287. Reid and Morton's (12) placing of the Esk Trachytes as Mesozoic is criticised.

(14) 1927. E. O. Marks: "Streams and Their Past," The Queensland Naturalist, vol. vi., No. 2, pp. 28 and 29. Here the Brisbane River and its tributaries are discussed with reference to geological structures possibly determining their courses.

(15) 1930. Dorothy Hill: "The Stratigraphical Relationship of the Shales about Esk to the Sediments of the Ipswich Basin," P.R.S.Q., vol. xli., p. 162. The Esk Series is redefined for the area south of Esk, as follows:—

Esk Series = {
Esk Shales = Bellevue Conglomerates = Basal Ipswich Conglomerates.
Acid Tuff Stage = Brisbane Tuff.
Andesitic Boulder Beds.

(B) UNPUBLISHED WORK.

In addition to the above, Mr. C. C. Morton did some preliminary mapping in the area between Esk and Ottaba, and along the Great Moreton Fault Area, and kindly made available to me his data. Rev. C. H. Massey and Dr. W. H. Bryan have given me notes of outcrops along the main road from Esk to Benarkin, and Mr. E. C. Tommerup has prepared for publication a paper on the country at the heads of the Brisbane River, to the north and north-west of Linville.

III.—PHYSIOGRAPHY.

Physiographically the area shown on the map consists of a long trough of Triassic sediments set in higher walls of Palæozoic rocks. In the western wall, head a number of streams which run to the centre of the Mesozoic trough as the western tributaries of the Brisbane River, which flows in a series of short meanders in a general south-easterly direction about the axis of the trough. The general direction of these tributaries is north-easterly, at right angles to the strike of both Palæozoic and Triassic deposits. Those streams heading in the eastern Palæozoic highlands have a general westerly course, and run into the Stanley River and the Brisbane River below its confluence with the Stanley, which flows southerly close against the eastern faulted junction of Triassic and Palæozoic. While in the schists, however, the Stanley follows a westerly course.

The general direction of the Brisbane River is a straight north-westerly line with meanders of short radius to either side. From Avoca Creek to south of Moorabool the position of the river has been determined by the Colinton axis of disturbance,* and possibly also by the Neara Creek Disturbance. The junction of the Upper and Lower Esk Series closely follows the course of the river.

The northern part of the Eastern Border Fault is responsible for the course of Sheep Station Creek.

* Marks, 1927: The Qld. Naturalist, vol. vi., No. 2, pp. 28, 29.

The divide between the Brisbane and the Stanley is formed by the Toogoolawah mountains (Kilcoy Range) rising to over 2,000 ft.; i.e., it is higher than the highlands of the schist walls. This height of Triassic sediments is due to their intense hardening by intrusions of felspar-hornblende, porphyry, and granodiorite along a line of disturbance. So sudden is the rise to the range from the surrounding country that erosion at the heads of streams has cut high canyon walls (e.g., Black Jack's Creek), while one mile downstream the same creek meanders about in its own alluvial plains. There are many unscaleable cliffs on the eastern side of the range also. The streams running into the Brisbane River have a general south-westerly course, while those running into the Stanley flow easterly. This divide is much closer to the Stanley than to the Brisbane, so that the former is confined on both sides, and in its lower course has had to cut its way through rhyolite and a large granodiorite intrusion, forming the well-known Stanley Gorge. This is in strong contrast to the Brisbane River, which has great wide alluvial flood-plains.

The important topographical units are thus three:—

(1) The bordering highlands of Palæozoic rocks;

(2) The basin of Triassic rocks, with its unsymmetrically placed backbone;

(3) The Toogoolawah mountains (Brisbane-Stanley Divide).

When the streams head in the Palæozoic rocks, their feeding gullies are V-shaped, steeply inclined, and of varying heights, while the tops of the ridges on which they are cut are approximately equal in height (which might perhaps be regarded as evidence of a pre-Mesozoic erosion level). The streams themselves in the schists have rocky banks, or narrow flood-plains built up of angular pebbles; but when they flow down on to the Triassics they have wide alluvial flood-plains of black soil, in which they are constantly changing their courses. The great flood-plain of Cressbrook Creek is one of the most noticeable of the topographic features. It is wider than that of the Brisbane River itself.

Thus the normal erosion of the Triassic rocks is a mature type; but, when they have been hardened by intrusion, youthful forms result (as seen in the Toogoolawah mountains). A line of hills, the Moore-Harlin ridges, runs N.W. to S.E. close to the western banks of the Brisbane River, crossing the river and running east at Harlin as the Staghurst Range to join the Toogoolawah mountains; and this line shows topography characteristic of steeply dipping differentially hardened basin sediments. A similar line of ridges runs from Ivory's Creek through Toogoolawah and Ottaba.

A second type of highland in the Triassics is due to the differential hardness of the unintruded sediments when trachytes are interbedded. The latter weather into long ridges when the dip is pronounced, and into flat-topped hills when the dip is negligible. Thus the rough country forming the foothills to the Blackbutt Range and the high banks of the

Brisbane River at Wheeler's Crossing are due to trachytes interbedded in sediments with rapidly changing dips, while the ranges about Coal Creek settlement owe their altitude to the capping of gently dipping Triassic trachyte.

The topography on the east of the river north and north-west of the Staghurst Range is most striking but monotonous. It consists of spherical, conical, or elliptical humps rising with arcuate (convex) profiles out of U-shaped gullies. They reach no great height above these gullies (80-100 ft.), but their convex profiles give them a forbidding steepness. They form excellent grazing country. This is the Andesitic Boulder Bed type of topography, and is persistent from Gregor's Creek to Monsildale Creek. Where it is hardened by intrusion, only the size of the hump is exaggerated.

Tertiary intrusions into flattish Triassic trachytes account for the great Mount Esk mass overlooking Esk from the east; a Tertiary rhyolite flow for the steep hill opposite Ottaba station; while a development of fluidal rhyolite forms the divide between the Cressbrook and Buaraba waters.

The Bundanba sandstone in the south weathers to characteristic mild "Hawkesbury" forms, due to the massive nature and gentle dips. It is rich in springs.

The whole of the trough of Mesozoic sediments forms excellent well-watered grazing and dairying country, while the value of the western wall of Palæozoic rocks lies mainly in its timber content. It is not well watered, and is much rougher than the country in the trough, and consequently is of much less value.

IV.—TECTONIC STRUCTURE.

The Esk Series (of Triassic age) between Esk and Linville has been trough-faulted into Palæozoic rocks along lines parallel to the geological grain of South-eastern Queensland—i.e., north-west. The Esk Series in the trough may be divided into two conformable units—the Upper Esk Series,* including the northern representatives of both Acid Tuff Stage† and Esk shales, and the Lower Esk Series (Andesitic Stage or Andesitic Boulder Beds). The distribution of the Upper and Lower Esk Series in the trough is remarkable. The Lower Esk Series is entirely confined to the north-eastern half of the trough, and the Upper Esk (with the exception of certain (?) faulted blocks in the Toogoolawah mountains) to the south-western. The reason for this distribution is not yet understood. Tilting of the Esk Series to the west before the trough-faulting seems the most likely of the many explanations offering.

* The combination of the Esk shales and Acid Tuff Stage into the Upper Esk Series is desirable in this paper because the work has not been detailed enough to sort out the northern equivalents of these two stages; and for the sake of uniformity the Andesitic Boulder Beds are here referred to as the Lower Esk Series.

† Proc. Roy. Soc. Qld., vol. xli., 1930, p. 169.

The most striking tectonic features of the trough are three axes of disturbance—the Ottaba axis, the Colinton axis, and the Toogoolawah mountains disturbance. All three are represented by topographic highlands. The first two of these are very sharp, fractured anticlines accompanied by intrusions along the line of disturbance, and the third will probably prove to be similar. Between these axes and the margins of the trough there are gentle synclinal structures. A development of Bundanba sandstone overlies with apparent conformity the most southerly development of the Upper Esk Series in this area, both being involved in the Western Border faulting.

At present there is no evidence to show whether the trough-faulting dropping down the Triassic sediments into the Palæozoic rocks occurred before, after, or contemporaneously with the folding and faulting within the trough. The Ottaba anticlinal fracturing took place before the extrusion of the Ottaba Tertiary rhyolite, and the marginal faulting occurred before the extrusion of the Ettswold Tertiary rhyolites and after the deposition of the Bundanba sandstone.

(A) Marginal Faulting.

(*a*) *Western Border Fault* System and Associated Palæozoic Rocks.*

This system covers the number of intersecting faults forming the western boundary of the Esk Series, with downthrow always towards the east. At Pryde's Pinch, Bundanba sandstones are downfaulted against pyritised (?) Permo-Carboniferous cherts and tuffs; but on the Kipper Divide the fault is overlapped by the Tertiary Ettswold rhyolite. North of the outcrop of this overlapping rhyolite, at Cressbrook Creek, the downthrow side of the fault (which there runs N.N.E.) is occupied by vertical Upper Esk conglomerates and trachytes. These are faulted against compact blue fossiliferous calcareous sediments and felspar porphyries of undoubted Permo-Carboniferous age, which strike N.W. and dip steeply (75°) to S.W. Locality A (*see* Map) yields *Monilopora, Trachypora*, and *Zaphrentis*, and Locality B *Monilopora, Mourlonia*, and *Conularia*, with B believed to be lower than A. The effects of this fault are distinctly visible for half a mile, but then the dips rapidly flatten to the normal horizontal position.

On the Esk-Biarra road the Upper Esk Series is downfaulted against old Palæozoic rocks probably equivalent to the Fernvale Series of the Brisbane Schists, and a long ridge of hard compact Upper Esk conglomerate runs parallel to the fault from the road to Cressbrook Creek. North of Cressbrook Creek, almost to Ivory's Creek, the rectilinear nature of the trough boundary is missing, and the alluvial plains of Cressbrook Creek run up to pink (Eskdale) granite intruded by blue diorites and a fine andesite, the junction being an irregularly rounded one. Just south of Ivory's Creek, however, the vertical Upper Esk

* This and the other structural names introduced in this and the following sections are now used for the first time, and have been chosen with regard to the localities in which they are typically developed.

conglomerates are again seen, and here they are downfaulted against weathered andesites, bluish cherts, and (?) rhyolites with a strike E. of N., intruded by a grey biotitic granite and a blue diorite (fine-grained), followed to the west by the red quartzites of the (?) Fernvale Series. The fault runs N. by W. almost to Maronghi Creek, the vertical conglomerates lying against the red (?) Fernvale quartzites. From near Maronghi Creek a fault runs N.W. to the Ironside Creek dam, where a fault coming in from the west steps out the western boundary of the Triassics about 3 miles to the west. This east-west fault may be called Ironside Fault, and appears to have some difference in downthrow from the Maronghi Creek-Happy Creek fault, for trachytes are not visible in the steeply tilted strata of the latter, while they are very obvious in the moderately dipping strata of the former.

The Palæozoic rocks west of Happy Creek and to the south of Ironside Creek are a series of vesicular andesites, slates, bluish cherts, and coarse grits, intruded by blue dioritic rocks, with an average strike of N. 30° W., and steep dips in both directions. Small quantities of gold are being obtained by washing from the various creeks on this development of Palæozoic rocks. The fault crossing the railway line near Benarkin runs N.N.W. and separates vertical Upper Esk conglomerates from granite; but on the Moore-Benarkin road the Palæozoic outcrops are obscured by a deep red laterite.

(b) *The Great Moreton or Eastern Border Fault System.*

The author has not touched upon this area in the field, except at Kilcoy, and is therefore much indebted to Mr. Morton, who has kindly given permission to use his unpublished mapping of the fault in this map. The several members of the Brisbane Schist Formation against which the Triassic rocks are downfaulted may be found in Mr. A. K. Denmead's "A Survey of the Brisbane Schist."*

(B) Central Faulting and Folding.

(a) *Bundanba Folding.*

Little is known of this: wherever dips were taken along Redbank Creek, the Bundanba sandstone appeared flat, except at its most easterly outcrop, where it was involved in the south-westerly dip of the Esk Series of the type area, and had a dip of 5° S.W., and at its most westerly outcrop where it was dipping slightly east due to the effects of the Western Border Fault. From the mapping, one suspects it of being a long monoclinal fold dipping S.W., tilted easterly just at its western edge by the influence of the Western Border Fault.

(b) *The Ottaba Axis of Anticlinal Fracturing and Intrusion.*

This is a most important structural line. Its structural and topographic effects are to be seen in the long line of ridges from Ivory's Creek south-easterly through Toogoolawah and Ottaba to the head of Coal Creek. It may be continued to the south-east as the augite andesite

* Proc. Roy. Soc. Qld. 1928, vol. xxxix., p. 71.

intrusions which are partly responsible for the weather-resisting mass of Mount Esk. North of Ivory's Creek its effects have not been distinguished from those of the western border faulting, and it may be that a continuation caused the Stone House Disturbance. From Ivory's Creek to Toogoolawah it forms a belt over a mile in width of sharp anticlinal uparching and fracture, the sediments being vertical or steeply dipping. In one place only (Por. 136 par. Biarra) is the accompanying intrusion visible. From Toogoolawah to Ottaba only the gently dipping eastern limb of the anticline may be seen rising out of the Cressbrook Creek flood-plains, but at Ottaba the area of disturbance broadens. Here it is accompanied by igneous intrusion divisible into three groups: (1) the eastern hornblende felspar porphyrite intrusions of Mount Beppo, (2) the augite andesite intrusions of Ottaba, and (3) the augite andesite intrusions of Por 28v par. Biarra, the last being overlaid unconformably by a Tertiary rhyolite flow. The sudden intensity of igneous effects at Ottaba has its analogue in the effects around Moorabool of the Colinton line or axis of movement.

(c) *The Stone House Disturbance.*

It will be observed that there has been a sudden steepening of dips to the north-east at the Stone House on Wallaby Creek, and again, north-west of this, in the Linville-Benarkin railway line. It is probable that these effects are due to the prolongation of the conjoined lines of disturbance of the Ottaba axis of disturbance and the Maronghi-Happy Creek fault.

(d) *The Coal Creek Syncline.*

South of Mount Esk, the Esk sediments are disposed in a gentle monocline dipping S.W. To the north of Mount Esk, however, a gentle syncline is formed between the Ottaba fractured anticline and this monocline. This structure may be termed the Coal Creek syncline, and is well shown topographically, due to the hardness of the interbedded trachytes. It is covered to the north by the alluvial plains of Cressbrook Creek.

(e) *The Glen Harding Syncline, the Maronghi Centrally Arched Syncline, and the Wallaby Syncline.*

North of Yimbun, synclines are again seen east of the Ottaba fractured anticline, but here their eastern limb forms the western limb of the Colinton fractured anticline. Between Ivory's Creek and Maronghi Creek the syncline is a simple one; between Maronghi Creek and Emu Creek it has a central anticline; and north of Happy Creek there is a long syncline running between the uparched strata of the Stone House Disturbance and the Colinton anticline, to be called the Wallaby syncline. These three synclines are obvious from the topograpy, due to the differential hardness of beds of sandstone and compact conglomerate as compared with shales and more loosely bedded conglomerates.

(f) *The Colinton Axis of Anticlinal Fracturing and Intrusion.*

The strata affected by this N.W.-S.E. disturbance may be seen from just east of Yimbun running north-west through Harlin, Colinton, Moore, and Linville to Avoca Creek. From Yimbun north-east to Por. 124v par. Neara, there is a three-mile-wide belt of what was once a gentle monocline dipping 3° S.W. and exposing to the east the Andesitic Boulder Beds. This has been cut through by at least two lines of sharp anticlinal fracturing with the concomitant intrusion of many sheets of coarse felspar-hornblende porphyry. These are concordant in the steeply arched strata and slightly transgressive in those which are only gently folded. The more westerly of these lines, seen in the Yimbun railway cuttings, is the southern end of the Colinton axis, and the more easterly may be called the Neara Creek fracture line. The Colinton line continues north-west as a disturbed anticlinal belt about 1½ mile wide, similar to the Ottaba line. Core-like intrusions are seen (Section VII. C (*b*)) near Nurinda station, at Colinton, and near Linville. Where the intrusions are not obvious, much fracturing with steep dips to either side may be seen across the belt, e.g. in the road between Harlin and Colinton, and between Colinton and Moore. The road between Moore and Avoca Creek seems from the constant steep N.E. dip to pass along the steep eastern limb of the anticline. This is the case as seen in the railway cuttings near Linville. It may reasonably be assumed to be the structure north of Linville.

(*g*) *The Neara Creek Fracture Line.*

This is the more easterly of the two fracture lines mentioned in the last paragraph. Its effects are seen in outcrops of vertical conglomerates and shales baked by the contemporaneous intrusion of coarse sill-like felspar porphyry in the ridges in Pors. 87, 88, 89 par. Neara, and north-west along the river to Neara Creek. These effects die out rapidly eastwards, and in Por. 124v par. Neara slight dips of 33° S.W. are noted in the basal Gregor's Creek syncline, in which are intruded sills of felspar porphyry and augite andesite, the latter forming cliffs. The Neara Creek fracture line appears to be prolonged to the south to Por. 117 par. Cressbrook, causing a local dip of 60° N.E. in the otherwise gently dipping sediments.

North-west at Avoca Creek soft shales and conglomerates of the Upper Esk Series dipping at 80° N.E. are seen on one side of the river, whereas intensely hardened andesitic boulder beds outcrop on the other, apparently dipping moderately N.E. Again, on the Arribaby Creek road, one-quarter of a mile from the river, Upper Esk conglomerates dipping 60° N.E. are separated from the Lower Esk andesitic boulder beds by only about 50 yards of alluvium. Relations here may prove to be the same as those in Pors. 87 and 124v par. Neara, but the possibility of a fault along the river bed here must not be overlooked. The Neara Creek Disturbance is also probably continuous to the south-east of Moorabool.

(*h*) *The Toogoolawah Mountains Disturbance.*

At the heads of Scrub and Black Jack's Creeks are seen hardened Upper Esk sediments conformably overlying hardened andesitic boulder beds, all being tilted at 80° to the north-east. Farther west, at the river, the dips were slight to the south-west. Consequently some faulting or folding has occurred between these two places. The intrusions of hornblende felspar porphyry, seen in these Upper Esk sediments from the heads of Scrub Creek south-east to Mount Goonnerringgiringi probably accompanied this disturbance. At the "K.C.B. tree," a noted survey mark, a great intrusion of a fine granular rock occurs, forming the Goonnerringgiringi cliffs, and south-easterly from Goonnerringgiringi the important Mount Brisbane granodiorite outcrops.

Thus the evidence shows that disturbance on a large scale has occurred in the Toogoolawah mountains, but the data are not sufficient to define its nature. It is probably the most important of all the disturbances affecting the Triassic sediments in the trough.

V.—THE UPPER ESK SERIES.

The Upper Esk Series is a series of basin sediments and volcanic rocks which occupies that half of the Brisbane Valley Trough to the south-west of the diagonally flowing Brisbane River, and which lies between the Lower Esk Series or Andesitic Boulder Beds and the Bundanba sandstone. It therefore includes the Esk shales and the Acid Tuff Stage.* It has been sharply folded about two north-west axes of anticlinal fracturing and tilted by the Western Border Fault. These movements, whose effects are the most spectacular attributes of the Upper Esk Series, have been treated in Section IV. The series has been intruded along the two lines of anticlinal fracturing by representatives of the Brisbane Valley Porphyrite Series† with hardening and freshening of the sediments and volcanics along the central zone.

An outlier or fault block of Upper Esk Series occurs in the Toogoolawah mountains, running from the heads of Scrub and Black Jack's Creeks along the range south-east to Mount Goonnerringgiringi. It consists of massive conglomerates, grits, and shales, usually intensely hardened by the numerous intrusions of felspar hornblende porphyry, dipping steeply (80° to 45°) N.E., and conformably underlaid to the west by the Andesitic Boulder Beds.

The Upper Esk Series lies conformably on the Lower Esk Series of andesitic boulder beds, as may be seen along the junction from Paddy Gully to Neara Creek. The best locality for studying this conformity is on Gregor's Creek, where the rocks at the junction are baked hard and massive (Por. 124v par. Neara). Here boulders consisting of the porphyritic andesite of the true boulder beds are set in a matrix which is clastic, instead of laval or tuffaceous as in the true andesitic boulder beds. This denotes the beginning of the permanent change from the conditions necessary for the formation of the peculiar andesitic boulder beds, to the action of ordinary sedimentary processes; and this point of

* *See* Footnote p. 33.

† *See* Section VII. (C).

change is the point of division between the Upper and Lower Esk Series, and the two are thus closely related. For both are the result of interacting volcanic and sedimentary processes, and while the Lower Esk might be referred to as the Andesitic stage,* the Upper Esk Series might be called the Trachytic stage. In the former volcanic activity was predominant over sedimentation, but in the latter sedimentation was predominant over volcanic activity, and almost to the same degree. In the south, at Paddy Gully, the change from Lower to Upper Esk is seen in trachyte flows and tuffs overlying the Andesitic Boulder Beds.

Relations between the Andesitic Boulder Beds and the Upper Esk Series at Avoca and Arribaby Creeks suggest a faulted junction, perhaps owing to lack of data, and more work may show relations like those of the Neara Creek fracture line.† In the south-western part of the area, the Upper Esk Series is overlaid by the massive current-bedded brown siliceous Bundanba Sandstones. The junction on the west at Cressbrook Creek shows angular conformity, but Messrs. Reid and Morton‡ consider that on the east there is a slight angular unconformity. The Bundanba Sandstone was deposited before the Western Border Faulting, and probably also before the anticlinal fracturing and intrusion.

The volcanic rocks interbedded with the basin sediments of the Upper Esk Series are biscuit-coloured trachytes and trachyte tuffs, with an occasional andesite. They are to be seen best developed in the north-west and south-east corners of the Upper Esk Series. In the south-east corner three flows are to be seen in the Coal Creek syncline, their tuffaceous representatives outcropping in the Paddy Gully monocline. In the north-western corner many trachyte flows and a few andesites and tuffs may be seen interbedded with the gently dipping massive conglomerates and grits on Wallaby Creek, and just to the north of the Ironside Fault. Many smaller outcrops (to be seen on the map) occur throughout the series. These localities are given in the section on Igneous Activity.

The basin sediments found are dark-green conglomerates and grits, olive-green shales, and some carbonaceous seams. The conglomerates have pebbles of from 1 to 4 in. in diameter, set usually in a fairly coarse matrix, which, like the grits, consists largely of fresh mineral fragments. The shales are very fine, sometimes colour banded, and where readily fissile usually rich in fossil plants of the typical Upper Esk facies. A wonderful locality for fossil plants is the "Rock Pool" in Happy Creek, just below the Ironside dam, and nearly all the genera and species characteristic of the Upper Esk Series, with some undescribed forms, occur here in abundance. Where freshened by intrusion, the conglomerates show a composite blue colour on unweathered surfaces. Whether the greenish colour of the unaltered sediments is primarily due to climatological factors during deposition or to the type of rocks from which the sediments were derived is a problem not yet investigated.

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* Reid and Morton, 1923, p. 9.

† *See* Section IV. (B) (*f*).

‡ *Loc. cit.* p. 16.

The investigation of the lateral lithological variations in these basin sediments was too detailed an undertaking for the present reconnaissance. It is fortunate, for future studies, that igneous activity recurred at short intervals during the Upper Esk sedimentation; for by tracing these fixed horizons continuously from east to west and from south to north (a matter of some difficulty and interest owing to the axes of sharp folding and fracturing) the sedimentary variations may be chronologically examined and locality-time-tables drawn up showing the temporal and spatial distribution of the lithological types. From these and from data such as current bedding, elongation of pebbles, lateral variation in size, and in percentage of lithological types of pebbles, it should be possible to determine the direction of currents in the basin, the position of shore lines and feeding rivers, and perhaps also movements affecting the basin during deposition.

The Paddy Gully section seems to be anomalous in the fineness of the sediments and the thickness of the Upper Esk Series, for elsewhere it is of much greater thickness and of much coarser grain. The possibility of Bundanba overlap is regarded as worth investigation.

VI.—THE LOWER ESK SERIES.

The Lower Esk Series, Andesitic Stage or Andesitic Boulder Beds, occupies that part of the Brisbane Valley Trough east of the Brisbane River, and is known to continue north-west to Boonara, a distance of over 100 miles. Why it outcrops no farther south than the Mount Brisbane area is not yet known. Its thickness has not been ascertained, but must be calculable in thousands of feet.

Little is yet known of the movements affecting this series beyond the facts (1) that it dips gently and conformably under the Upper Esk Series to the south-west, (2) that it is sharply uptilted at its eastern faulted junction with the Brisbane Schists, and (3) that some disturbance in the Toogoolawah mountains accounts for an outlier of steeply tilted Upper Esk Series. It is known to have been intruded by the Brisbane Valley Porphyrites near Avoca Vale, on Gregor's Creek, and in the Toogoolawah mountains, and in these places the matrix of the boulder beds is very hard and fresh.

Andesitic boulder beds make up by far the greatest bulk of the Lower Esk Series, hence the retention of the name Andesitic Boulder Beds to emphasize the peculiarity of the stage as compared with an ordinary "andesitic stage." The boulders of the boulder beds are always of porphyritic andesite; and the beds containing them may be divided into types according to their matrix. The first type is one in which the matrix is itself an andesitic flow; and the boulders included are usually very large and round. The second type is one in which the matrix is a tuff and the boulders here are of different sizes and mostly very angular. In a third type the matrix is partly tuffaceous and partly clastic; and the fourth type is a true conglomerate, with its matrix consisting of clastic grains, its boulders rounded and not all of porphyritic andesite. Such a conglomerate outcrops along the road to Kilcoy at Por. 50v par. Kilcoy. Interbedded with the boulder beds are seen andesitic tuffs (in one of which *Nilssonia* cf. *princeps** has been found), andesite flows, rhyolite flows, rhyolite tuffs, tuffaceous grits and shales, the latter often containing plant remains. Thus the Andesitic Boulder Beds were laid down under water, so that in between the periods of volcanic activity short periods of ordinary sedimentary deposition occurred.

Many things remain to be explained regarding this series, e.g.—(1) How did such a tremendous extent of porphyritic andesite come to be broken up into countless millions of boulders of all sizes and shapes and deposited in various matrices in the Triassic Basin? (2) Why does the series not appear south of Mount Brisbane? (3) Why does it not appear on the western side of the trough? (4) What is the relation of the chemical composition of the porphyritc andesite to the Brisbane Valley Porphyrites, the Upper Esk Trachytes, the Permo-Carboniferous volcanics, and the Tertiary volcanics? The study of the lateral lithological variation of the Lower Esk Series would be no less interesting than that of the Upper Esk Series.

VII. IGNEOUS ACTIVITY.

Igneous activity occurred in the down-faulted area four times since the beginning of sedimentation in the basin. The earliest is the andesitic activity to which the deposition of the Lower Esk Series is due; the second is the trachytic activity during the deposition of the Upper Esk Series; the third is the intrusion of the Brisbane Valley Porphyrites while the central folding and faulting was in progress;; and the fourth the Tertiary rhyolitic activity. No chemical or microscopical examinations of the rocks have been made during this work, so that the chemical and mineralogical interrelations of the various phases cannot be properly discussed; and, in the sections which follow, the conclusions drawn have been based on macroscopic examinations of hand specimens only. One fact is obvious, however, and it is that the parent magmas of the Andesitic Stage, the Trachytic Stage, and the Brisbane Valley Porphyrites were of an intermediate type and it may reasonably be inferred that they are closely related one to another. Indeed it may be that the one parent magma was drawn on during all three periods of activity.

(A) Andesitic Boulder Beds.

The boulders of the Andesitic Boulder Beds have been derived from a tremendous quantity of porphyritic andesite, the product of some very extensive igneous activity, probably volcanic. The similarity of type of these boulders over the whole of the area is remarkable; and a general description will cover them all:—Cream or sometimes flesh-coloured felspars, usually lath-shaped and of varying sizes, with some-

* Verbal communication, W. H. Bryan.

times a few needle-shaped hornblendes fairly closely set as phenocrysts in a very fine-grained or glassy matrix, the colour of which varies from red through intermediate shades to bluey-grey or green. The boulders vary in size from 2 in. in dimeter to as long as 4 ft.; while the commonest sizes are 4 in. and 1 ft.

Where the matrix of the boulders is a flow this flow is also a porphyritic andesite, and its greenish matrix has phenocrysts of creamy felspar which are rather stouter than those of the boulders, and tend to be arranged with their longer axes parallel, giving a fluxion structure. Where the matrix is tuffaceous it is generally very weathered, but well-shaped felspars may usually be distinguished in it.

The author has not seen any interbedded andesite flows, but andesitic tuffs are very common. In the Toogoolawah mountains, along Macphail's branch of Black Jack's Creek, two steeply dipping developments of *banded rhyolites* are to be seen interbedded with the boulder beds. Glassy phenocrysts of orthoclase may be distinguished in their grey, waxy matrix. The lower rhyolite is accompanied by a tuff.

As to the age of this volcanic activity, it is later than the movement folding the Permo-Carboniferous beds of Cressbrook Creek and earlier than the Upper Esk Series (of Keuper* age), for it lies conformably below the Upper Esk Series, and the latter is downfaulted against the folded Cressbrook Creek Permo-Carboniferous.

(B) Acid Tuff Stage.

The volcanic rocks of this division consist of a number of trachyte flows and tuffs with an occasional andesite interbedded with the basin sediments of the Upper Esk Series. The flows are biscuit-coloured, due to the limonitic nature of the fine, powdery, rather weathered matrix. Set in this matrix are rather sparsely distributed phenocrysts of lath-shaped or tabular creamy felspars and usually long limonitic patches showing the position of phenocrysts of needle-shaped hornblende; in fresher rocks the unweathered hornblende needles may be seen, and the matrix is then a light-brown colour. Nests of calcite are occasionally seen.

This description applies to all three of the Coal Creek syncline flows and to all those seen on Wallaby Creek and north of the Ironside fault. It also applies to trachytes seen in the Ottaba ridge, to the flow in Por. 42v par. Biarra, to that in Por. 64 par. Esk, to those in Por. 51 par. Esk, and to parts of the Esk trachyte.† Probable trachytes of a grey colour are seen in Por. 139 par. Biarra, and in Por. 71A par. Colinton.

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* Proc. Roy. Soc. Qld. 1930, vol. xli., p. 186.

† This term, by reason of a controversy as to its age and origin (*see* P.R.S.Q. 1930, vol. xli., p. 178), applies to the trachyte a mile west of Esk. Interbedded acid tuffs of the Upper Esk Series are seen just to the west of the "Esk trachyte," but their relation to the "Esk trachyte" is not known. If the "Esk trachyte" should prove to be a flow, as seems likely, then the Esk shales as defined by the author must be regarded as a subdivision of her Acid Tuff Stage, which would then become synonymous with the "Upper Esk Series."

The tuffs associated with these trachytes are also biscuit-coloured, usually fine in grain, but often consisting of fairly coarse angular fragments in a finer matrix, e.g. those associated with the middle trachyte of the Coal Creek syncline, the tuffs of Paddy Gully, those in Por. 30 par. Esk, and those associated with trachytes in the Ottaba ridge. Coarse acid tuffs are interbedded with the steeply dipping conglomerates in the Yimbun railway cuttings, and in the gently dipping Upper Esk or Neara Creek. Fine-grained tuffs are associated with a very weathered trachyte flow on the northern boundary of Por. 18 par. Biarra. Trachyte tuffs are not common in the Wallaby Creek beds.

Andesite flows in the Upper Esk Series are occasionally seen. They usually show needle-shaped phenocrysts of a glassy felspar and hornblende in a fine grey-green matrix, e.g. Paddy Gully andesite, but those on Wallaby Creek take on a different texture, glassy rounded felspars in an iron-grey matrix. Cliffs of an (?) augite andesite conformable with the bedding of the Upper Esk shales are seen on Gregor's Creek (Por. 124v), but this development is possibly intrusive.

(C) The Brisbane Valley Porphyrites.

This is the name proposed for an important series of intrusive rocks discovered piercing the Esk Series along lines of anticlinal fracturing in the Brisbane Valley. The intrusions are all porphyritic in texture and intermediate in chemical type, and have not been responsible for any mineralisation of the injected sediments. They are all distinctly related to one another, and the following general description covers any one of them:—Abundant large phenocrysts of felspar and hornblende set in a fine-grained grey matrix. Nevertheless for purposes of more detailed description they can be divided into several sub-classes, and these, with the localities in which they are to be found and the nature of the intrusion, are seen below:—

(*a*) The felspar and hornblende phenocrysts are present in about equal proportions—

(i.) The rocks are truly porphyritic. This type is seen in the Mount Beppo intrusions and in Pors. 81 and 82 par. Cressbrook, Moreton (Toogoolawah mountains). These intrusions are transgressive.

(ii.) The rocks are nearly equigranular, due to the very small development of matrix. This type is seen in the slightly transgressive intrusions of Moorabool and the Sugarloaf paddock.

(*b*) The felspar phenocrysts are very large, and very few and small hornblendes are present—

(i.) The felspars are stout. These are seen in the slightly transgressive sheets of Gregor's Creek (pink felspar) and the sills of the Yimbun railway cutting and Neara Creek.

(ii.) The felspars are tabular, twinned along the narrow axis. These are seen in the core-like intrusion at Nurinda and Colinton. Associated with it at Nurinda is a beautiful green mottled rock, the spots consisting of radiating lath-shaped crystals of felspar and hornblende.

(*c*) Large phenocrysts of hornblende are developed almost to the exclusion of felspar phenocrysts. The hornblendes are idiomorphic with beautifully developed faces, and all are complete crystals, neither fractured nor corroded. This type occurs in Por. 1 par. Biarra.

(*d*) Small idiomorphic hornblendes and large white felspars form a spotted rock. No groundmass is present. This is the intrusion which forms the Goonnerringgiringi cliffs.

(*e*) Instead of hornblende, the ferro-magnesian phenocrysts are augite, and the felspars are small. These are the Ottaba augite andesites described by Richards.*

This Brisbane Valley Porphyrite series is quite new, and opens a very interesting field of study to the petrologist. The Mount Brisbane grano-diorite and related intrusions are in all probability part of it. The Porphyrites were intruded before the extrusion of the Tertiary Ottaba rhyolite, for the latter lies unconformably on Upper Esk sediments intruded by the Ottaba augite andesites. A coarse-grained intrusion of felspar and hornblende rock lies between the Upper Esk Series and the Bundanba sandstones on Paddy Gully. If, as seems likely, this sill can be shown to belong to the Brisbane Valley Porphyrites, the date of intrusion of the latter could be fixed as post-Bundanba.

(D) Miscellaneous Igneous Rocks.

The Ottaba and Glen Rock Tertiary rhyolites have both been described by Dr. Richards.† A third development of Tertiary rhyolite is seen on the Kipper and Cressbrook and Buaraba divides, and is a northern finger from the Buaraba rhyolites reported on by Mr. Reid.‡ Heavy developments of rhyolites of unknown relations are seen in the Stanley Gorge and east of the Brisbane River at Murrumba. A basalt overlies the tilted Upper Esk Series at Biarra, and a fine-grained andesite occurs in Por. 31v par. Biarra.

Brief Notes on the Occurrence of Igneous Rocks in the Palæozoics along the Western Boundary of the Trough.

A considerable development of a light-coloured quartz porphyry occurs associated with the fossiliferous beds of Permo-Carboniferous age at Cressbrook Creek. Its relationships have not been ascertained.

Very compact andesitic and (?) spilitic rocks form a considerable

* Proc. Roy. Soc. Qld. 1916, vol. 27, p. 159.
† Proc. Roy. Soc. Qld. 1916, vol. 27, p. 139.
‡ Reid, 1923, Qld. Govt. Min. Jrnl. p. 463.

part of the (?) Devonian basement in the upper part of the Cressbrook Creek area. Weathered (?) Devonian andesites are seen in Por. 30v par. Biarra.

A pink quartzitic granite is seen north of Sandy Gully school, associated with a fine-grained andesite with small glassy phenocrysts of felspar.

In Por 112 an augite diorite is intruded by a similar andesite, and in Por. 114 the augite diorite intrudes a grey biotitic granite (like the Eskdale granite). This grey granite intrudes in its turn the weathered andesites interbedded with the Fernvale jaspers in Por. 114.

On Happy Creek (?) Devonian vesicular andesites occur, and this series is intruded farther to the west by a fine andesite.

VIII.—POSSIBLE PRESENCE OF COALFIELDS.

Of the Mesozoic formations of the Brisbane Valley between Esk and Linville, only the Upper Esk Series might be regarded as having been deposited under conditions favourable to the formation of coal. This important conclusion was reached for the following reasons:—

1. The Lower Esk Series is almost entirely volcanic.
2. The small area of Bundanba sandstone is, as in the Ipswich field, quite barren.
3. No equivalent of the Ipswich coal measures occurs here between the Upper Esk Series (or Basal Ipswich conglomerate) and the Bundanba sandstone.

The work done in the area shows that the chance of finding payable coal is still further restricted by the following considerations:—

1. The closeness of the lines of sharp anticlinal fracturing and intrusion leaves little space between for the extensive occurrence of flat-lying seams.
2. The rapid fluctuation in the conditions governing sedimentation in the basin, as shown by the rapid alternation and lateral change of coarse conglomerates, grits, and shales, has precluded any continuously extensive coal horizons being formed.

There is a possibility, however, that synclinal areas may have in some places coincided with a part of the original basin where the conditions of deposition were favourable to the formation of coal. If such could be found, then there would be an opening for a small colliery or collieries to supply the industries of the Brisbane Valley. A map has been drawn up to show the probable extent of coal in those localities where coal has been found to outcrop. The localities are numbered as in the descriptions below.

(A.) The existence of coal in small quantities had been reported from the following localities before the work was undertaken:—

(1) A carbonaceous seam just outside the town of Esk in a well in Por. 33 par. Esk had been reported on by Dr. E. O. Marks* as not large enough to be remunerative to work. It occurs in a gentle monocline, and the area is thus structurally suitable; but judging from the outcrops this monocline is not promising.

(2) In the same report Dr. Marks mentioned several small seams outcropping at the junction of Coal Creek and the Brisbane River. These he also considered economically unimportant. The Coal Creek syncline, the structural unit to which I refer these small seams, is structurally favourable but does not appear to contain payable coal, since these indications are the only ones noted from it. An analysis of this coal gives:—

	Per cent.
Moisture	2·05
Volatile H.C.	23·10
Fixed C.	61·10
Ash	13·30

(3) Dr. Marks also noted thin coaly bands in the railway cuttings and the hills about Ottaba, but spoke of this area as being so disturbed as scarcely to be desirable for prospecting. My map shows that the Ottaba area lies on the Ottaba axis of sharp anticlinal fracturing and intrusion, so that even large deposits here would scarcely be payable.

Mr. Morton† had examined two occurrences of coal in the Toogoolawah mountains.

(4) The first of these, found in one of the heads of Black Jack's Creek behind Governor's Rock, was a 7-ft. seam of good bright coal which was, however, standing vertically. Its analysis was—

	Per cent.
Moisture	8·9
Volatile H.C.	23·4
Fixed C.	60·6
Ash	7·1

He reported unfavourably on this, as the area was obviously one strongly affected by movement and intrusion, and very mountainous.

(5) The second occurrence was at the head of Splitter's Creek, on the Stanley side of the divide. Here there were several small seams, also vertically disposed. My work shows that the Toogoolawah mountains may be regarded as a very

* Qld. Govt. Min. Jrnl. 1912, p. 322.

† Unpublished Report to Geol. Survey of Queensland.

unlikely area for the occurrence of payable coal. All the strata are affected by a disturbance which is probably the greatest of the Brisbane Valley, and which is accompanied by much the largest intrusions.

(6) While on a coach journey from Esk to Nanango in 1901 Mr. Ball* noted several coaly outcrops on the road at the foothills to the Blackbutt Range as worth prospecting. I found here a number of seams of bright coal dipping gently to the east with a maximum thickness of about 20 in. But, half a mile to the east, the Stone House Disturbance affects the strata, and cuts out any possible extension of the coaly seams farther to the east; and I do not believe enough coal could be mined to justify the opening of even a small colliery. Nevertheless, this occurrence is the most promising I have seen.

(B) The following occurrences are noted for the first time:—

(7) Two miles from Esk on the Esk-Murrumba road in Por. 56 par. Esk, three small bands of carbonaceous material are seen. The structure is favourable, being a small syncline auxiliary to the Coal Creek syncline, but the coal is not there in sufficient quantities to warrant the establishment of a mine.

(8) On Happy Creek, about half a mile below the Ironside Dam in Por. 132 par. Colinton, a 30-in. seam of bright coal outcrops, accompanied by several smaller bands, interbedded with conglomerates and extraordinarily fossiliferous shales. The dip, however, was 50° N.E. This coal outcropped in the strata uptilted by the Western Border Fault and the prolongation of the Ottaba axis of anticlinal fracturing. It was thought that the seams might be tapped in the gently dipping synclines to the east, but the seams were found not to be persistent along the line of strike.

(9) Thin coaly bands, steeply tilted for the same reason as the Happy Creek seams, were seen on the road half a mile north-east of Happy Creek seams and in the gully to the east of the road.

(10) On the road between Moore and Colinton a few thin coaly seams are seen. But this is in a region intensely disturbed by the strong Colinton axis of sharp anticlinal fracturing and intrusion, and is consequently of no promise.

(11) Similar bands are seen on the road between Linville and Avoca Creek, but these are of no promise for the same reason as occurrence No. 10.

* Geol. Sur. Qld. Pub. 159, p. 16.

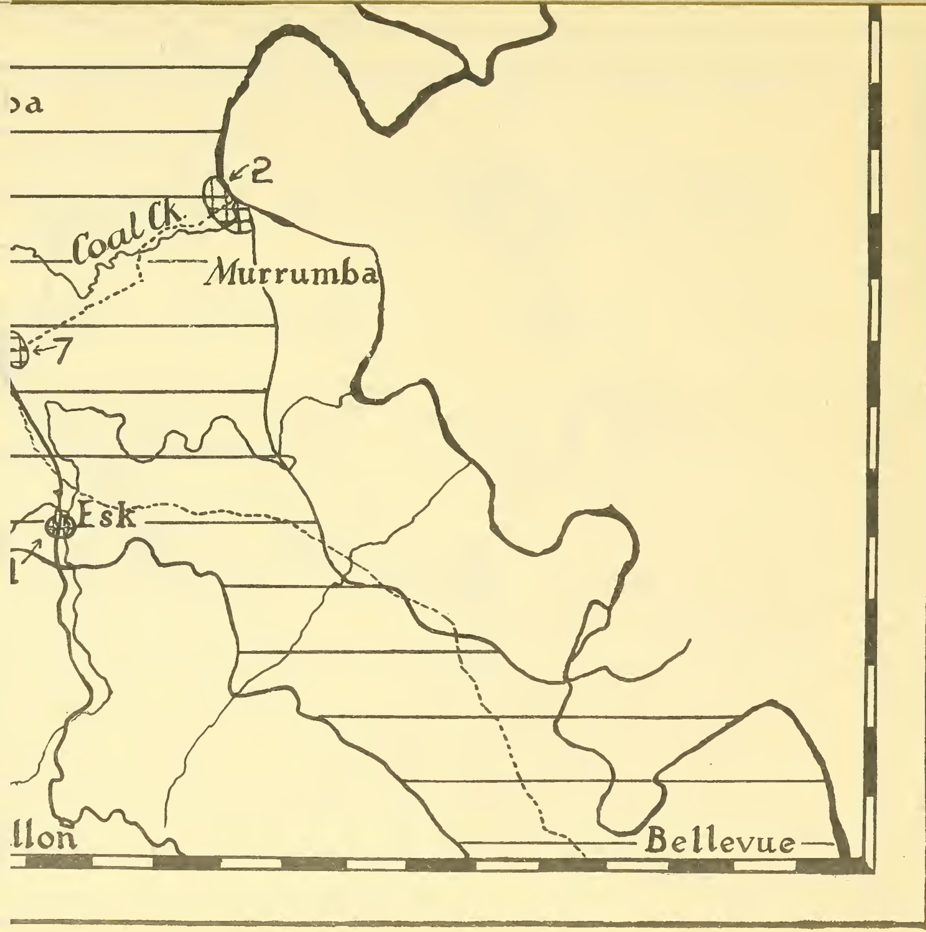
(C) The following negative evidence is of value:—

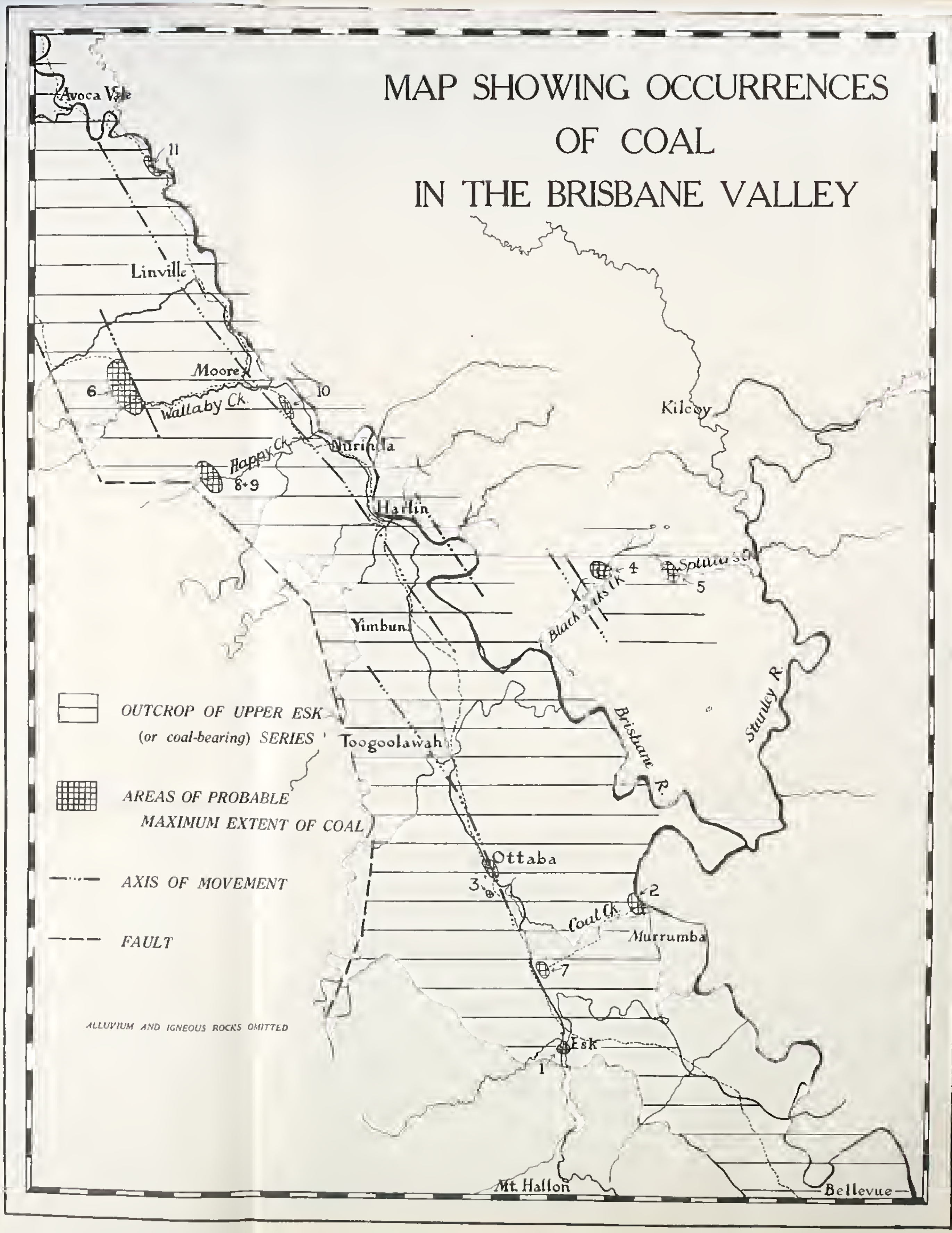
No indications of coal were seen in the ridges and gullies of the Glen Harding and Maronghi synclines, or in that part of the Wallaby syncline south of the Moore-Benarkin road, during traverses over these synclines. The Wallaby syncline north of the Moore-Benarkin road has not been prospected.

IX.—SUMMARY AND CONCLUSION.

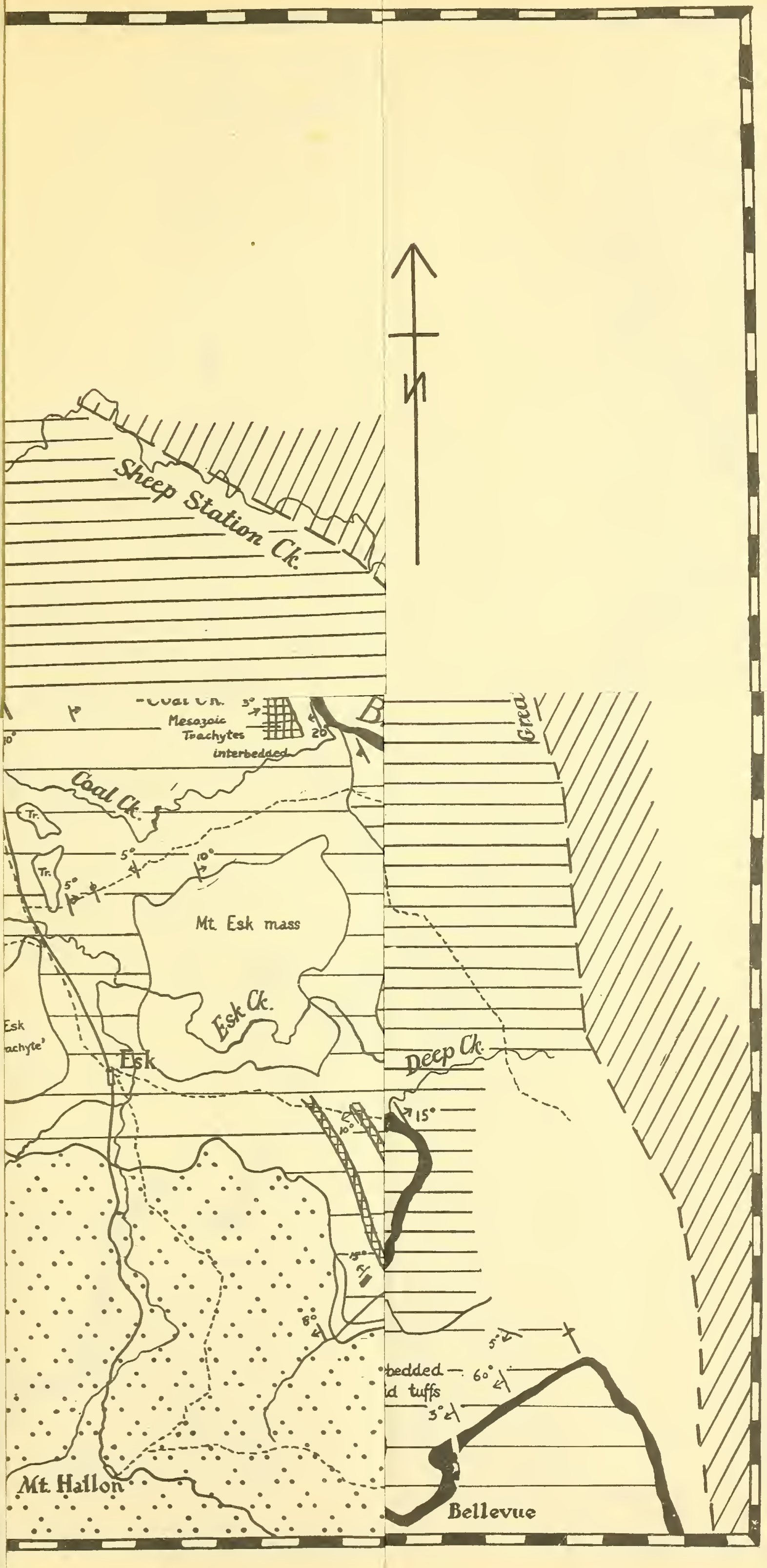
In the Brisbane Valley between Esk and Linville a series of Triassic rocks is trough-faulted along the north-westerly grain of the country into the Palæozoic (including folded Permo-Carboniferous) formations. These Triassic rocks, the Esk Series, are freshwater basin deposits laid down by rapidly changing currents, with intensive contemporaneous volcanic activity. The Lower Esk Series is typified by very intense andesitic activity, with the formation of a great thckness of peculiar andesitic boulder beds, small sedimentary deposits being formed during periods of temporary cessation of volcanic activity. The strictly conformable Upper Esk Series, however, is typified by a thick development of rapidly varying sedimentary deposits, with interbedded flows and tuffs resultant from intermittent trachytic activity. Above the Upper Esk Series, the Bundanba sandstones, now all eroded away except from the southern part of the area west of Esk, were deposited without angular unconformity. In addition to the trough-faulting, the Esk Series has been strongly affected by sharp north-westerly directed anticlinal fracturing, accompanied by the intrusion of an important series of hypabyssal rocks, the Brisbane Valley Porphyrites, closely related in mineralogical type to the flows and tuffs of the period of sedimentation. The time relations of the trough-faulting and anticlinal fracturing are unknown, but they both occurred before the extrusion of the Tertiary rhyolites.

It is concluded that the conditions of deposition and the type of folding of the Esk Series do not promise well for the occurrence of a large field of workable coal, but that the synclinal areas are worth more detailed mapping in the chance of the discovery of a deposit large enough to support a small colliery.


Coal Ck.
Murrumba
Esk
Bellevue
2
7
1



MAP SHOWING OCCURRENCES OF COAL IN THE BRISBANE VALLEY
Avoca Vale
11
Linville
Moore
6
Wallaby Ck.
10
Kilcoy
Nurinda
Happy Ck.
8+9
Harlin
4
5
Black Snakes Ck.
Yimbun
Brisbane R.
Stanley R.
OUTCROP OF UPPER ESK (or coal-bearing) SERIES
Toogoolawah
AREAS OF PROBABLE MAXIMUM EXTENT OF COAL
Ottaba
AXIS OF MOVEMENT
3
2
Coal Ck.
Murrumba
FAULT
7
ALLUVIUM AND IGNEOUS ROCKS OMITTED
Esk
1
Mt. Hallon
Bellevue



N
Sheep Station Ck.
Coal Ck.
Mesozoic
Trachytes
interbedded
Coal Ck.
Tr.
Tr.
Mt. Esk mass
Esk Ck.
Esk
Deep Ck.
Mt. Hallon
Bellevue
bedded
tuffs

GEOLOGICAL SKETCH MAP
OF THE
COUNTRY BETWEEN
ESK AND LINVILLE
Scale of Miles
ALLUVIUM.
TERTIARY VOLCANICS
BUNDANBA SANDSTONE.
BRISBANE VALLEY PORPHYRITES
UPPER ESK SERIES
TRACHYTES (of Upper Esk Series)
LOWER ESK SERIES.
TRIASSIC
GRANITE
PERMO-CARBONIFEROUS
BRISBANE SCHISTS.
Avoca Vale
Louisavale
Monsildale Ck
Arrababy Ck.
Sheep Station Ck.
Kangaroo Ck.
Linville
Colinton Axis
Stone House Dist.
Moore
Wallaby Ck.
Spring Ck.
Colinton
Nurinda
Happy Ck.
Ironside Fault
Emu Ck.
Kilcoy
Royston
Villeneuve
Mt. McConnell
Goonneringjirring
Splitter's Ck.
Moorhool
Scrub Ck.
Cressbrook
Toogoolawah
Ottaba Axis
Cressbrook Ck.
Mt. Beppo
Mt. Brisbane
Granodiorite
Rhyolite
Rocky Ck.
Coal Ck.
Brisbane R.
Murrumba
Rhyolite
N. Gallinani Ck.
Mt. Esk mass
Esk Ck.
Esk
S. Gallinani Ck.
Paddy Ck.
Redbank Ck.
Ettswold
Mt. Hallon
Interbedded acid tuffs
Bellevue
Great Fault

Essential Oils from the Queensland Flora.

Part I.—*BÆCKEA VIRGATA.*

By T. G. H. JONES, D.Sc., and M. WHITE, M.Sc.

(*Tabled before the Royal Society of Queensland, 28th April, 1930.*)

Bæckea virgata is a tall erect and closely branched shrub growing along watercourses in the Brisbane area, being particularly abundant and of vigorous growth on the banks of the Woogaroo Creek, Goodna. Its botany is described in the Queensland Flora (Bailey).[1]

On crushing the leaves a strong odour of cineol is readily detected. The yield of oil obtained on distillation was 1 per cent. Examination of its chemical constituents showed that the oil consisted very largely of d-α-pinene 50–60% cineol 30% together with aromadendrene, a sesquiterpene alcohol, and a trace of a lower alcoholic body diagnosed tentatively as pino-carveol.

In view of the large quantities of pinene and cineol present the oil has some economic value.

EXPERIMENTAL.

353. lb. of leaves and terminal branches collected along Woogaroo Creek, near Goodna, on the 21st August, 1929, and distilled on the 22nd, gave 1,560 ccs. of oil, the greater part of the oil distilling over in a couple of hours.

The following constants were determined:—

$d_{15\cdot5}$	·9021
$n_{20 D}$	1·4742
$[\alpha]_D$	+18
Acid number	1
Ester value	nil
Acetyl value	17

No absorption in the usual reagents, except for cineol, could be detected.

1,000 ccs. of oil were fractionated under diminished pressure and the following fractions collected:—

Fraction.	Ccs.	Temp. Range °C.	Pressure.	$d_{15\cdot5}$.	n^{20}_D.	$[\alpha]_D$.
1	317	0 – 55°C.	24 mms.	·8705	1·4679	+ 36 0
2	242	55 – 65°C.	24 mms.	·8825	1 4670	+ 26·0
3	110	65 – 75°C.	24 mms.	·9200	1·4602	+ 0·9
4	30	75 – 85°C.	24 mms.	·9305	1·4691	– 3·0
5	53	85 – 105°C.	24 mms.	·9500	1·4895	– 6·5
6	97	82 – 95°C.	8 mms.	·9337	1·4958	+ 5·5
7	112	95 – 108°C.	8 mms.	·9512	1·5005	+ 2·8
TOTAL	961	Resinous loss, 40 ccs.				

Fractions 1 and 2 were repeatedly extracted with 50% resorcin solution to extract cineol.

The residual oil after refractionation possessed the following constants:—

$d_{15 \cdot 5}$	·8641
$n_{20 \atop D}$	1·4660
$[\alpha]_D$	+43
b.p.	155–156°C.

Identification with pinene was established by the usual oxidation to pinonic acid, the semicarbazone of which melted at 204°C. No β pinene could be detected.

Fraction 3 consisted of relatively pure cineol. Independent determination of this constituent on the original oil gave a value approximating 30%.

Fractions 4, 5, and 6.—The noticeable increase in density in fraction 5, with a diminution in fraction 6, pointed to a constituent of somewhat higher density in these fractions, with a higher boiling point than that of cineol but lower than that of the sesquiterpene fraction 6, and therefore probably a terpene alcohol. They were accordingly refractionated as far as possible, and the small amount of resulting oil combined with phthalic anhydride by boiling with this reagent in benzene solution for several hours. Decomposition of the acid phthalate gave an alcoholic body with the following constants:—

$d_{15 \cdot 5}$	·974
$n_{20 \atop D}$	1·4965
$[\alpha]_D$	—23
b.p.	220°C.

The constants appeared to agree only with those recorded for pino-carveol, a somewhat rare alcohol occurring in *Eucalyptus globulus*.

Combustion Results—

Found C 79·1, H 10·8.

$C_{10}H_{16}O_0$ (pino-carveol) requires C 78·9, H 10·5.

Confirmation of the identity of the alcohol with pino-carveol was sought in attempts to prepare the phenyl urethane, but we were unable to obtain sufficient of this derivative for complete purification, although the melting point (79°C.) approximated to that required for this derivative 82°C.

This alcoholic body is only present in very small quantities in the oil, the total amount obtainable from the 1,000 ccs. being only about 2 ccs. It would therefore probably escape detection in small amounts of oil.

Fractions 6 and 7 were further refractionated and separated into a sesquiterpene and sesquiterpene alcohol fraction.

The sesquiterpene, purified by repeated distillation over sodium, possessed the following constants :—

b.p.	92–95°C. (7–8 mms.)
$d_{15\cdot5}$	·9181
$n_{20 \atop D}$	1·4985
$[\alpha]_D$	+11

The usual colour reaction with bromine vapour suggested the presence of aromadendrene, the characteristic sesquiterpene of the Myrtaceæ. The combustion results agreed with $C_{15}H_{24}$.

Sesquiterpene Alcohol.—

The final fraction, purified as far as possible by repeated distillation, possessed the following constants :—

b.p.	105–107°C (4–5 mms.)
$d_{15\cdot5}$	·9656
$n_{20 \atop D}$	1·4992
$[\alpha]_D$	—·6

Combustion Results.—

Found C 82·6%, H 11%.

$C_{15}H_{24}O$ requires C 80·2%, H 10·9%.

Evidently a sesquiterpene alcohol was the preponderating constituent of this fraction still in admixture with aromadendrene. Its small amount precluded further examination.

Our thanks are due to the Council for Scientific and Industrial Research for a grant which has defrayed the cost of collection of leaves, to Mr. C. T. White for his usual botanical assistance, and to Miss D. Hill, M.Sc., who assisted in the collection of leaves.

REFERENCE.

1. Queensland Flora, F. M. Bailey, 585 (5).

The Physiographical Significance and Non-migration of Divides.

By E. O. MARKS, B.E., M.D.

Two Maps.

(*Read before the Royal Society of Queensland, 26th May, 1930.*)

IN the theoretical consideration of stream development as described in physiographical literature generally, and particularly by that giant amongst physiographers, Professor W. M. Davis, the headward erosion of streams or migration of divides, with the changes resulting therefrom, have been given very great importance, and even a nomenclature implying origin by this theoretical process of development.

Griffith Taylor and most other writers on Australian physiography have given a corresponding importance to the process in the interpretation of our own river systems. It is to be noted that they have usually given attention only to the river courses and none to the divides separating their basins.

This paper is intended to draw attention to certain divides which seem to the writer to indicate that the fundamental theory cannot be entirely correct. An examination into the theory suggests, as do the divides themselves, that "migration" can only be of very minor importance except in very unusual circumstances in regions of great elevation, and that it is quite incapable of the results usually claimed for it.

Professor Davis fully describes the theoretical migration of divides resulting from the encroachment by headward erosion of one stream at the expense of the drainage area of another less advantageously situated for erosion. This would take place more quickly in soft rocks than in hard, and lead to the development of valleys and streams in the softer rocks and so to a rearrangement of the drainage in accordance with geological structure.

It is not desired here to recapitulate the details of the supposed stream development, with river captures and so on, and the nomenclature given, but it is necessary to emphasize the dependence of it all on the occurrence, as a very active denudational principle, of this encroachment by any stream possessing an erosional advantage over its competitor on the other side of a divide. Without this headward encroachment the whole scheme is void, and only in so far as this encroachment takes place can the scheme be valid.

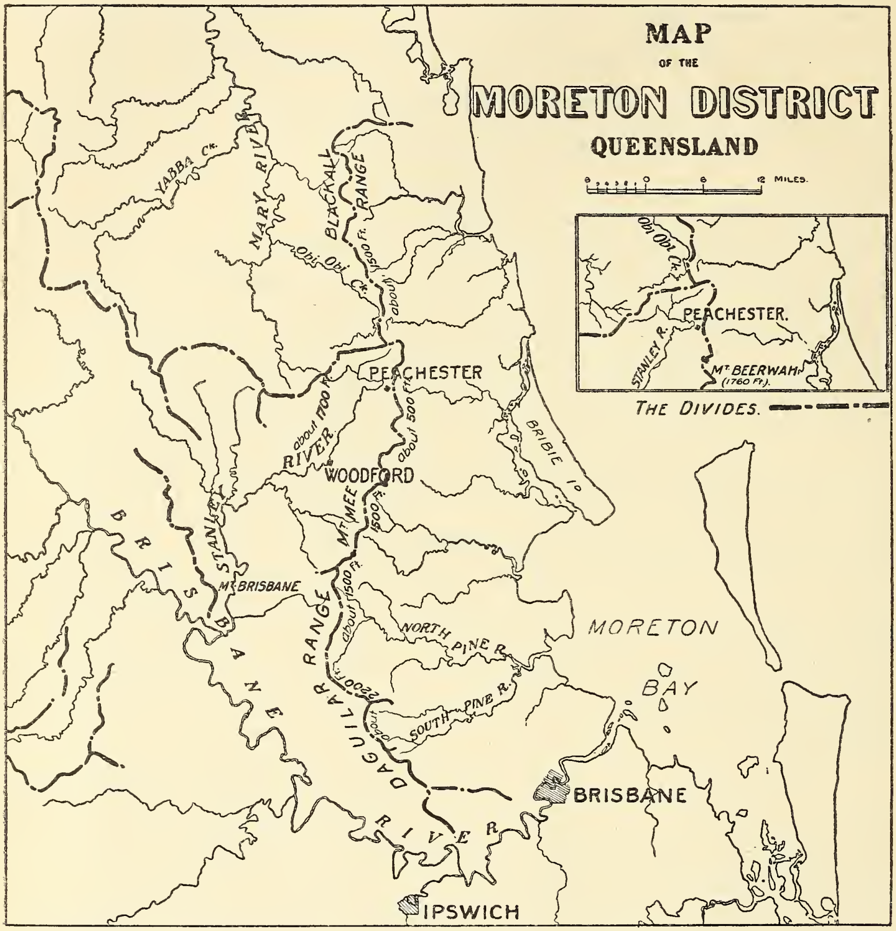
Structure and climate being equal on the two sides of a divide, if one side has a bigger fall, steeper slopes, and therefore more active streams than the other, denudation will be greater on that side, with a consequence that headward erosion will take place, the drainage area of the more active stream gaining at the expense of the less active one. There is, of course, no question that this must take place to some extent; views such as one gets of the Toowoomba Range show it clearly, but the question raised here is as to whether the process does take place sufficiently to affect appreciably the general physiographical development.

According to the theory the migration of a divide must necessarily be somewhat irregular, for it will depend on the relative slopes and stream gradients of the two sides, on the resistance of the rocks, on climate, vegetation, and probably other factors not so obvious. Since these conditions cannot be equal throughout, one portion of a divide must migrate more rapidly than another. If originally straight denudation must make it crooked. It could only remain straight if the original elevation, slopes, stream gradients, rock structure, climate, &c., were uniform throughout the whole length of the divide, which is practically an impossible occurrence. Apart from developing the linear outcrop of a resistant rock we may be quite certain that denudation could neither make a crooked divide straight nor develop a straight or evenly curved one. Only some geological structure could give rise to it, such as a faulting, folding, or warping of the earth's surface.

A straight divide must therefore be what Davis calls a "consequent" divide—i.e., a consequence of an original water parting. An irregular divide might also be "consequent," the result of some original irregular water parting, or it might result from subsequent denudation and be what has been termed "subsequent." It is to a consideration of some approximately straight divides and their bearing on the theory of migration that the writer would call attention.

To the north of Brisbane the D'Aguilar and Blackall Ranges form, with very minor local irregularities, one nearly straight divide, except at the southern end, where it bends from a north-south to a south-easterly direction. It separates the watersheds of the numerous short streams which run easterly courses directly into the sea, having courses up to 30 miles in length, from those of the streams which run westerly into the Upper Mary and Brisbane Rivers, the water in these having up to 180 miles to travel to reach the sea.

The geological structure is very varied, as is the elevation and character. At the southern end the rocks consist of the partly metamorphosed sediments we call the Brisbane Schists, and one or two small cappings of basalt. The elevation rises to over 2,000 feet. There is a gap near the head of the North Pine River where the elevation is down to 1,000 feet, but it rises again to the north, where the divide is on the tableland of Mount Mee at an elevation of 1,500 feet and composed of more basic schists and some basalt. After some 10 miles on the tableland the divide drops to about 500 feet for some 12 miles, separating here the wide valley of the Stanley (Jensen's Woodford peneplain) from the lower coastal country. The divide here is partly of deeply decomposed granite but mainly of soft sandstone, and from it rises the trachyte plug of Mount Beerwah to a height of 1,760 feet. North of Peachester, for another 12 miles or so the divide is on the eastern edge of the basalt capping which forms the Blackall Range tableland, about 1,500 feet high, the western fall being into Obi Obi Creek and thence to the Mary River.



The most interesting part of the divide for our present purpose is the 12 miles or more at an elevation of only 500 feet, composed of soft rocks, having a wide "peneplain" valley to the west of it and the low coastal plain to the east, while to the north and south the divide is on tablelands of harder rocks, with an elevation of about 1,500 feet. From the divide itself rises the trachyte plug to 1,700 feet, and the other Glass House Mountains rise in a similar way from the coastal plain, while to the west of the Stanley is a flat-topped mountain, more or less a continuation of the Blackall Range and 1,700 feet high. The Stanley itself near its junction with the Brisbane has cut a gorge through Mount Brisbane, the lower side of which is of much greater elevation than the low divide, and the higher side, Mount Brisbane, is over 2,000 feet above the sea.

It seems, therefore, perfectly certain that extensive denudation has taken place, while differential denudation would fully account for the low elevation and the character of this portion of the divide. How much has been removed it is impossible to say, but it cannot have been less than 1,000 feet to bring it up to the present level of the tablelands to the north, west, and south.

Now let us look at the map to observe the extent of encroachment by the very short streams running direct to the sea over soft sandstone country, these having obviously an enormous advantage as compared with the waters running into the Stanley with 180 miles to go, much of it over hard rocks. We look in vain, for the divide is deviated only in the most trivial manner, the deepest recess being less than 2 miles in from the eastmost prominence, and the mean position not being shifted westwards at all as compared with the higher divide to north and south. Moreover, any suggestion that the straight divide might be of the nature of a fault scarp is definitely precluded to the north by the geological structure (the basalt not being faulted down), and to the south by the occurrence of high ground to the east of the actual divide.

If we look at the map for signs of river capture as indicated by the directional changes in the streams, attention is at once caught by the uppermost portions of the Obi Obi and Stanley. Initially both these streams, the one on top of the Blackall tableland and the other below it, run parallel courses eastwards as if making straight for the sea, but when within a mile of the divide change their courses to the north-west and south-west. What the cause of this remarkable change in direction could have been we need not speculate upon, but this is certain, that if a sudden change of direction has any real value as an indication of river capture, then the Obi Obi and Upper Stanley with long courses and attacking from opposite directions have succeeded in capturing the head-waters of two adjacent short streams whose present lower courses are at a much lower elevation than either of the attacking streams. Which is absurd.

A consideration thus of the D'Aguilar-Blackall divide shows that stream development has not taken place as it should have done, and indeed must necessarily have done according to the widely accepted theory.

Since straight or regularly curved divides must be original divides and not "subsequent" we may inspect the map for other straight divides and see what indication for or against migration these may give.

Taking first the Main Divide—Dividing Range is a misnomer—which separates the Pacific drainage from the western flowing rivers, we observe a regular nearly straight length of almost 300 miles separating the Burdekin waters from the Thomson, Barcoo, and Flinders. This divide traverses the tableland on which are the inland basins of Lakes Buchanan and Galilee, and these introduce a choice in their vicinity as to where the Main Divide is situated. Dr. Danes regarded them as evidence that the divide is recent. There is certainly no suggestion of irregular migration in this 300 miles which runs from the chief water-parting centre of the North, whence the drainage runs by the Einasleigh, Gilbert, and Flinders into the Gulf of Carpentaria, by the Thomson into the inland system and by the Burdekin to the Pacific, to the similar parting centre near Tambo whence water drains into the Barcoo of the inland system, the Warrego of the Darling-Murray system, the Nogoa of the Fitzroy and the Belyando of the Burdekin system, the two latter both entering the Pacific.

For about 150 miles from near Tambo the divide is irregular, but the portion running nearly east and west for 150 miles from near Mitchell to near Chinchilla is again regular and separates the Condamine waters of the Darling-Murray system from the Dawson of the Fitzroy system and the Auburn of the Burnett. It is to be noted that the latter has not eroded back the divide in comparison with the Dawson, which has a much longer course.

Near Chinchilla the direction of the divide changes and runs nearly straight for 100 miles in a south-easterly direction, parting the Condamine waters on the one side from those of the Boyne (Burnett) and Upper Brisbane. Though these two have very different courses, and have both been competing against the Condamine waters on the other side of the divide, there is no deviation to indicate that one has gained more than the other, as it surely must have done according to the theory. The divide remains straight, apparently in its original position.

In the region of Toowoomba the map is very suggestive of some minor nibbling back of the divide by the heads of Lockyer Creek, of the Brisbane River basin. Just here there is no range as one approaches the divide from the west or Darling Downs side, and the Lockyer is draining the scarp of a tableland some 1,500 feet above it. Even with this great advantage the headward nibbling does not seem to be a matter of more than 3 or 4 miles, and the wide Lockyer valley a few miles from the escarpment has the characters of an old stream.

South from Toowoomba the Main Divide is a range of mountains as approached from the west, nearly as steep though not so high as on the eastern side. The divide varies in elevation from about 2,000 feet in the gaps to 4,000 on the peaks, but shows no appreciable deviation to indicate headward encroachment by the varied streams draining its lower eastern side, although the gorge cut by Reynolds Creek through the trachyte mountain of Mount Edwards shows that denudation of at least 2,000 feet has occurred.

Apart from the Main Divide there is one remarkably straight line of water parting which immediately catches the attention on looking at the map of Queensland. This runs for 250 miles from near the coast at Mackay southwards to near Camboon, where it turns a little west of south and continues straight for another 100 miles to join the Main Divide. This long regular water parting separates the basin of the Mackenzie-Dawson system from the streams on the east of it—namely, the very short coastal streams in the Mackay-St. Lawrence region, the lower part of its own combined stream the Fitzroy, the subsidiary basin of the Don, and the Burnett waters. This long line is only crossed by two streams, the Don crossing it from east to west to join the Dawson, and the main combined stream crossing it from west to east on its way to the sea.

This long straight divide, like the parallel courses of the Dawson and Mackenzie, must have some, probably the same, tectonic origin. It varies greatly in character and geological structure, and in the length of the streams attacking it, but denudation has not caused any serious deviation. One could hardly suppose that the Lower Fitzroy alone of all the streams attacking it from the eastern side has succeeded in breaching it and also in capturing the main stream, while the Don a tributary of that main stream attacked and breached it from the west, capturing some of the eastern waters, the while the rest of the divide has not been deviated to any appreciable extent, even by the very short coastal streams at the northern end.

The late Dr. Danes suggested that the compound systems of the Burdekin and Fitzroy had formerly been inland basins which had found egress to the sea by the present combined lower streams. Such an explanation would fit well with the apparent non-migration of the divide if the egress was found by overflow through a low or lowered part of the divide rather than by the usual idea of river-capture by headward encroachment, and similarly for the Don in the opposite direction.

A consideration thus of these Queensland divides, some at least of which have been subjected to extensive denudation, does not seem to show that headward encroachment, with resulting deviation, has taken place to any significant extent, as it certainly should have done if the physiographical theory is correct. Though formerly accepting it, the writer has thus felt compelled to examine the theory for some flaw in what had previously appeared sound reasoning. Whether the explanation now offered is the true one is very questionable, for like the original theory it is purely theoretical. What we must face is the cold fact that migration has not taken place to any appreciable extent in just those very circumstances where it would necessarily have done so had the present widely accepted theory been substantially correct.

In his essay on the Geographical Cycle, W. M. Davis has a paragraph on the development of graded valley sides, a grading which can only take place after the stream itself has become graded. He says, "Maturity is passed and old age entered upon when the hill-tops and hill-sides as well as the valley floors are graded." The grade of both stream and valley will become flatter as denudation lowers the general level and so alters the conditions. The grade of a valley side must depend on the climatic conditions, the nature of the rock, and the elevation of the valley side. Once graded, a flattening of the grade can only take place by a reduction of the elevation. If the elevation persists then the grade must also persist suitable to that elevation, so that the grade will not become flatter, for instance, on the sides of a tableland until the level of the tableland is lowered.

We must fully realise that, except for the trivial effect of river meanders, denudation is entirely vertical. A waterfall is only cutting down the bed of the stream; it is not cutting it back in any way, or altering the drainage area; it is merely lowering an already existing valley.

Davis's diagrams give the impression of a young stream cutting back and gaining more ground as it entrenches itself, whereas the position and drainage area must have been determined for it *ab initio*. The water collected in the original depressions would carve down and develop the valley. Since it is the water that is doing the carving, the valley must be formed where the water happens to run, and the entrenchment of the valley can only follow up the already existing stream, for elsewhere there is no water. It cannot pick out soft structures since the lowering of the surface, no matter how soft, cannot get below the streams into which it drains. As a stream only cuts down its bed, after the manner of a saw in its groove, it has got to cut whatever rocks it meets with in its groove.

The cutting is done by rain-water particularly when collected into streams and (it must be repeated) is entirely vertical. The original water parting, where there is no stream, must therefore be quite unaffected except for the actual rain falling directly on it, until the valley is opened out and the stream and valley sides graded right back to the divide. Before that no migration from denudation is possible, as the water on each side of the parting would merely flow each way removing its own débris.

The actual head of a stream is only the end of its valley, the terminal valley side, and it must be graded by the same controls as determine the rest of the valley sides. If, for simplicity, we suppose a stream heading in a plateau scarp, the terminal side having a grade of 1 in 10, each 100 feet vertically removed from the valley side would only shift the divide 1,000 feet, and a removal of 500 feet would be necessary for a migration of one mile. One in ten is not a steep valley side, and the steeper the grade the less the shift. With a grade of 1 in 5, 1,000 feet would have to be removed for a migration of one mile. Thus, while on a steeper grade denudation is doubtless more rapid, a much greater vertical depth of material has to be removed to achieve the same result, neutralising the advantage to some extent. When further we remember that the steeper the grade the more perfect the drainage, and therefore the less chemical disintegration of the rock, the advantage of a steep slope over a less steep one may be much less than would appear at first sight.

Now it is only when the streams and valley sides are graded that there can possibly be any headward encroachment whatsoever, for it is only then that the denuding of the valley sides can start to cut back the divide. This is the stage, according to Davis, when maturity has been reached and old age is beginning. In the theory as propounded by him, the rearrangement of drainage and formation of "subsequent" streams take place in the earlier stages, but it follows from the above considerations that the encroaching stream must have at least attained maturity. It follows also that the lateral shift resulting from denudation of the valley sides—the migration of the divide—can only be very slight except in regions of great elevation, and then only if the stream were cutting back into the edge of a plateau. Even so, an enormous vertical depth of material would have to be removed from the valley sides to achieve any migration of physiographical significance. Where moderately steep slopes occur on both sides of the divide, the shifting of the divide must be quite negligible, for both sides are acting, until such time as the divide is lowered to become a plateau scarp, or in other words until the basin of the weaker stream has become a fully developed peneplain.

That these exceptional circumstances may sometimes occur there is no doubt, but they must be very rare. It must be rare indeed for the migration to be sufficient to tap a stream of any considerable magnitude. One might as easily imagine a divide being lowered sufficiently for an exceptionally high flood to go over it and thus start a new direction of flow, but this would be river dumping rather than capture. The conditions to make it possible would also be very rare.

The physiographical conception of a reversal of drainage in the lower part of a stream resulting from its capture higher up is extremely improbable, since the part immediately below the capture would become a new divide, and the recession of it would be that of a valley side, not of a stream, unless the floods in the lower part were sufficiently high to flow back over the new-formed divide. When this improbability is added to the improbability of river-capture at all, the theoretical development of a reversed or "obsequent" stream is just about impossible.

Those of us who have seen Mount Edwards gorge where a comparatively small stream has cut down through the trachyte mountain which a small deviation would have avoided, and the similar behaviour of the Stanley at Mount Brisbane where also a small deviation would have avoided the obstruction, cannot fail to be impressed with the manner in which these streams have had to stay "put," and have not selected the softer rocks in the vicinity. Now it would seem that we must also regard the divides as more or less fixed, except in somewhat unusual circumstances, while even in those circumstances the migration must seldom be of importance. If this conclusion is correct and we accept the general fixity of divides, then all that part of physiographical theory which depends on their migration must be discarded.

In concluding, the writer desires to state that since the paper is concerned rather with general physiographical theory than with local problems, and has considered the local features from an entirely different viewpoint from previous writers, little reference to or criticism of previous work has been made. There are points of agreement and disagreement, but these have purposely not been mentioned, so as not to cloud the main issue, which is threefold:—

1. That in studying physiographical developments the divides must be considered equally with the stream courses.

2. That in the D'Aguilar-Blackall divide nature has performed for us an almost ideal experiment, with proper controls, on the ability of denudation to cause a migration of

the divide. In the experiment this action has been negligible. It is only one clear experiment, but a consideration of other divides confirms the finding that headward encroachment by streams is a much less important principle than the accepted theory would indicate.

3. That the general theory must in consequence be seriously modified in so far as it depends on the migration of divides.

The writer further desires to express his thanks to Dr. W. H. Bryan for suggestions and modifications in the composition of the paper.

LITERATURE OF QUEENSLAND PHYSIOGRAPHY WITH BEARING ON REGIONS REFERRED TO IN TEXT.

ANDREWS, E. C.—Preliminary Notes on the Queensland Coast, with reference to the Geography of the Queensland and New South Wales Plateau. Proc. Linn. Soc. N.S.W., 1902.

ANDREWS, E. C.—Geographical Unity of Eastern Australia in Late and Post-Tertiary Time, with Applications to Biological Problems. Journal Royal Soc. N.S.W., 1910.

ANDREWS, E. C.—Plains and Peneplains of Australia. Commonwealth Year Book, 1912.

BRYAN, W. H.—The Queensland Continental Shelf. Reports, Great Barrier Reef Committee, vol. ii., 1928.

DANES, J. V.—On Some Problems of Queensland Hydrography, and A Tour Along the Dividing Range from Aramac to Pentland. Qld. Geographical Journal, 1909-1910.

DANES, J. V.—On the Physiography of North-eastern Australia. Proc. Royal Bohemian Society of Sciences, 1911.

DAVID, T. W. E.—Notes on some of the Chief Tectonic Lines of Australia. Jour. Roy. Soc. N.S.W., 1911.

DAVID, T. W. E.—Geology of the Commonwealth. Federal Handbook of Australia, 1914.

JARDINE, F.—The Physiography of the Lower Fitzroy Basin. Qld. Geographical Journal, 1923.

JENSEN, H. I.—Geology of the Volcanic Area of East Moreton and Wide Bay Districts, Queensland. Proc. Linn. Soc. N.S.W., 1906.

MARKS, E. O.—Notes on Portion of the Burdekin Valley. Proc. Roy. Soc. Q., 1912.

MARKS, E. O.—Presidential Address. Roy. Soc. Q., 1924.

MARKS, E. O.—Presidential Address, Queensland Naturalists' Club. Queensland Naturalist, 1927.

POOLE, W.—Physiography of North Queensland. Aust. Assn. Adv. Science, 1909.

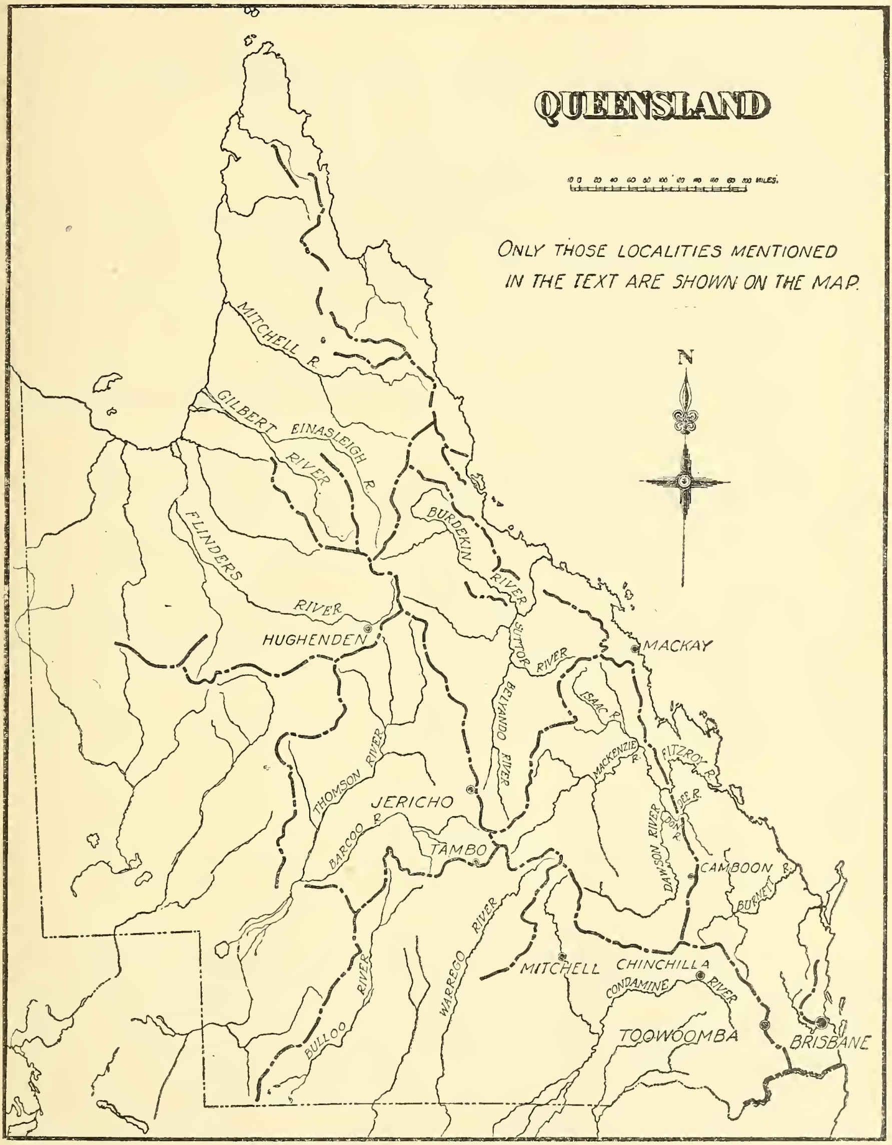
REID, J. H.—Coal Measures of Western Moreton District. Q. Govt. Mining Journal, Dec. 1922.

RICHARDS, H. C.—The Volcanic Rocks of South-eastern Queensland. Proc. Roy. Soc. Qld. 1916.

TAYLOR, T. G.—The Physiography of Eastern Australia. Commonwealth Meteorological Bureau, Bulletin No. 8.

WEARNE, R. A., and WOOLNOUGH, W. G.—Notes on the Physiography of West Moreton, Queensland. Journ. Roy. Soc. N.S.W., 1911.

The references to Professor W. M. Davis's works are from "Geographical Essays" by William Morris Davis, edited by Douglas Wilton Johnston and published by Ginn and Company.


QUEENSLAND
ONLY THOSE LOCALITIES MENTIONED
IN THE TEXT ARE SHOWN ON THE MAP.
N
MITCHELL R.
GILBERT
EINASLEIGH R.
RIVER
FLINDERS
RIVER
HUGHENDEN
BURDEKIN
RIVER
SUTTOR RIVER
MACKAY
ISAAC R.
BELYANDO RIVER
MACKENZIE R.
FITZROY R.
THOMSON RIVER
JERICHO
BARCOO R.
TAMBO
DAWSON RIVER
DON R.
DEE R.
CAMBOON
BURNETT R.
WARREGO RIVER
MITCHELL
CHINCHILLA
CONDAMINE RIVER
BULLOO RIVER
TOOWOOMBA
BRISBANE

Chaetognatha from the Society Islands

By B. B. GREY, F.L.S.

(Twelve Text-figures.)

(Communicated by Mr. F. A. Perkins, B.Sc. Agr., to the Royal Society of Queensland, 26th May, 1930.)

THE Chætognatha discussed in this paper were all taken in a surface net in Papetoai Bay, Moorea Island.

The collection was made in sixteen hauls, irregularly spaced over the period of twelve months, all made with the same net and steaming over about the same course.

Ten species are represented, including one apparently new to science, which are embraced by two genera, *Sagitta* and *Pterosagitta*.

COINCIDENT OCCURRENCE OF SPECIES OF CHÆTOGNATHA IN PAPETOAI BAY.

—	Oct. 22, 2.	Nov. 7, 10, 13.	May 21.	Aug. 10, 13.	Sept. 28, 29.	Oct. 1926. 1, 9, 11, 12, 13, 23.
S bipunctata ..	..	..	..	+		
S. enflata ..	+ +	+ +	..	+	+	+ + + +
S. fridrici ..	+	+ +	..	+ +	..	+ + + +
S. minima ..	+	+				
S. neglecta ..	..	+				
S. planctonis ..	..	..	..	+		
S. regularis ..	..	..	+			
S. tenuis ..	..	..	..	+		
S. oceania, n.s. ..	..	..	..	+	+	+ + +
Pt. draco ..	..	..	+	..	..	+
	..	..				

Of the above species *S. enflata* Grassi alone varied from the type description. Normally the lateral fins are separated from one another by from 9% to 15% of the total body length. All the Moorea specimens were examined while alive, and it was found that the anterior and posterior fins were nearly always confluent, also the anterior fin occasionally had a clear outer zone as well as a clear inner zone and anterior portion, while in one case the anterior fin was entirely rayless. The individuals were all very small for this species, but as all the other characters agree with the published descriptions the establishing of a new species did not seem justified, and it is likely that this newly noticed character of the fins has not been observed before owing to damage to these very frail structures.

Sagitta oceania sp. nov.

A transparent, robust form, which keeps its shape well.

Length—4·4–8·3 mm.

Breadth—5%–7% total length.

Tail—29%–38% total length.

Anterior teeth—5–8.

Posterior teeth—15–20.

Jaws—6–7. The tips of some are slightly hooked.

Anterior fin—14%–22% total length. It is rayed obliquely throughout and reaches the ventral ganglion.

Posterior fin—25%–29% total length; rayed obliquely throughout; almost reaches the seminal vesicle; less than 50% in front of the tail septum. The fins are separated from one another by from 3%–8% of the total length of the animal.

The ovary reaches the region of the ventral ganglion when mature and contains a single row of large and small ova.

The seminal receptacle is small and round.

The seminal vesicle is small but conspicuous; almost reached by the posterior fin, and widely separted from the tail fin.

Intestinal diverticulæ are present.

Two rows of sensory papillæ bearing setæ are present, extending from the neck region to the tail. In young specimens the tips of the setæ comprising each tuft are joined together and the whole spirally twisted to the shape of a candle flame (Fig. 2). In later life the tip of the composite tuft gets broken and the released setæ straightened themselves out.

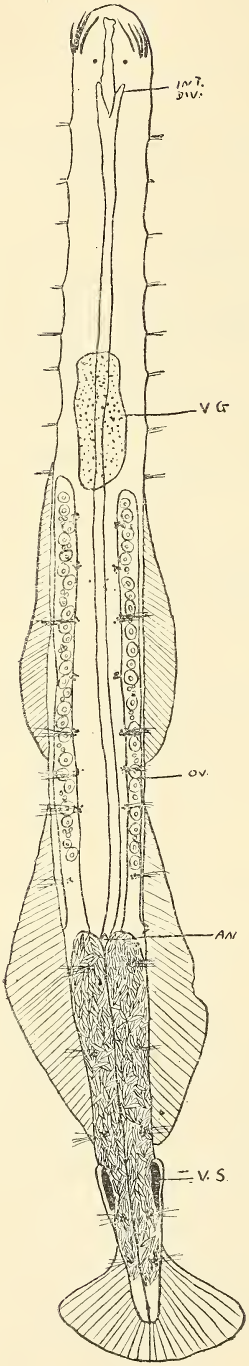
S. oceania is immediately distinguishable from all other species with sensory papillæ and setæ by the absence of the collarette.

The new species was taken in five hauls in Papetoai Bay, Moorea.

Fertilisation of the Chætognatha.

In a paper on the spermatogenesis of Chætognatha, Lee (1888) described fertilisation in which the spermatozoides penetrated the septum between the body and tail cavities and so reached the ovaries direct, and Stevens (1903) observed a close fertilisation of *S. bipunctata*. In Fig. 5, which is a *Camera lucida* drawing of the region about the tail septum of *S. oceania,* two bundles of spermatozoides can be seen in the inner portion of the seminal receptacle which seems to support their observations. Unfortunately these were not seen until after the animal was dead, and so it was not possible to make further observations of the route taken, but the presence of the bundles of spermatozoides in the seminal receptacle of *S. oceania,* at any rate, may be due to some accidental fracture of the septum, such as might easily be caused by the presence

Fig 1



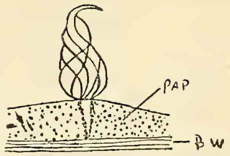


Fig 2

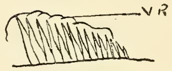


Fig 3

Fig 4

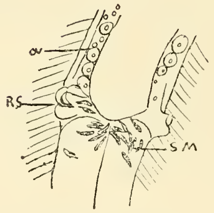


Fig 5

Fig 6

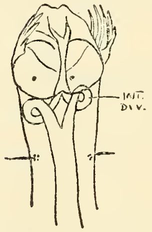
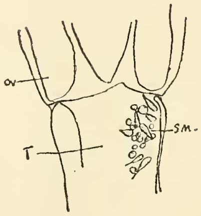


Fig 8



of some vigorous parasite, such as a nematode or trematode, as the presence of seminal vesicles in all species, and of large and conspicuous ones in many, would seem to point to a more ordinary functioning of the male parts in the majority of cases.

The suggestion of a normal ejection of the male product is borne out by observations made on living specimens of *S. enflata* taken during the month of October. During this month the male products were ripe. The rounded sperm morulæ gradually became elongated (Fig. 8) and formed spindle-shaped bundles, some of which were ejected whole through the seminal vesicle with the spermatozoides of which they were composed vibrating rapidly, while others broke up in the tail itself (Fig. 7). The bundles that were ejected into the water broke up during, or immediately after, ejection and the individual spermatozoides wriggled rapidly about.

The ova were apparently ripe at the same period, but no movement was observed in the ovary.

Parasites.

During October several individuals of four species collected were found to be parasitised by trematodes, nematodes, or cysticerci:—

——	Parasite.	Region Infected.
S. enflata 1	Trematode	Tail cœlome
S. enflata 2	Trematode	Ovary
S. fridrici 1	*Camallanus trispinosus* ..	Intestine
S. fridrici 2	Cysticercus	Body cœlome
S. oceania	Trematode	Body muscles
Sagitta sp.	Trematode	Tail cœlome

The Distoma found in *S. enflata* is apparently identical with that figured by Scott (1896).

The trematodes seem to be able to force their way out through the body wall of the Sagittæ without much difficulty, and to move about in the muscles as they like. The nematodes are also extremely vigorous, and the presence of either one or the other in the tail cœlome probably renders the male products useless, as the sperm morulæ are broken up by the constant movements of the parasite. As suggested above, the former presence of a parasite that forced its way from the body cavity to the tail cavity might account for the presence of the sperm bundles in the region of the ovary as shown in Fig. 5, especially as the sperm morulæ are generally in active motion, passing in a continuous stream up the outer wall of the tail cœlome, and down again along the septum separating the two portions of the tail cavity. Fig. 5 is of an individual captured during October when several specimens were found to contain parasites.

A Meal taken by S. enflata.

At 4 o'clock a small individual of *S. enflata* was seen to attack an *S. fridrici* of about half its size. The victim was seized by the head, Fig: 7.

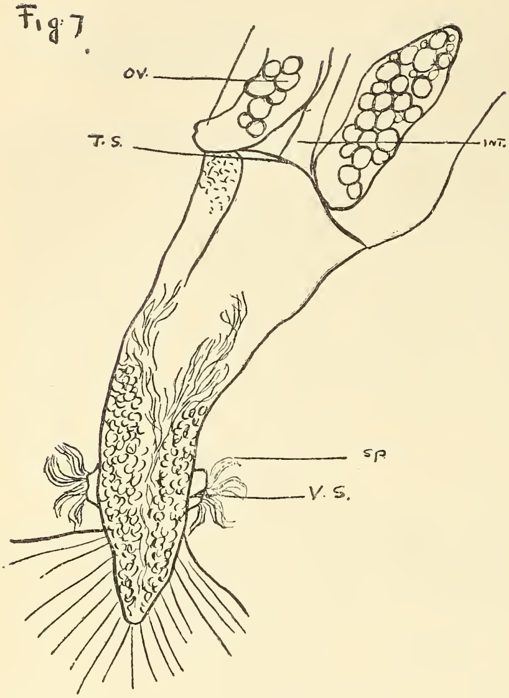


Fig: 9

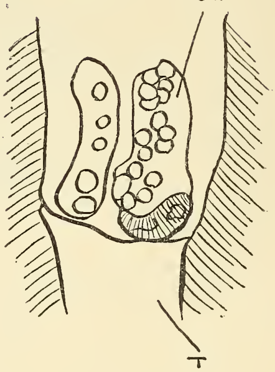
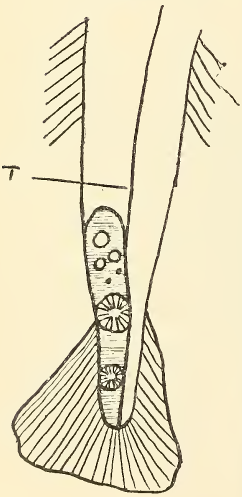


Fig. 10



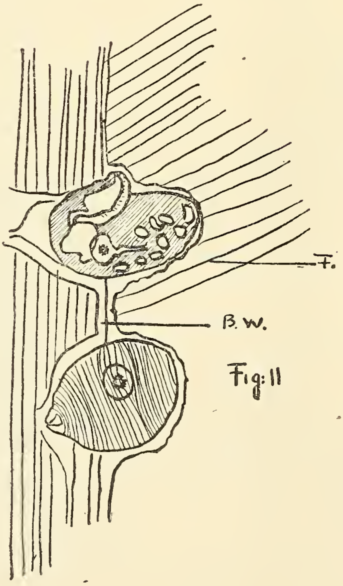


Fig: 11

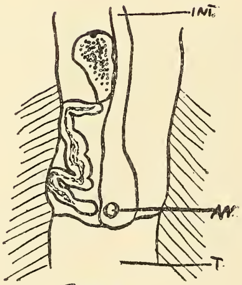


Fig: 12

quivered slightly, but made no attempt to escape. It was swallowed straight down the intestine, and at 4.8 the head had reached the region of the anus. A rotary motion now commenced in the intestine of the eater, and at the same time the body of the eaten was moved up and down in the intestine, and this crushing motion gradually broke up the muscles until by 4.20 only the jaws, skin, and gut were intact, and the rest of the body was quite fluid. All nourishment had apparently been extracted by 4.40, when the remains were ejected through the anus, as a small shapeless mass, with only the jaws to show what it had once been.

BIBLIOGRAPHY.

1888: LEE, A. B.—La spermatogenese chez les Chetognaths. La Cellule 4.

1896: SCOTT, T.—Additions to the Fauna of the Firth of Forth. Ann. Rep. Fish. Board Scot. 14.

1903: STEVENS, N. M.—On the Ovogenesis and Spermatogenesis of *S. bipunctata*. Zool. Jahrb. Abt. Morph, 18.

1911: MICHAEL, ELLIS L.—Classification and Vertical Distribution of the Chætognatha of the San Diego Region. University of California publications in Zoology, vol. viii., No. 3.

1911: RITTER-ZAHONY, RUDOLPH VON.—Revision der Chatognathen. Deutsche Sudpolar Expedition, xiii. Band. Zoologie V. Band, Heft 1.

1918: OYE, PAUL VAN.—Examination of the Chætognatha in the Java Seas. Contributions a la Faune des Indes Neerlandaises.

1919: MICHAEL, ELLIS L.—Report on the Chætognatha collected by the United States Fisheries steamer ''Albatross'' during the Philippine Expedition, 1907-1910. Smithsonian Institution Bull. 100, vol. i., part 1.

1922: GREY, B. B.—Notes on Species of Sagitta collected during a voyage from England to Australia. Proceedings of the Royal Society of Queensland, vol. xxxiv., p. 171.

EXPLANATION OF FIGURES.

(All from *Camera lucida* drawings.)

Fig. 1.—*Sagitta oceania* sp. nov.

Fig. 2.—*S. oceania.* Sensory papilla and setæ bundle from immature specimen.

Fig. 3.—*S. oceania.* Posterior teeth.

Fig. 4.—*S. oceania.* Anterior teeth.

Fig. 5.—*S. oceania.* Region of tail septum, ventral view.

Fig. 6.—*S. oceania.* Head and neck, showing intestinal diverticulæ.

Fig. 7.—*S. enflata.* Showing ejection of spermatozoides.

Fig. 8.—*S. enflata.* Showing changing sperm morulæ.

Fig. 9.—*S. enflata.* Trematode in ovary.

Fig. 10.—*S. fridrici.* Trematode in tail cœlome.

Fig. 11.—*S. oceania.* Trematode escaping through body wall, drawn by reflected and transmitted light.

Fig. 12.—*S. fridrici.* Cysticercus in body cœlome.

AN., anus; B.W., body wall; F., fin.; INT., intestine; INT. DIV., intestinal diverticulum; OV., ovary; PAP., papilla; R.S., seminal receptacle; S.M., sperm morula; SP., spermatozoides; T., tail; T.S., tail septum; V.G., ventral ganglion; V.R., vestibular ridge; V.S., seminal vesicle.

Essential Oils from the Queensland Flora.

Part II.—*AGONIS ABNORMIS.*

By T. G. H. JONES, D.Sc., and M. WHITE, M.Sc.

(Tabled before the Royal Society of Queensland, 26th May, 1930.)

The genus *Agonis* belongs to the large family Myrtaceæ and consists of about sixteen species, ten of which occur in Western Australia and six in Queensland; one of the Queensland species, namely *Agonis abnormis,* stretching into northern New South Wales.

Agonis abnormis is a tall shrub or small tree common along river banks in South-eastern Queensland from Stanthorpe to the Wide Bay district, in the latter district being fairly common along Tinana Creek. It has a trunk with the rough bark persistent at the base but shed in ribbons or flake-like pieces about halfway up, leaving the upper bark quite smooth. The leaves are narrowly lanceolate in shape, averaging about 1 to 12 inches in length; the flowers are white, the stamens 20 or more in number, the capsules small and opening in 3 valves. The species was originally described as *Leptospermum abnorme* by Mueller, but was later transferred to the genus *Agonis* by White and Francis.[1]

Our supplies of leaves for the present investigation were obtained from the banks of the Blunda Creek; 400 lb. of leaves and terminal branches collected on 8th August, 1929, and distilled on 9th August, yielded 1,180 ccs. of oil or ·6%, while from 900 lb. of leaves collected on 9th December, 1929, 2,810 ccs. of oil were obtained.

Little essential difference was observed in the two samples of oil thus obtained.

Examination of the oil as far as it has proceeded shows that it consists of dextro α-pinene (30–40%), sesquiterpenes 60%, and the residue 5–10% sesquiterpene alcohol.

The sesquiterpene fraction possesses physical constants and gives colour reactions similar to those given by aromadendrene, the characteristic sesquiterpene of the Myrtaceæ. Although several investigators have examined this sesquiterpene—in particular that obtained from *Eucalyptus nova-anglica*[2]—very little can be definitely stated regarding it. Semmler[3] considered that it consisted essentially of a mixture of two distinct sesquiterpenes, but Briggs and Short express as the results of their investigation the opinion that essentially only one such body is present.

The essential oil from *Agonis abnormis* is remarkable in containing a relatively large amount of this sesquiterpene, probably more so than any other oil yet examined, and in view of the ready availability of this oil it has appeared to us of interest to examine the sesquiterpene fraction in detail. The main difficulty in connection with the chemistry of aromadendrene seems to be that it cannot be definitely asserted that what is usually described as aromadendrene in various essential oils is always the same substance or mixture of substances, the similarity of physical constants and colour reactions being not sufficiently diagnostic for the purpose.

Although our examination of the sesquiterpene fraction of *Agonis abnormis* has not proceeded sufficiently far to enable us to give precise information regarding its chemistry—the details of which are reserved for a future communication—it is possible to state that at least two sesquiterpenes and possibly three are present, their separation involving prolonged and tedious fractionations.

EXPERIMENTAL.

The essential oil, pale yellow in colour and of pleasant odour, possessed the following constants :—

$d_{15 \cdot 5}$	·9040
n_D^{20}	1·4905
$[\alpha]_D$	+ 9
Ester number	7·4
Acetyl value	16
Acid number	1·7

A combustion of the oil showed that it contained very little oxygen and consisted essentially of hydrocarbons : only a trace was dissolved in 8% sodium hydroxide solution.

2,400 ccs. of the oil were distilled under diminished pressure and the following fractions collected :—

Fraction.	Distillation Temp.	Volume.	$d_{15 \cdot 5}$.	n_D^{20}	$[\alpha]_D$
1	0–75°C. (29 mms.) ..	525 ccs.	·8647	1·4636	+ 43
2	60–95°C. (5 mms.) ..	1,350 ccs.	·9091	1·4962	+ 2·5
3	95–105°C. (5 mms.) ..	268 ccs.	·9255	1·4998	− 1
4	105–110°C. (5 mms.) ..	165 ccs.	·9695	1·5002	− 10
TOTAL	..	2,308 ccs.			

Residue and loss 92 ccs.

Fraction 1 consisted almost exclusively of α-pinene. On further fractionation and distillation over sodium this substance was isolated in a high degree of purity with the following constants :—

$d_{15 \cdot 5}$	·863
n_D^{20}	1·4654
$[\alpha]_D$	+ 47·6
b.p.	155°C.

Its identity was established by the usual oxidation to pinonic acid and the preparation of the semicarbazone M.P. 207°C. No β-pinene could be detected.

Fractions 2 and 3 were further fractionated and 1,300 ccs. of sesquiterpene obtained. The constants determined were as follows :—

$d_{15 \cdot 5}$	..	..	..	·9121
$[\alpha]_D$	..	..	..	+ 2
n^{20}_D	..	..	..	1·4990
b.p.	..	..	..	78–86°C at 5 mms.

These are in fair agreement with those usually quoted for aromadendrene, and the usual colour reaction with bromine vapour was also shown. As indicated in the first part of the paper, the sesquiterpene fraction is essentially a mixture of isomers, and, in view of the prolonged series of operations necessary to separate the constituents in a state of approximate purity, further details regarding the chemistry must be deferred for a subsequent publication.

Fraction 4 was found on further fractionation to consist of sesquiterpene alcohols in admixture with sesquiterpenes and probably also a mixture of closely similar isomers difficult to separate.

We have also commenced investigations of the other *Agonis* species of Southern Queensland.

Our thanks are due to Mr. C. T. White for his usual botanical assistance, and to the Commonwealth Science and Industry Research Fund, which has defrayed the initial cost of the oil.

BIBLIOGRAPHY.

1. Botany Bulletin 22, Department of Agriculture and Stock, Brisbane, p. 20.

2. Smith and Baker. A research on the Eucalypts. Briggs and Short, Journal Chemical Society, 1928, p. 2524.

3. Ätherischen Öle, 1905, 11, 530.

The Genus *Oxyscelio* Kieffer, its Synonymy and Species, with a description of one new Genus (Hymenoptera: Proctotrypoidea).

By Alan P. Dodd.

(*Tabled before the Royal Society of Queensland, 30th June, 1930.*)

In the Australian Scelionid fauna there is a homogeneous group of many species, whose generic position has given me considerable cause for thought; several of the species have been described in *Sceliomorpha* Ashmead, two in *Dicroteleia*, and various others in my collection remain unnamed.

Sceliomorpha was based on a male of *S. longicornis* Ashmead from Brazil; a second species, *S. bisulca* Ashmead, from the United States, was doubtfully included (Bull. U. S. National Museum, vol. 45, 1893, p. 239). In 1909 and 1910 Kieffer added six new species from Brazil and Peru. Previously that author had described *S. flavipes* from Australia as a doubtful member of the genus, but later (1916) transferred it to his genus *Psilanteris*. Being in doubt as to the Australian species being congeneric with *S. longicornis*, I submitted examples of *S. rugulosa* Dodd to Mr. A. B. Gahan of the U. S. National Museum, who kindly compared them with the type of *longicornis* and supplied me with the following notes:—"In my judgment *S. rugulosa* and *S. longicornis* are not congeneric. In *longicornis* the pronotum is quite different, being partly dorsal and carinately margined in front; the marginal vein is thickened to form a small rounded stigma; the first segment of the abdomen lacks entirely the deep fossæ at base and is without an enclosed area; and the entire body, including the eyes, is covered with conspicuous long hairs." A sketch by Mr. Gahan of the thorax and wing venation represents an insect which is clearly not congeneric with the Australian species.

Subsequently the late Professor C. F. Baker, of the Philippine College of Agriculture, loaned me the cotypes of several Philippine Scelionids, including *Camptoteleia carinata* Kieffer and *Xenoteleia flavipennis* Kieffer, genotypes respectively. Examination of the former insect at once proved its generic identity with the Australian species of *Sceliomorpha* and *Dicroteleia*, while *X. flavipennis* possessed no characters which, in my opinion, excluded it from *Camptoteleia*.

Having established the fact that *Camptoteleia* Kieffer and the Australian species of *Sceliomorpha* and *Dicroteleia* were identical generically, that many species of the genus occurred in the Philippines and in Australia, and that a congeneric species, *Sceliomorpha ceylonensis* Dodd, had been described from Ceylon, I made a careful comparison of the descriptions of other Oriental genera and species erected by Kieffer. This investigation has resulted in my offering the following synonymy of several genera, or of certain authors' interpretation of genera, in which *Dicroteleia* Kieffer, *Camptoteleia* Kieffer, and *Xenoteleia* Kieffer are regarded as being identical with *Oxyscelio* Kieffer:—

OXYSCELIO Kieffer.

Zeitschr. Hym. Dipt., vol. 7, 1907, p. 310; genotype *O. foveatus* Kieffer from Java.

Dicroteleia Kieffer, Notes Leyden Museum, vol. 30, 1908, p. 92; genotype *D. rugosa* Kieffer from Java. Dodd, Proc. Royal Soc. Qld., vol. 26, 1914, p. 105.

Camptoteleia Kieffer, Insecta, vol. 3, 1913, p. 387; genotype *C. carinata* Kieffer from the Philippines.

Xenoteleia Kieffer, Insecta, vol. 3, 1913, p. 390; genotype *X. flavipennis* from the Philippines.

Sceliomorpha (not Ashmead) Kieffer, Berlin Ent. Zeit., vol. 51, 1907, p. 296; Dodd, Trans. Royal Soc. South Aust., vol. 37, 1913, p. 139; Archiv. fur Naturg. Berlin, vol. 79, 1913, p. 165; Proc. Royal Soc. Qld., vol. 26, 1914, p. 103; Trans. Ent. Soc. London, 1919, p. 349; Proc. Royal Soc. Qld., vol. 38, 1927, p. 128.

Hoploteleia (not Ashmead) Dodd (part.), Trans. Royal Soc. South Aust., vol. 37, 1913, p. 176.

Psilanteris Kieffer (part.), Broteria, vol. 14, 1916, p. 177.

Scelio (not Latreille) Girault, private publication, Brisbane, 1926.

DISCUSSION OF THE GENERIC CHARACTERS.

Examination of many Australian species has thrown considerable light on the variability of certain characters that might be regarded of value for generic distinctions, and has made possible an understanding of the limits of the genus. As previously stated, the identity of *Camptoteleia*, *Xenoteleia*, and the Australian species described in *Sceliomorpha* and *Dicroteleia* has been established from a study of type or cotype material. On the other hand, the genotypes of *Oxyscelio* and *Dicroteleia* have not been seen by me, and, as the proposed sinking of the several genera may be open to question, an attempt is made to justify the suggested changes.

A comparison of Kieffer's descriptions of *Oxyscelio foveatus*, *Dicroteleia rugosa*, and *Camptoteleia carinata*, genotypes respectively, reveal many striking resemblances but few differences that would warrant separation. In each case, either in the generic diagnosis or in the description of the species, Kieffer stresses the fact that the submarginal vein is far removed from the costa, the marginal vein is punctate or square, and the postmarginal vein is absent. This combination of venational characters, particularly that of the remoteness of the submarginal vein from the costa, is, in my opinion, an outstanding feature of the segregate. The stigmal vein may branch off a little before the submarginal vein joins the costa, as in *Camptoteleia bifurcata* K. and *Dicroteleia rugosa* K., or from the punctiform or square marginal vein.

It will be observed that in the above three genotypes Kieffer mentions the presence of a median carina on the mesoscutum, a character on which he places considerable generic value. Among an extensive collection of Australian Scelionidæ I have met this character in two genera, viz., *Hoploteleia* Ash. and the segregate under discussion, but it may or may not be present in species closely related and clearly congeneric. For example, *Sceliomorpha rugulosa* Dodd can be distinguished with difficulty from a species which appears to be *S. flavipes* Kieffer except that the median carina occurs in the former but not in the latter. Again, Kieffer himself states that the carina is not present in *Camptoteleia spinosiceps* in contradistinction to the various other species that he described in that genus. So much importance did that worker place on the character that he transferred the species originally designated *Hoploteleia carinata* Kieffer (1913) to *Camptoteleia* as *C. perplexa* Kieffer (1926), the specific name being preoccupied by *C. carinata* Kieffer (1913); I have examined a cotype of this species which possesses a long postmarginal vein and is truly a species of *Hoploteleia,* its correct name being *H. serena* Dodd (1919), the name *carinata* being preoccupied by *Hoploteleia carinata* Cameron = *Apegusoneura carinata* Cam. (1912). Here it may be remarked that the Australian *Hoploteleia elevata* Dodd bears the median carina on the mesoscutum.

Another character of the segregate is to be found in the metanotum which bears a prominent plate, usually transverse but subject to some modification. Of *Oxyscelio foveatus,* Kieffer states, "metanotum longitudinally striate, nearly square, narrower and one-third shorter than the scutellum, covering but not projecting beyond the median segment." This is not the usual form of the metanotum in the Australian species but occurs in *Dicroteleia solitaria* Dodd. Kieffer describes this sclerite in *Camptoteleia carinata* as "with two small pointed teeth nearly contiguous at the base"; my notes on a cotype of *carinata* read "metanotal plate hollowed out, the posterior margin depressed, the lateral margins prominent, the posterior-lateral angles raised and prominent." The excavated type of the plate with the raised lateral margins and prominent, although usually rounded, posterior-lateral angles is dominant in the Australian forms. In his 1926 description of *Dicroteleia rugosa,* Kieffer does not mention the metanotum, but in the generic diagnosis states "metanotum unarmed, forming a narrow cross-stripe." Of *Xenoteleia flavipennis,* Kieffer merely mentions that the metanotum is transversely foveate, whereas my notes made from a cotype state that the metanotal plate is transverse, its posterior-lateral angles rounded.

The propodeal characters are rather different than in most Scelionid genera. The propodeum is short medially, long laterally, and there are long true lateral carinæ some distance from the median line. The posterior margin is broadly and rather deeply concave almost to the base of the sclerite, but the concavity ends at the junction of the lateral carinæ where the margin is rather strongly angled and blunt projections extend slightly into the depressions on either side of the raised area at the base of the abdomen.

The abdomen varies considerably in length. In its stoutest form it is no longer than the head and thorax united and hardly twice as long as its greatest width, as in *Sceliomorpha rugulosa* Dodd. At the other extreme it is much longer than the head and thorax united and three to four times as long as its greatest width, as in *Oxyscelio foveatus* K., *Dicroteleia rugosa* K., *D. solitaria* Dodd, and *Xenoteleia flavipennis* Kieffer. The base is broad and not much narrower than the greatest width of the abdomen; segments 2 and 3 are almost subequal in length, each somewhat longer than 1 and 4. On the basal segment there is a broad raised median area bounded laterally by a carina or strong stria; on either side of this area the surface is depressed and may form a deep fossa against the anterior margin; the raised area is usually flat, but may form a hump or blunt prominence as in *Dicroteleia solitaria* and *Xenoteleia flavipennis* (Kieffer erroneously states that there is no basal prominence in this species); this form of the basal segment is found in *Psilanteris atriclava* Kieffer and the new genus herein described as *Bracalba*.

THE SPECIES OF *OXYSCELIO*.

It would seem necessary to give a list of the species that appear to belong in *Oxyscelio* in accordance with the views expressed in this paper; the species appear in alphabetical order.

1. *O. acutiventris* Kieffer. Philippine Islands.

   Trichoteleia acutiventris Kieffer, Broteria, vol. 14, 1916, p. 176.
   Dicroteleia acutiventris Kieffer, Das Tierreich, 1926, p. 388.

2. *O. atricoxa* Dodd. New South Wales.

   Sceliomorpha atricoxa Dodd, Proc. Royal Soc. Qld., vol. 26, 1914, p. 104.

3. *O. bifurcatus* Kieffer. Philippine Islands.

   Camptoteleia bifurcata Kieffer, Broteria, vol. 14, 1916, p. 172.

4. *O. brevinervis* Kieffer. Philippine Islands.

   Camptoteleia brevinervis Kieffer, Broteria, vol. 14, 1916, p. 175.

5. *O. carinatus* Kieffer. Philippine Islands.

   Camptoteleia carinata Kieffer, Insecta, vol. 3, 1913, p. 387.

6. *O. ceylonensis* Dodd. Ceylon.
   Sceliomorpha ceylonensis Dodd, Trans. Ent. Soc. London, 1919, p. 349.
7. *O. concoloripes* Dodd. New South Wales.
   Sceliomorpha concoloripes Dodd, Proc. Royal Soc. Qld., vol. 26, 1914, p. 104.
8. *O. consobrinus* Kieffer. Philippine Islands.
   Camptoteleia consobrina Kieffer, Broteria, vol. 14, 1916, p. 173.
9. *O. crassicornis* Kieffer. Philippine Islands.
   Camptoteleia crassicornis Kieffer, Broteria, vol. 14, 1916, p. 174.
10. *O. cupularis* Kieffer. Philippine Islands.
   Camptoteleia cupularis Kieffer, Philippine Jour. Sci., vol. 9, 1914, p. 298.
11. *O. dorsalis* Kieffer. Philippine Islands.
   Camptoteleia dorsalis Kieffer, Broteria, vol. 14, 1916, p. 173.
12. *O. excavatus* Kieffer. Philippine Islands.
   Camptoteleia excavata Kieffer, Insecta, vol. 3, 1913, p. 388.
13. *O. flavipennis* Kieffer. Philippine Islands.
   Xenoteleia flavipennis Kieffer, Insecta, vol. 3, 1913, p. 390.
14. *O. flavipes* Kieffer. Queensland.
   Sceliomorpha flavipes Kieffer, Berlin Ent. Zeit., vol. 51, 1907, p. 296. *Psilanteris flavipes* Kieffer, Broteria, vol. 14, 1916, p. 177.
15. *O. foveatus* Kieffer. Java.
   Zeit. Hym. Dipt., vol. 7, 1907, p. 310.
16. *O. frontalis* Kieffer. Philippine Islands.
   Camptoteleia frontalis Kieffer, Broteria, vol. 14, 1916, p. 175.
17. *O. glabriscutellum* Dodd. Queensland.
   Dicroteleia glabriscutellum Dodd, Proc. Royal Soc. Qld., vol. 26, 1914, p. 106.
18. *O. grandis* Dodd. Queensland.
   Hoploteleia grandis Dodd, Trans. Royal Soc. South Aust., vol. 37, 1913, p. 176.
19. *O. hyalinipennis* Dodd. Queensland.
   Sceliomorpha hyalinipennis Dodd, Archiv. Naturg. Berlin, vol. 79, 1913, p. 165.
20. *O. kiefferi* nom. nov. Philippine Islands.
   Camptoteleia flavipennis Kieffer, Philippine Jour. Sci., vol. 9, 1914, p. 297.

21. *O. magniclavus* Dodd. New South Wales.
    Sceliomorpha magniclava Dodd, Proc. Royal Soc. Qld., vol. 26, 1914, p. 103.

22. *O. magnus* Kieffer. Philippine Islands.
    Camptoteleia magna Kieffer, Philippine Jour. Sci., vol. 9, 1914, p. 296.

23. *O. marginalis* Kieffer. Philippine Islands.
    Camptoteleia marginalis Kieffer, Broteria, vol. 14, 1916, p. 172.

24. *O. mirellus Dodd.* South-west Australia.
    Sceliomorpha mirella Dodd, Trans. Ent. Soc. London, 1919, p. 349.

25. *O. montanus* Dodd. Queensland.
    Sceliomorpha montana Dodd, Archiv. Naturg. Berlin, vol. 79, 1913, p. 165.

26. *O. nigriclavus* Dodd. New South Wales.
    Sceliomorpha nigriclava Dodd, Proc. Royal Soc. Qld., vol. 26, 1914, p. 104.

27. *O. nigricoxa* Dodd. Queensland.
    Sceliomorpha nigricoxa Dodd, Archiv. Naturg. Berlin, vol. 79, 1913, p. 165.

28. *O. rugosus* Kieffer. Java.
    Dicroteleia rugosa Kieffer, Notes Leyden Museum, vol. 30, 1908, p. 92.

29. *O. rugulosus* Dodd. Queensland.
    Sceliomorpha rugulosa Dodd, Trans. Royal Soc. South Aust., vol. 37, 1913, p. 139.

30. *O. shakespearei* Girault. Queensland.
    Scelio shakespearei Girault, Brisbane, private publication, 1926.

31. *O. solitarius* Dodd. Queensland.
    Dicroteleia solitaria Dodd, Proc. Royal Soc. Qld., vol. 26, 1914, p. 105.

32. *O. spinosiceps* Kieffer. Philippine Islands.
    Psilanteris spinosiceps Kieffer, Broteria, vol. 14, 1916, p. 178. *Camptoteleia spinosiceps* Kieffer, Das Tierreich, 1926, p. 386.

It will be observed that the genus is confined to the Indo-Malayan and Australian regions. Being well represented by species in the Philippine Islands and Australia, *Oxyscelio* is probably a dominant group throughout the Papuan and East Indian islands. The following four American species, which possess a long postmarginal vein, are excluded and their generic position is uncertain.

Oxyscelio connectens Kieffer, Ann. Soc. Ent. France, vol. 78, 1910, p. 313.

Oxyscelio trisulcatus Kieffer; *Chromoteleia trisulcata* Kieffer, Berlin Ent. Ziet., vol. 51, 1907, p. 265.

Dicroteleia foveatifrons Kieffer; *Prosanteris foveatifrons* Kieffer, Ann. Soc. Sci. Brussels, vol. 32, 1908, p. 136.

Dicroteleia carinata Ashmead; *Macroteleia carinata* Ash., Jour. Linn. Soc. London, vol. 25, 1894, p. 222; *Dicroteleia carinata* (Ash.) Kieffer, Das Tierreich, 1926, p. 390.

THE GENERIC RELATIONS OF *OXYSCELIO* KIEFFER.

Oxyscelio contains medium-sized to rather large Scelionids of rather stout form and coarse sculpture. In general appearance the species resemble those of *Scelio* Latreille and *Hoploteleia* Ashmead. The relationship with *Scelio* is mainly superficial, and the two genera may be distinguished by the following characters:—

Male antennæ 10-jointed; propodeum without true lateral carinæ; segment 1 of abdomen without a raised median area, segment 2 transversely depressed at base; forewings with the basal portion distinctly paler and with a more or less distinct stigmal spot .. *Scelio*.

Male antennæ 12-jointed; propodeum with true lateral carinæ; segment 1 of abdomen with a raised median area, segment 2 not depressed at base; forewings uniformly stained, not distinctly paler at base, without a stigmal spot .. .. *Oxyscelio*.

The resemblance to *Hoploteleia* is pronounced, but there are several distinguishing features, viz.:—

Postmarginal vein long; lateral carinæ of propodeum short; posterior margin of propodeum uniformly gently concave .. .. .. *Hoploteleia*.

Postmarginal vein absent; lateral carinæ of propodeum long; posterior margin of propodeum deeply concave medially, then with a blunt projection at the junction of the lateral carinæ .. .. .. *Oxyscelio*.

As more than one species of *Oxyscelio*, namely *O. flavipes* K. and *O. spinosiceps* K., have been placed by Kieffer in *Psilanteris* Kieffer, a discussion of that genus seems appropriate. *Psilanteris* was erected in 1916 with *Anteris bicolor* Kieffer (1908) as the genotype. Kieffer's description of *bicolor,* which states that the metanotum bears a spine or tooth, that the sub-marginal vein is not remote from the costa, and that segment 3 of the abdomen is as long as 1 and 2 united, represents an insect which is clearly not congeneric with the species of *Oxyscelio.* But *Psilanteris atriclava* Kieffer (1916) from the Philippines does not possess these characters; from an examination of a female cotype of this species I have made the following notes:—"Resembles a small species of *Camptoteleia,* but the head is much wider than the thorax; the sculpture of the head, scutum, and scutellum is coriaceous and without punctures; the metanotum is transverse, strongly foveate medially but without a produced plate; the propodeum is short, the lateral carinæ wide out from the median line, the posterior margin uniformly gently concave; venation as in *Camptoteleia,* the submarginal vein remote from the costa, the marginal vein punctiform, the postmarginal not developed; abdomen as in *Camptoteleia,* segment 2 a little longer than 1 or 3, 1 with a slightly differentiated broad, flat median area.'' The wide head, sculpture of head and thorax, and shape of the posterior margin of the propodeum exclude this species from *Oxyscelio,* and its generic position, as well as that of *P. atriceps* Kieffer (1913) which from the description appears closely related, is obscure.

Probably the new genus *Bracalba,* described herewith, exhibits closer affinities with *Oxyscelio* than any known genus. In both are found the raised median area on segment 1 of the abdomen, the deep median concavity and lateral projections of the posterior margin of the propodeum, and the venational character of the submarginal vein being distant from the costa. The distinguishing features may be summarised as follows:—

Postmarginal vein absent; eyes bare; female antennæ with a stout compact club, the sixth antennal joint much smaller than the seventh; metanotal plate usually excavated, its lateral margins not strongly oblique .. .. *Oxyscelio.*

Postmarginal vein long; eyes hairy; female antennæ with the club hardly differentiated, the sixth antennal joint not smaller than the seventh; metanotal plate very large, not excavated, its lateral margins oblique .. .. *Bracalba.*

BRACALBA New Genus.

Chromoteleia (not Ashmead) Dodd, Trans. Ent. Soc. London, 1919, p. 329.

Female: Male.—Medium-sized, stout-bodied, coarsely sculptured Scelionids with the habitus of *Hoploteleia* and *Oxyscelio.* Head from dorsal aspect transverse, no wider than the thorax, the vertex moderately long and sloping to the posterior border which is not margined; from lateral aspect the vertex is somewhat convex, the frons strongly convex; lower frons with a rather narrow median depression which is not margined; cheeks narrow dorsally, rather broad ventrally; eyes wide apart, large, with noticeable fine pubescence; ocelli large, wide apart, the lateral pair against the eyes. Antennæ 12-jointed; in the female with a loose 7-jointed club which is scarcely wider than and hardly differentiated from the funicle, the first funicle joint long; in the male the flagellar joint except the first sub-quadrate. Thorax stout; pronotum visible laterally, its anterior angles sub-truncate; scutum large, shortly precipitous against the anterior margin which is very broadly rounded; parapsidal furrows complete, foveate; scutellum large, strongly foveate against its margins, the posterior margin rimmed and broadly semicircular; metanotum armed with a broad, coarsely sculptured lamella, two-thirds as long as the scutellum, projecting over the propodeum and extreme base of abdomen, its lateral margins oblique, its posterior margin either gently convex or concave; propodeum short medially, long laterally, the posterior margin medially deeply concave to its base, and on either side with a blunt tooth-like projection which juts slightly into the basal depressions of the abdomen; lateral carinæ of propodeum complete. Forewings long and broad; submarginal vein well-distant from the costa which it joins in a punctiform or square marginal vein, the stigmal vein very long and oblique, the postmarginal long, gradually vanishing into the costa distally but fully twice as long as the stigmal vein; basal, median, and a long radial vein indicated by brown lines. Legs normal, slender. Abdomen a little longer than the head and thorax united; broadly sessile at base; truncate or almost pointed at apex; segments 2 and 3 slightly longer than 1 or 4: segment 1 at base on either side deeply depressed, so that medially there is a broad, elevated flat or humped area which in the female projects forward slightly into the concavity of the propodeum (this raised area is not bounded laterally by definite striæ or carinæ as in most of the species of *Oxyscelio*).

Type.—*Bracalba laminata* described herewith.

A genus related to *Hoploteleia* and *Oxyscelio*, the characters separating it from the latter having already been discussed; from *Hoploteleia* it differs in the form of the metanotum, propodeum, and base of the abdomen. Three species are known, two of which are described herewith.

BRACALBA LAMINATA New Species.

Female.—Length, 4·25 mm. Black; legs, including the coxæ, bright reddish yellow; antennæ black, the scape reddish yellow; tegulæ dusky.

Head wholly strongly confluently punctate including the frontal depression, and with a pubescence of long fine pale hairs. Antennal scape moderately short and stout, twice as long as funicle 1; pedicel twice as long as its greatest width; funicle 1 elongate, two-thirds longer than the pedicel, 2 scarcely one-half as long as 1, 3 somewhat shorter than 2, quadrate; next six joints as long as wide, scarcely widened, gradually tapering to apex, the apical joint one-half longer than wide. Thorax one-fourth longer than its greatest width; pronotum and scutum strongly confluently or sub-confluently punctate and with fine pale pubescence; scutellum with large punctures which are not confluent; metanotal lamina strongly reticulate-rugose, without carinæ or striæ, its posterior margin gently concave medially; projections on either side of median cavity of the propodeum in the form of stout rounded teeth, the margin deeply concave between the projections and the posterior-lateral angles, the lateral carinæ reaching the margin at the base of these concavities. Forewings extending to posterior margin of fourth abdominal segment; lightly stained with brown; venation fuscous. Abdomen one-fifth longer than the head and thorax united, a little more than twice as long as its greatest width; segments 1 and 4 sub-equal, 2 and 3 a little longer, 5 four-fifths as long as 4, 6 three-fifths as long as 5, its dorsal surface excavated apically so that the apical dorsal margin is deeply concave; median area on segment 1 somewhat rounded and projecting forward a little; segment 1 confluently punctate and longitudinally striate, the striæ stronger and more regular medially; 2-6 rather strongly confluently punctate with an irregular longitudinal arrangement but without defined striæ; abdomen with a short, inconspicuous pubescence which is longer laterally and on the two apical segments.

Male.—Length, 4 mm. Differs from the female as follows:—Coxæ dusky black; frontal depression deeper; scutellum confluently punctate; abdomen with seven visible segments, broadly truncate or faintly concave at apex, the apical segment short, broad, and transverse; median area of segment 1 not rounded and not projecting forward. Antennæ black, the scape red at extreme base; scape rather short and stout; pedicel short, slightly longer than its greatest width; funicle 1 twice as long as the pedicel, fully twice as long as its greatest width; 2 a little longer than wide; 3-9 quadrate; apical joint one-half longer than the penultimate.

Habitat.—Queensland; Gogango, 40 miles west of Rockhampton, one female, one male, in March, A. P. Dodd.

Holotype and *Allotype* in the Queensland Museum (*Hy. 4477*).

BRACALBA NIGRESCENS Dodd.

Chromoteleia nigrescens Dodd, Trans. Ent. Soc. London, 1919, p. 329.

From the original description it is evident that this species, erected on a male from South-west Australia, is closely related to both *laminata* and *cuneata*. No comparison with the other species could be made as the holotype of *nigrescens* is in the British Museum.

BRACALBA CUNEATA New Species.

Female.—Length, 3·40 mm. Black; legs bright reddish yellow, the coxæ dark at base, the tarsi dusky; antennæ black, the first three or four joints bright reddish yellow; tegulæ dusky yellowish.

Head strongly confluently punctate and with pale pubescence, the frontal depression smooth medially. Antennal scape over twice as long as funicle 1 which is a little longer than the pedicel, the latter twice as long as its greatest width; funicle 2 as wide as long, 3 a little wider than long; next six joints a little yet distinctly wider than long, the apical joint not much longer than its greatest width. Thorax one-fifth longer than its greatest width; pronotum, scutum, and scutellum strongly confluently punctate and with fine pubescence; metanotal lamina strongly reticulate-punctate and with several obscure irregular longitudinal striæ, of which the median one projects a little at the posterior margin; posterior projections of propodeum less tooth-like than in *laminata* and broader at apex, the posterior margin not deeply concave between the projections and the posterior-lateral angles, the lateral carinæ reaching the margin at the apex of the projections. Forewings extending to posterior margin of fifth abdominal segment; lightly stained with brown; venation thick, fuscous. Abdomen one-fifth longer than the head and thorax united, somewhat more than twice as long as its greatest width; relative length of segments about as in *laminata;* segment 6 not excavated, its apical margin rounded and a little depressed; median area on segment 1 very broad, scarcely rounded; sculpture as in *laminata* except that the punctuation on segments 2-6 has a more pronounced tendency toward longitudinal arrangement and there are numerous irregular striæ.

Male.—Unknown.

Habitat.—South Queensland; Chinchilla, three females in February and March, A. P. Dodd.

Holotype in the Queensland Museum (*Hy. 1478*) ; *Paratypes* in the author's collection.

Closely related to the genotype but differing in antennal and propodeal characters.

Two Interesting Queensland Eucalypts.

By W. F. BLAKELY (Botanic Gardens, Sydney) and C. T. WHITE (Government Botanist, Brisbane).

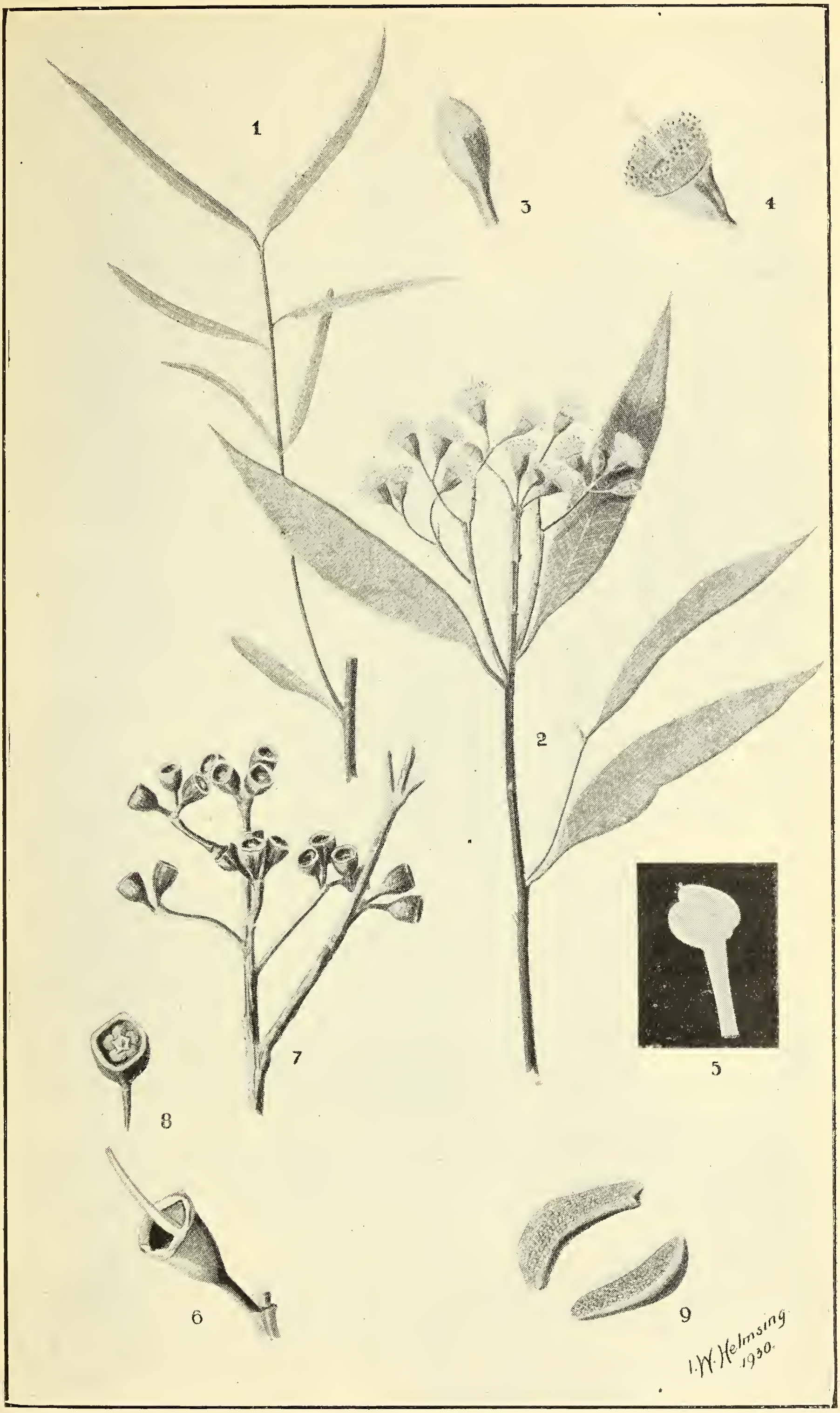
Plate I.

(*Read before the Royal Society of Queensland, 28th July, 1930.*)

Eucalyptus Curtisii n. sp.

Frutex vel arbor parva 3-7 m. alta; cortice lævi griseo. Folia juvenilia vel primaria oblonga vel anguste lanceolata, opposita vel alterna, breviter petiolata, superne obscure viridia, inferne pallida, 2·5-7 cm. longa, 0·4-1 cm. lata, venis lateralibus e costa media angulo 50°-60° emergentibus. Inflorescentiæ axillares vel paniculas corymbosas terminales dispositæ, umbellis 3-6 floris; pedunculis compressis vel anguste alatis. Flores pedicellati, gemmæ 1 cm. longæ, 0·5 cm. diam.; tubo calycis leviter subcostato, limbo minute bidentato; operculo conico, calycis tubo brevius. Antheræ versatiles, late ovatæ vel orbiculares longitudinaliter dehiscentes. Capsulæ pedicellatæ, campanulatæ, venulosæ et subcostatæ 7-8 mm. diam., disco parvo, inconspicuo, valvis 4-6 truncatis profunde inclusis.

A Mallee-like shrub or small tree 3-7 m. high, with grey-silvery stems 5-8 cm. in diameter. Bark smooth, leaden grey in colour, decorticating in long ribbons. Timber very pale, hard and tough. Juvenile leaves (not seen in the earliest stage) linear oblong to narrow lanceolate, opposite and alternate, shortly petiolate, dark green above, pale beneath, the margins slightly irregular and sub-revolute, 2·5-7 cm. long, 0·4-1 cm. broad. Mature leaves alternate or occasionally opposite, shortly petiolate, lanceolate, dark green and shining above, pale beneath, 6-13 cm. long, 1-2·7 cm. broad. Venation rather obscure, the lateral veins making an angle of 50°-60° to the midrib, the veinlets reticulate, intra-marginal vein remote from the edge. Inflorescence in the upper axils forming fairly large terminal corymbose panicles which become infrater-minal by the time the fruit develops. Umbels 3-6 flowered; peduncles compressed or narrowly winged, 10-15 mm. long. Buds conical clavate, pedicellate, pale green, 1 cm. long, 5 mm. in diam. at the broadest part. Calyx-tube slightly 4-ribbed or subdipterous at the base, two of the ribs more prominent than the others and terminating in rudimentary teeth on the edge of the calyx rim. Operculum conical, rather thin, pale green shaded pink, shorter than the calyx-tube. Anthers versatile, broadly ovate to orbicular, with distinct cells opening longitudinally, gland rather small, attached to the upper half of the connective. Fruit pedicellate, campanulate, venulose and faintly costate, one or two of the ribs sometimes expanded into narrow wings, 7-8 mm. diam. Disc small and obscure, slightly oblique; valves 4-6, truncate, deeply enclosed.



Explanation of Plate I.

Eucalyptus Curtisii (Blakely and White.)

Fig. 1. Juvenile or coppice leaves, ½ nat. size.
Fig. 2. Flowering Twig, ½ nat. size.
Fig. 3. Flower bud, × 1½
Fig. 4. Flower, × 1½.
Fig. 5. Anther, × 25.
Fig. 6. Calyx tube and pistil, × 1½.
Fig. 7. Fruiting inflorescence, ½ nat. size.
Fig. 8. Capsule, nat. size.
Fig. 9. Seeds, enlarged.

Description of Seeds.—The seeds are somewhat similar to those of *Tristania conferta* R. Br., and quite distinct from any other species of Eucalyptus, hence a new subseries, Leptospermæ, is proposed.

Fertile seeds pale brown, glossy, minutely rugose on the sides only, the back smooth and glossy, flask-shaped to arcuate, usually 2-ribbed, the base obtuse or produced into a small, straight point, gradually narrowed upwards into the small truncate hilum, $1\frac{1}{2}$ mm. long, $\frac{1}{2}$ mm. broad in the widest part. Sterile seeds somewhat similar in shape and size to the fertile seeds, but straighter and of a darker colour.

Description of Seedlings.—Cotyledons reniform, 5 mm. long, $2\frac{1}{2}$ mm. in diameter. Hypocotyl slender, terete, pale pink, 1-1·5 cm. long. First pair of leaves linear-lanceolate, shortly petiolate, pale green, 1-1·5 cm. long, 4-5 mm. broad. Second pairs of leaves linear-lanceolate, petiolate, 1·5-2 cm. long, 6-7 mm. broad, dark green above, pale beneath. Third to fifth pair of leaves narrow-lanceolate, shortly petiolate, smooth, pale on the lower surface, 4-8 cm. long, 0·7-1 cm. broad. Sixth to eighth pair narrow-lanceolate, 7-12 cm. long, 1-1·3 cm. broad, the same colour as the earlier leaves. Intermediate leaves alternate, petiolate, lanceolate to obliquely lanceolate, 6-8 x 1·5-2 cm. Venation fine and somewhat obscure.

Range.—Sandstone hills near Plunkett, about 33 miles S.W. of Brisbane: *C. T. White*, 26/8/1923 (sine No.). Bushes 6-8 ft. high, bark peeling off in long strips; 24/2/29 No. 5592, very common on sandstone ridges, small trees up to 7 m., but mostly smaller of Mallee-like growth, trunks with a smooth grey silvery bark; Nov. 1929 (flowering specimens), *D. Curtis* (the type).

The species is named in honour of Mr. Densil Curtis, who first drew the attention of one of us (C.T.W.) to the tree when collecting in that locality in 1923. Unfortunately, only fruiting specimens were gathered. The locality was again visited in February 1929, but again the trees were only seen in fruit, although a good series of fruiting specimens, wood, and coppice leaves were gathered. Mr. Curtis, however, gathered good flowering specimens in November 1929, which enabled us to draw up a satisfactory description.

Affinities.—The species closely resembles *E. Shiressii* Maiden & Blakely, in shape, colour, and general appearance of the juvenile and adult leaves, also in the shape of the buds, but the anthers place it in a different subsection, while the fruits are more venulose, and the wood is pale.

The leaves are reminiscent of those of *Tristania laurina* R. Br., and the fruits and seeds resemble the corresponding characters of *T. conferta* R. Br. to a marked degree.

Systematic Position.—It is a very interesting species with the Mallee-like habit of *E. eudesmioides* F. v. M. and the rudimentary toothed calyx of some of the members of the Eudesmieæ, but the staminal ring is regular, and the filaments are not tufted. The rather large terminal inflorescence is not unlike the Corymbosæ, but the anthers are much shorter, the fruits not urceolate, and the timber is white.

It cannot be satisfactorily placed under any of Bentham's subseries (Series Normales in the "Flora Australiensis") and a new subseries—Leptospermæ—intermediate between the Corymbosæ and Eudesmieæ, is here proposed to receive it. The characters are as follows:—

Subseries Leptospermæ.—Flowers rather large, inflorescences borne in the upper axils forming a terminal more or less corymbose panicle (infraterminal in fruit). Calyx ribbed, two of the ribs produced into minute teeth on the calyx rim. Capsule campanulate, seeds narrow, minutely rugose on the sides, the back smooth.

Eucalyptus tenuipes n. sp.

Arbor parva vel mediocris, cortice fibrato persistenti. Folia juvenilia opposita vel alterna, linearia vel anguste lanceolata, sessilia vel breviter petiolata; folia matura vel secundaria opposita vel alterna breviter petiolata, anguste lanceolata, 6-15 cm. longa et 0·8-1·8 cm. lata; venis lateralibus e costa media angulo 60°-70° emergentibus, venis lateralibus et venulis subobscuris. Inflorescentiæ umbellas axillares dispositæ; umbellis 5-10 floris; pedunculis 1·2-1·7 cm. longis; pedicellis tenuibus subteretibus, 0·7-1·1 cm. longis. Flores ignoti. Capsulæ hemisphericæ vel late turbinatæ 4-5 mm. diam. valvis 3-4 leviter inclusis vel discum subæquantibus.

A "Stringybark or Mahogany" of medium size, bark long-fibred, dark reddish brown, close and persistent to the small branches. Juvenile leaves not seen in the earliest stage; those available are smooth, yellowish-green when dry, opposite and alternate, linear to narrow-lanceolate, sessile to shortly petiolate, dark coloured and subcaniculate above, pale beneath, with a yellowish prominent midrib, 5·15 cm. long, 0·5-1 cm. broad. Mature (adult or secondary) leaves opposite and alternate, shortly petiolate, narrow-lanceolate, thin and pale, drying a dull yellowish green, 6-15 cm. long, 0·8-1·8 cm. broad. Venation very fine and subobscure, the lateral veins diverging at an angle of 60°-70° to the midrib; the intramarginal vein very close to the edge. Inflorescences in axillary umbels of 5-10 markedly pedicellate flowers. Peduncles slender, subangular, 1·2-1·7 cm. long; pedicels very slender, subterete, 0·7-1·1 cm. long. Flowers unknown. Fruit pedicellate, hemispherical to goblet-shaped, remarkably thin, 4-5 mm. diam. Disc depressed or much lower than the calycine ring, rather flat, or forming a thin carnose ring over the delicate capsule and partly concealing the three or four very small valves. Fertile seeds pale brown, D-shaped to obliquely pyramidal, glossy, faintly 2-ribbed 1½ x 1 mm. Hilum small, terminal, irregular in shape. Sterile seeds pale brown, as long as the fertile seeds, but narrower and more irregular in shape.

Affinities.—Its affinities are firstly with *E. acmenioides* Schauer, particularly in the venation of the leaves, shape and sculpture of the fruit, and probably in the anthers; the bark is also like that of *E. acmenioides* Schauer, known in New South Wales as White Mahogany and in Queensland as Yellow Stringybark. It is, however, readily distinguished from *E. acmenioides* by its narrow sub-rigid juvenile leaves, its uniformly narrower adult leaves, and in the exceedingly long slender pedicels to the fruits. *E. Curtisii* Blakely & White resembles this species mainly in the narrow juvenile and adult leaves, and to some extent in the shape of the fruits, but *E. Curtisii* is a smooth-barked, small, Mallee-like shrub or tree, with a large terminal inflorescence, while *E. tenuipes* is a medium-sized tree with a very fibrous persistent bark.

Synonym.—*E. acmenioides* Schauer, var. *tenuipes,* Maiden & Blakely Crit. Rev. Gen. Euc. vol. vii. (part lxx.), p. 464, plate 285, figs. 5, 6.

Range.—Meteor Creek, South-Central Queensland; local name "Peppermint Stringybark": *Dr. H. I. Jensen,* July 1921 (type). Dalby Forest district, "Stringybark of medium size": *Deputy Forester Singleton,* No. 34. Nudley *via* Dalby: *Forest Overseer Scouller:* Chinchilla, small "Stringybark" tree of stunted appearance, very loose outside bark, 25-30 ft. high; the best stem I could find was 8 inches in diameter, older trees very hollow; I only know of one patch of these trees about here; inside wood of a brown colour. *R. C. Beasley,* No. 17, 3/7/1928: Chinchilla on poor stony ground, local name "Mahogany." *R. C. Beasley:* Additional specimens 16/1/30 (sine No.).

The Consideration of certain Factors as Potentialities in Mosquito Control in Australia.

By R. HAMLYN-HARRIS, D.Sc., City Entomologist, Brisbane.*

Plates I.–II.

(*Read before the Royal Society of Queensland, 1st September, 1930.*)

INTRODUCTION.

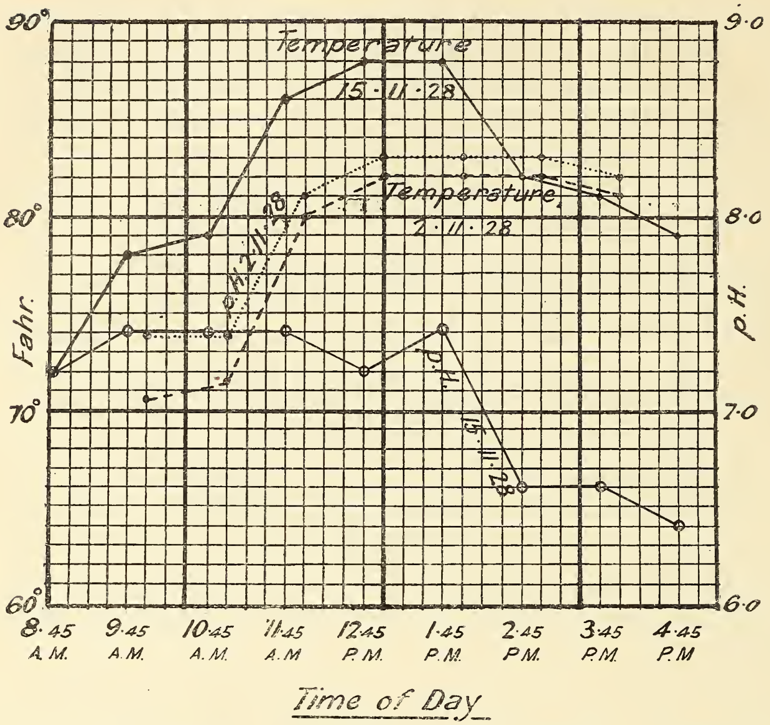
There is perhaps no phase of mosquito control less understood than that appertaining to the breeding places of mosquitoes in the open. It is commonly supposed by the average person that any and every water-holding swamp is an actual breeding place, and it is extremely difficult to bring home the actual truth with regard to this difficult question because, whilst we know that there are many that are not and never do breed mosquitoes, it is very difficult to give a correct interpretation of what is actually going on. In order to explain the position with any degree of accuracy, it has been sought to divide breeding places into places of selection as opposed to places of compulsion. The explanation as to why this should be so, however, cannot be sought by taking one factor alone into consideration, and therein lies the difficulty of the problem.

POTENTIAL *VERSUS* ACTUAL BREEDING PLACES.

During fieldwork it may be possible to determine the causes of avoidance or selection with some degree of certainty in isolated instances, but unfortunately these reasons cannot be generally applied. The most obvious thing with regard to the selection of breeding places seems to be the factor of the food supply. Of recent years a good deal of attention has been given to the hydrogen ion concentration of the water, and, though these investigations have not so far yielded the results we had hoped, yet the consideration of this interesting side of the question has produced valuable scientific data (MacGregor[10] and others). Records indiscriminately taken and applied without any

* From the Entomological Section, Department of Health, Brisbane City Council.

careful co-ordination tend to become useless and in some cases are grossly misleading. The hydrogen ion concentration of any given water is a useful indication of the types of waters selected by different types of mosquitoes and for this purpose alone is helpful. Hydrogen ion concentration, however, is a far more difficult thing to determine than appears at first sight, for the changes are sometimes so rapid and are influenced by so many factors that it is quite possible to take the readings of the same water at different places, at different levels, and under varying conditions of temperature and locality, and obtain different results each time, so that no useful purpose can be served by the reiteration of their values. Hydrogen ion concentration readings should be taken, therefore, with the greatest possible care, and in view of the fact that temperature has such a profound influence upon ionic dissociation, or whatever the cause may be, the temperature of the water at the very spot at which records are taken should go hand in hand. Most waters show a gradual rise in pH during the height of the sun's activities, which drops again the moment the temperature begins to fall. Some have regarded this change in pH as due to the presence of aquatic vegetation only, producing by photosynthetic activity changes in the water irrespective of temperature. This pH range can, however, be induced quite irrespective of vegetation; the change is just as pronounced and shows practically no difference from those waters which are supposed to be constantly affected by the vegetation which abounds. The way in which temperature influences the rise and fall of pH is shown by the accompanying graphs. An interesting instance of the supposed effects of aquatic vegetation upon the pH is that recorded by Matheson & Hinman[11] when they interpret the presence of *Chara fragilis* as giving rise to lethal effects and producing the death of mosquito larvæ, the lethal action of the plant being said to be closely associated with a high pH which varies directly with the degrees of photosynthetic activity. In Queensland *Nitella phauloteles* is said to act in a similar way, and yet, when the water is examined in which this Charophyte flourishes, the pH is shown to stand mainly in relationship to the temperature of the water, and even on the hottest day in summer this rarely exceeds 88° F. or so during the peak period of the day when the highest pH is reached, with the decline of temperature the pH also declines. This plant is definitely stated to be lethal to mosquitoes, and yet throughout the greater part of November and December 1928 both *Anopheles annulipes* and *Culex annulirostris* were found thriving in thick masses of it. This does not suggest any lethal action in the field at all events.



GRAPH I.—HYDROGEN ION CONCENTRATION OF "NITELLA" WATERS.

The relationship of temperature and pH in a small pool with *Nitella cristata* and *Nitella phauloteles,* illustrated by two different readings taken within a fortnight of one another at the same spot, the first on 2nd November, and the second on 15th November, 1928 (rapidly drying up). On both occasions *Anopheles annulipes* and *Culex annulirostris* were plentiful. *Chara benthami* was also present in small quantities. Larval destructors exceptionally numerous.

It is an extraordinary thing that, however varied the readings may be, there exists some definite relationship between temperature and pH, for notice how the pH drops with the decrease in temperature. Furthermore, as evidence that this pH is not induced by photosynthetic activity but is produced by the effects of temperature upon ionic dissociation, it is instructive to notice that test tubes provided with water placed in the pools from which the readings are taken will show similar differences throughout the day to those shown by the pools themselves.

Enoggera Creek (5-mile radius from Brisbane Post Office).

Of greater importance, by far, than this question of pH seems to be the presence of decomposition products in the water. Here we tread on surer ground, at least so it would appear, and possibly by far the greater mortality amongst mosquito larvæ can be attributed to the toxic effects of these. That this would prove of importance has been foreshadowed by others (Harvey[6 7 8]; Pruthi[15 16]; MacGregor[10]; Williamson[23]). Some experiments conducted by the writer during the winter months, with a view to discovering the changes that would be likely to take place under laboratory conditions, have yielded results of scientific and practical interest.

Four large glass jars holding approximately 9 or 10 litres each, to which a 2·5 per cent. peptone solution had been added as nitrogen supply, were used.

Object of such Experiments.

Sample 1.—This experiment was conducted with the express intention of testing the effects of a well-aerated peptonised solution upon mosquito larvæ. It was thought that a superfluity of oxygen might possibly prolong life. In order to supply oxygen to the water regularly, air was bubbled through it night and morning. In other respects this jar was the same as No. 3. Both were exposed to the atmosphere.

Sample 2 was used to test the effect of a CO_2 blanket kept constantly upon the surface of the water. The air was kept excluded by means of a glass cover. CO_2 was delivered from a Kipp's apparatus night and morning.

Sample 3.—This jar was left exposed to the atmospheric conditions of the room during the whole period and acted in some measure as a control.

Sample 4 was kept covered to exclude dust. Further 5 cc.'s were added on five different occasions, making a total of 50 cc.'s of peptone solution during the whole period under observation. This was done to allow for the food factor. The possibility of the food supply being used up during the process of the experiment was thereby excluded.

It is, however, recognised that, with the appearance of toxic substances as by-products of putrefaction, the killing power of the solution becomes apparent. It is unfortunate, however, that though we have every reason to believe in their presence we know so little about the nature of them.

Samples of the water as per the accompanying table were taken and subjected to analysis at intervals of about ten days, attention being specially given to consideration of the nitrogen products and the changes induced therein.

Six egg-rafts of *Culex fatigans,* approximating anything from 1,000 to 1,500 eggs, were added to each on the 27th August (1928); temperature of tap water used being in each case 67° F.

EXPERIMENTS DEALING WITH PUTREFACTION CHANGES.

No. of Specimens and date of collection of Water subjected to examination.	pH.	Free Ammonia, p.p.m.	Albuminoid Ammonia, p.p.m.	Nitrite, p.p.m.	Nitrate, p.p.m.	Total Nitrogen.	Oxygen Consumed, 212° in 30″.
Experiments. Sample 1 kept well aerated throughout—1928.							
(1) September 5	8·0	2·10	2·16	0·150	0·005	4·415	7·25
(2) September 10	8·2	2·90	2·75	0·01	0·1	5·76	8·6
(3) September 25	8·0	3·40	2·34	0·01	0·05	5·80	..
(4) October 31	8·4	0·8	0·5	0·012	0·10	1·412	..
Experiments. Sample 2 with CO_2 blanket never absent—1928.							
(1) September 5	7·0	4·40	2·26	0·187	0·005	6·852	7·5
(2) September 10	6·4	3·10	2·85	0·01	0·10	6·06	9·4
(3) September 25	6·3	6·30	2·20	0·005	0·0075	8·555	..
(4) October 31	6·3	0·40	0·55	16·0	0·20	17·15	..
Experiments. Sample 3—Normal control—1928.							
(1) September 5	8·0	3·80	2·06	0·005	0·005	5·870	7·5
(2) September 10	8·2	3·10	2·15	0·005	0·200	5·455	7·4
(3) September 25	8·4	3·44	2·40	0·0075	0·075	5·9225	..
(4) October 31	8·0	0·40	0·75	0·30	0·10	1·55	..
Experiments. Sample 4—Peptone solution gradually raised by regular additions of 5 c.c. for food purposes—1928.	7·5—						
(1) September 5	8·0	5·30	2·51	0·40	0·005	8·215	7·5
(2) September 10	8·2	7·80	3·45	0·0225	0·15	11·4225	14·8
(3) September 25	8·4	7·94	3·8	0·0087	0·10	11·8487	..
(4) October 31	8·3	5·4	1·05	0·020	0·050	6·520	..

NOTE.—I would here like to express my gratitude to Mr. W. J. Chamberlain, Water Chemist to the Brisbane City Council's Water and Sewerage Department, for the trouble he has taken in making the analyses above detailed.

Time—Aug. 25, 1928, 4 p.m.	Temperature in Room at 10 a.m.	Peptonised Fluid prepared and Mosquito Eggs added.			
		Sample 1.	Sample 2.	Sample 3.	Sample 4.
Aug. 28	..	Eggs hatched by 2 p.m.	A portion of eggs hatched	Eggs hatched out	Eggs hatched out
Aug. 30	65·5°F.	First moult 4.15 p.m., numbers considerably reduced	First moult commenced (31st), numbers considerably reduced	First moult	First moult
Sept. 3	..	Second moult	Second moult	Second moult	Second moult
Sept. 10	72°F.	Large numbers dead	Larvæ reduced; remainder well but uncomfortable	Larvæ well but numbers reduced	Large numbers of larvæ present; appear in a flourishing condition
Sept. 14	72°F.	Third moult	Numbers considerably reduced. No sign of moulting	Numbers of larvæ dead	Larvæ numerous and in a flourishing condition
Sept. 17	72°F.	Conditions unaltered	Fœtid smell particularly noticeable	Conditions unchanged	Larvæ splendid; isolated ones growing at a rapid rate
Sept. 28	72°F.	Still no pupæ	A miserable looking pupa makes its appearance	Still no pupæ	First two pupæ noticed at 12 noon; first male hatched 3 p.m.
Oct. 9	72°F.	Of the original larvæ only about 2 dozen left	One male hatched but died soon after; only about 30 of the original larvæ left	12 of the original larvæ left	First female hatched 3rd October, and by the 9th 4 further females and 2 males had hatched; about 200 larvæ still flourishing
Oct. 22	73°F.	Only 12 larvæ left; no objectionable smell noticed	Only 6 larvæ left; certain protozoa very plentiful; examined dead larvæ under microscope; collapse of tracheæ observed	6 larvæ left alive; unpleasant smell	Several specimens hatched; smell of water like glue
Oct. 27	77°F.	First pupa noticed	Larvæ dying fast	..	Larvæ dying off
Oct. 30	77°F.	Pupa died in the attempt	One or two larvæ left	6 larvæ left; spend all their time in gyrations on the surface of the water	About a dozen larvæ still living
Oct. 31	74°F.	6 larvæ and 1 pupa left; pupa motionless on the surface, failed to mature	..	..	Larvæ abnormal
Nov. 7	84°F.	One single pupa hatched out at 1.30 p.m.	2 pupæ floating dead upon the surface	1 pupa noticed; 1 adult	..
Nov. 12	All dead	All dead	All dead	All *C. fatigans* gone but several *Ædes argenteus* noticed developing in this jar, which had evidently been selected by them earlier in the month, when several small larvæ were noticed for the first time	2 adult females dead on the top of the water; 3 dead pupæ noticed, all the remainder dead

The interpretation of these results is fraught with much difficulty, but it will be recognised at a glance, however, that the mortality of the larvæ was such that very few adults matured. The peptone solution was intended to meet the food demand, and, in order to make doubly sure that there was no possibility of the larvæ dying from starvation, additional quantities of peptone were added to Sample 4 from time to time. It is interesting to note that, under such favourable conditions as at first obtained, the larvæ made rapid progress, and at the end of the first week or two, when most of the other jars were sadly depleted, Sample 4 contained by far the greater number of larvæ in a thoroughly flourishing condition. Everything seemed to go well until suddenly the larvæ commenced to disappear, and from that time on disaster after disaster overtook them.

Approximately 600 c.c. were abstracted from the jars each time water was taken for analysis, so that, allowing for a certain amount of evaporation, the tendency would be for each breeding place to become more restricted, including also possibly a higher concentration of the water contents.

It is difficult to explain the tremendous mortality of the larvæ in all the experimental jars except in terms of the nitrogen cycle; these facts seem to speak for themselves, forcing us to the belief that in this instance this question is of greater moment than the food supply. It certainly has proved itself to be so in the laboratory; in the field a greater number of factors are naturally brought into play, but we have no reason to believe that in the main the mortality would be any less in the field, given similar conditions, than elsewhere.

Particularly astonishing are the results recorded from Sample 2. It must occasion some surprise that the larvæ continued to live on for some time in spite of the CO_2 blanket which was never absent from the surface of the water. It may be presupposed that very little of this would enter into solution, and it is a mystery from where the larvæ procured their oxygen. The only feasible explanation seems to be that larvæ must be capable of using up dissolved oxygen from the water.

The opinion may be further expressed that the water would probably contain sufficient oxygen to enable the original larvæ to keep alive in spite of the presence of a narcotic poison, on the surface. With regard to the larvæ themselves there is a further factor to be taken into consideration besides that of oxygen, namely, the conversion of free and albuminoid ammonia into nitrite. In the proportions in which it occurs there can be little doubt that the nitrite would be toxic to mosquitoes, and the experiments tend to show that the toxicity of the decomposition products was responsible for the final debacle. Peptone is a putrefying substance, and, according to Pruthi,[16] the moment the first important change causes the appearance of toxic substances, the killing time (his researches deal with fish) would only be a matter of hours.

For purposes of comparison, the following analysis of water taken from a manure pit should be studied. The liquid was a highly concentrated one and was full of all developmental stages of *C. fatigans;* hence, for the purposes intended, no more typical breeding place of this species could be imagined.

The total nitrogen is considerable; the presence of albuminoid ammonia in such quantities is evidently responsible for the existence of such an ideal breeding place in which large numbers of bacteria would swarm. The larvæ of this species seem to prefer coarse foodstuffs which insure rapid development. It is further extraordinary how consistently *Culex fatigans* selects "hay infusion" mixtures of this sort. A further interesting instance of this is often seen in the field when waterholes, hitherto free from infestation, commence to breed *Culex fatigans* freely the moment rotting grass is thrown into the water.

In such a sample as this the amount of organic matter present is not only natural but of immense value as a food reserve, and the so-called "suspended developmental phase," with which one is so familiar, seldom occurs. The significance of chlorides and total alkalinity is very imperfectly understood at present, though the high content might be a factor in the retardation of development of certain sylvan mosquitoes. No other mosquito with the possible exception of *Lutzia halifaxi,* which is also occasionally found in liquid manure, could exist in such concentration.

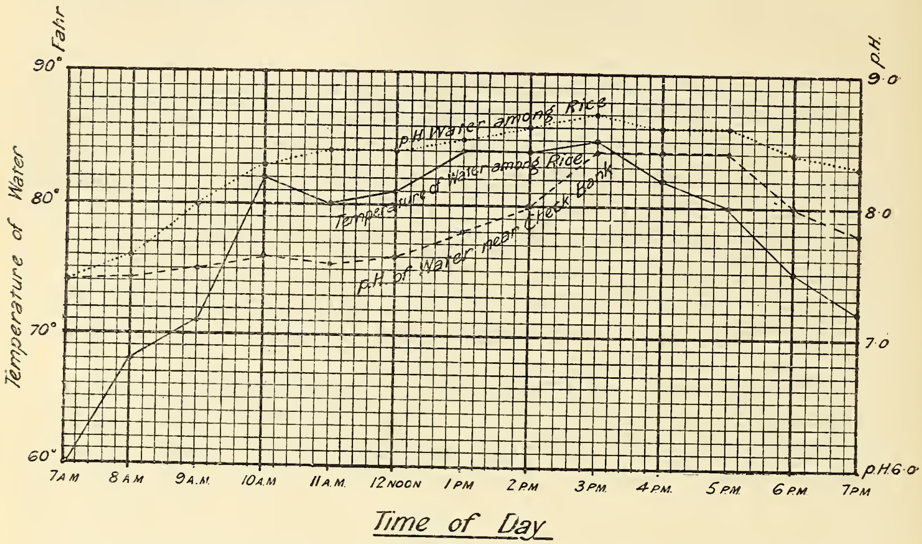
Parts per Million.

Free ammonia	25·75
Albuminoid ammonia	25·5
Nitrites	·0025
Nitrate	·6
Chloride	220·0
Total alkalinity	820·0
Consumed oxygen at 212° in 30 mins.	370·0
pH	7·5

HYDROGEN ION CONCENTRATION AND TEMPERATURE.

Our knowledge with regard to hydrogen ion concentration and its contributing factors is undergoing many changes.

For some time past the necessity for taking readings of various waters, waters of all kinds and description, some breeding mosquitoes, some not, some containing vegetation, and some not, has been apparent. As has already been stated, the hydrogen ion concentration will vary throughout the day irrespective of the presence of aquatic life. It is a significant fact that, from the moment a peak period is reached in the temperature of the day and the temperature commences to fall, the hydrogen ion concentration of the water falls with it. It is of course not to be supposed that temperature alone is responsible, but from actual readings taken over and over again it would seem as if this were the main determining factor. That there are contributory causes must be self-evident from the variations that are liable to take place. A study of the accompanying graphs should make this quite clear.



Graph No. 2.—Hydrogen Ion Concentration of "Rice" Waters.

The hydrogen ion concentration of the rice-fields varies. In this instance the maximum is reached in water among the rice itself. Though the localities at which the temperature and pH were taken were only 4 yards apart, the presence of rotting soudan grass near the check-bank asserted itself by influencing the pH as shown above, the pH remaining nevertheless all the time on the alkaline side of neutrality.

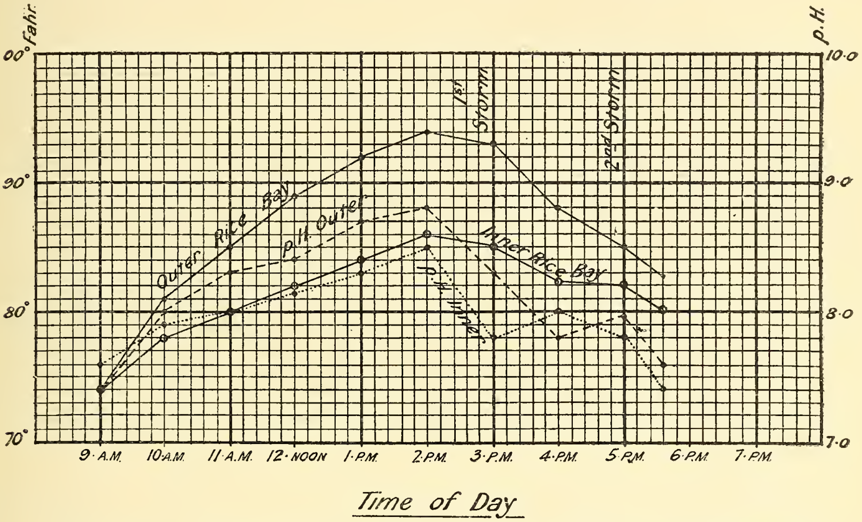
These readings were taken in crabhole country at Ellimo, near Yenda (Farm No. 1640, Patterson). The paddock was 5 acres in extent and the rice ten weeks old.

Anopheles annulipes was present along portions of the check-bank in small quantities, and *Culex annulirostris* was just commencing to breed in association.

The tendency of rotting fibre to alter the pH, as is suggested by this record, opens up the question of the efficacy of such to create conditions unfavourable to mosquito breeding.

18th December, 1928—Mirrool, M.I.A.

In taking readings, the greatest care has been taken that the thermometer is placed in the same spot every time and that no disturbing influences are allowed to affect the water, for it is quite possible that discrepancies in some records may be attributable to disturbing elements which are apt to upset the equilibrium of the water during the course of the day. Particularly noticeable is this in Graph 3, which records happenings in one of the rice paddocks of the Yanco district, Murrumbidgee Irrigation Area, taken during a very hot spell. During the course of the day the temperature of the water rose steadily to its highest point of 95° F. by 2 p.m. The pH at the same time of the day rose to 8·8; suddenly there was a change in the atmosphere and by about 2.45 p.m. a severe dust-storm had swept over the rice-fields, travelling it was estimated at a rate of about 30 miles an hour, and the drop in the pH was exceptionally noticeable, which during that short period of time had fallen to 7·8. From that time on, the temperature continued to fall and the pH with it. At 5.30 p.m. another storm made its appearance, which necessitated retreat. A slight rise in the hydrogen ion concentration between the two storms remains unexplained.



GRAPH No. 3.—THE TEMPERATURE OF "RICE" WATERS IN ITS RELATION TO HYDROGEN ION CONCENTRATION.

Temperature of pH readings taken in one rice-field on each side of a check-bank dividing two bays at Murrami, Farm No. 1081 (Tooth) on 7th January, *Culex annulirostris* and *Anopheles annulipes* present in both bays. The period under review suffered two dust-storms, one between 2 and 3 o'clock in the afternoon and the other after 5 o'clock, necessitating retreat; the fall in temperature and the corresponding alterations in pH are particularly noticeable. The rice crop was grown on the same chocolate soil two years running.

The difference in the temperature and pH of the two bays throughout the day is difficult to account for. Pools forming the floor of a creek-bed and situated side by side all vary in the same kind of way. Such changes are not at all uncommon.

It must of course be conceded that waters taken in different parts of the rice-fields will yield slight variations of temperature as well as slight variations of pH. (Graphs 2 to 4.)

It is a foregone conclusion that water in the field will not have the same temperature or pH as it will have after having been brought into the laboratory, where we find the tendency is for the water to increase in alkalinity quite irrespective of any photosynthetic activity or temperature. When once the water has been brought into equilibrium with the temperature of the laboratory the water still shows a tendency to rise in pH, so that when conducting experiments in the laboratory this side of the question must not be overlooked. It is interesting to note, however, that hydrogen ion concentration seems to follow very much the same rate of development in most waters, at all events in Southern Queensland, whether provided with aquatic vegetation or not, and, unless there is some abnormal condition responsible, the pH rarely if ever rises beyond 8·6 to 8·8, even on the hottest day in Brisbane. Where a high pH of 9·0 is reached in the field, whatever apparently the conditions may be that have induced it, mosquitoes invariably fail to select it. On investigation it nearly always transpires that the pH is due to the presence of some other factor rather than temperature, in one case, perhaps, to an increase of an alkali or some other chemical which may be present. If a weed like *Nitella phauloteles* is allowed to remain in an aquarium for a considerable length of time so that the whole jar becomes balanced, there is generally a slight variation in pH during the course of the day, and when the jar is placed during the hottest part of the day in the direct sunlight the pH rises only gradually; though many figures relating to Charophyta have been accumulated, I have never been able to get the high pH referred to by Matheson & Hinman.[11] Furthermore it is of importance to note at times, if such a jar containing *Nitella phauloteles* placed in the laboratory is supplied with egg-rafts of *Culex fatigans,* the eggs hatch quite normally but seldom mature. This has been a source of continual worry, because the same thing happened with other Charophyta which normally in the field breed thousands of mosquitoes though perhaps a sylvan type.

Seeing that the pH reached in these jars is usually a consistent one, it was determined to test out the food factor as thoroughly as possible, and, knowing the voracity of *C. fatigans* larvæ and their preference for coarse organic substances, a fish food known as "Piscidin" was used as a supplemental food, with unexpected results, for the larvæ thrived and continued to thrive. As long as they were fed with this food every third day, the breeding cage was thronged with adults of both sexes in a shorter space of time than is usually the case. Such results proved that *Nitella phauloteles* is not lethal to mosquitoes under normal conditions, provided that the food supply is adequate to meet all larval requirements.

This is further confirmed in the field. During the recent summer of 1928, pools forming the bed of Enoggera Creek were numerous, and in these pools time after time various species of Nitellas had come to rest, so that the whole floor of the pools was covered from end to end and from side to side with copious growths of various Charophytes consisting of *Nitella cristata* and *Nitella phauloteles, Chara benthami, Chara australis,* and others, and in some of them several species were so entwined that it was futile to attempt to separate them. In all these pools without exception, *Anopheles annulipes* Walker occurred breeding side by side with large numbers of *Culex annulirostris* Skuse. The waters in which these plants occur are rich in iron and the deposition of iron salts is considerable, influencing to some extent the hydrogen ion concentration of the water in question, and, though iron salts in the ferrous state would seem to destroy food organisms, these sylvan mosquito larvæ seem to be in no way inconvenienced thereby.

The Waters of the Rice-fields.

The potentialities of the rice-fields must not be overlooked, because with the greater accumulations of water the numbers of mosquitoes will naturally tend to increase. In every part of the world where rice is grown, the carriers of malaria in particular constitute a serious menace. It is no wonder, therefore, that the numbers of *Anopheles annulipes* in the Murrumbidgee Irrigation Area should be a matter of some concern.

Breeding in the rice-fields is first induced by mosquitoes which have survived the winter in drain-ditches and such like. *As colonisation of the rice-fields must take place every year, the sources of supply from which those mosquitoes come should be regarded as the principal breeding places in the area, and control should be directed against them.* After colonisation of the rice has once taken place, breeding may go on unrestrictedly. During the period of the rice's growth the water reaches a high temperature, but, with the stooling, shade is provided and mosquito larvæ linger in the cooler portions of the rice-field. With the growth of the rice, the water becomes more and more suitable for breeding purposes. The presence of organic matter is shown by the analyses of rice-waters taken from the spot. For this reason it would appear as if the rice-paddocks in the early stages were not so suitable for larval growth, as in the latter, when the water has become suitably balanced, vegetation is plentiful, and food supplies are assured.

As the Graphs 2-4 show, rice-water is usually on the alkaline side of neutrality; probably this condition suits not only the rice best but also the organisms and bacteria which flourish therein. There has been some talk of the condition of water being affected adversely by rotting fibre (Williamson[23]). So far no experiments have been made to test this possibility, though it was noticeable that in one of the rice-paddocks containing a considerable quantity of last year's rice-trash no mosquito larvæ could be located. Such a negative finding, though apparently of little value, may some day lead to more positive results. The adverse influences of toxic substances produced as by-products of putrefaction against which no mosquito larvæ can possibly hope to survive have yet to be studied. Research in mosquito eradication tends to take this direction, and, compared with the importance of this aspect of the question, the food supply sinks into mere insignificance.

Analyses of Samples of Water from the Rice-fields at Kubank's Farm, No. 101, Murrumbidgee Irrigation Area:—

Sample 1.—Taken from the edge of rice-field on eastern end of Farm, Mirool. Less turbid than Samples 2 and 3.

Sample 2.—Taken from drain outside check-bank on the western side of the rice-field. Sample turbid and containing green algal growths. Little movement of water in this drain.

Sample 3.—Taken from drain along road to the south of the rice-field. Little movement of water in this drain; water turbid and containing green vegetable growths.

Duplicate samples of about one litre each were taken, and the results are averages of the duplicates. No mosquitoes were breeding in any of these waters at the time.

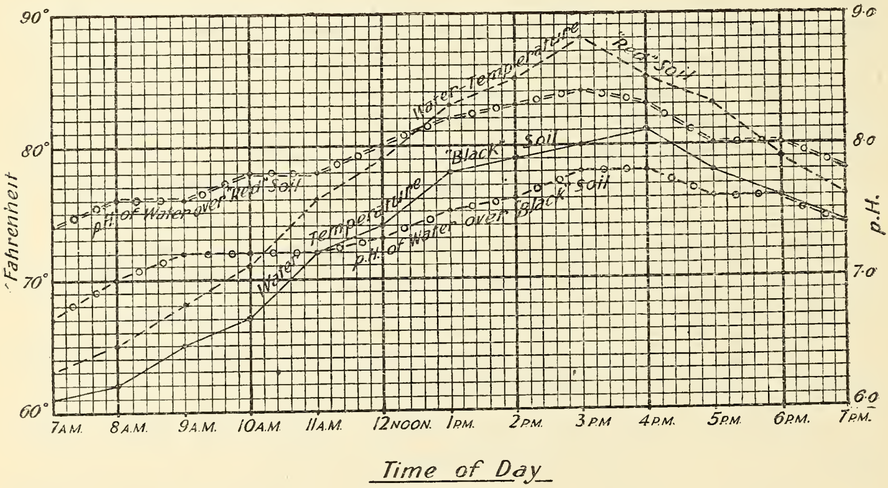
——	pH.	Alkalinity, p.p.m., expressed as $CaCO_3$.	Cl., parts per 100,000.	Oxygen consumed at 212° F. at 30 min., parts per 100,000.
Sample 1	7·2	62·0	1·22	8·31
Sample 2	8·1	60·0	1·60	10·89
Sample 3	7·5	72·2	1·62	11·33

Remarks: (1) pH.—These results do not give a correct idea, since the readings were determined 2½ hours after having been taken into the laboratory, so that by that time the water had come to equilibrium with the laboratory temperature, which at 3 p.m. stood at 77° F.

(2) Cl.—The chlorine content of this water is low, but there is no particular reason why it should be higher than that of the water in the canal, which would be very suitable for irrigation purposes if it contained any great quantities of salts.

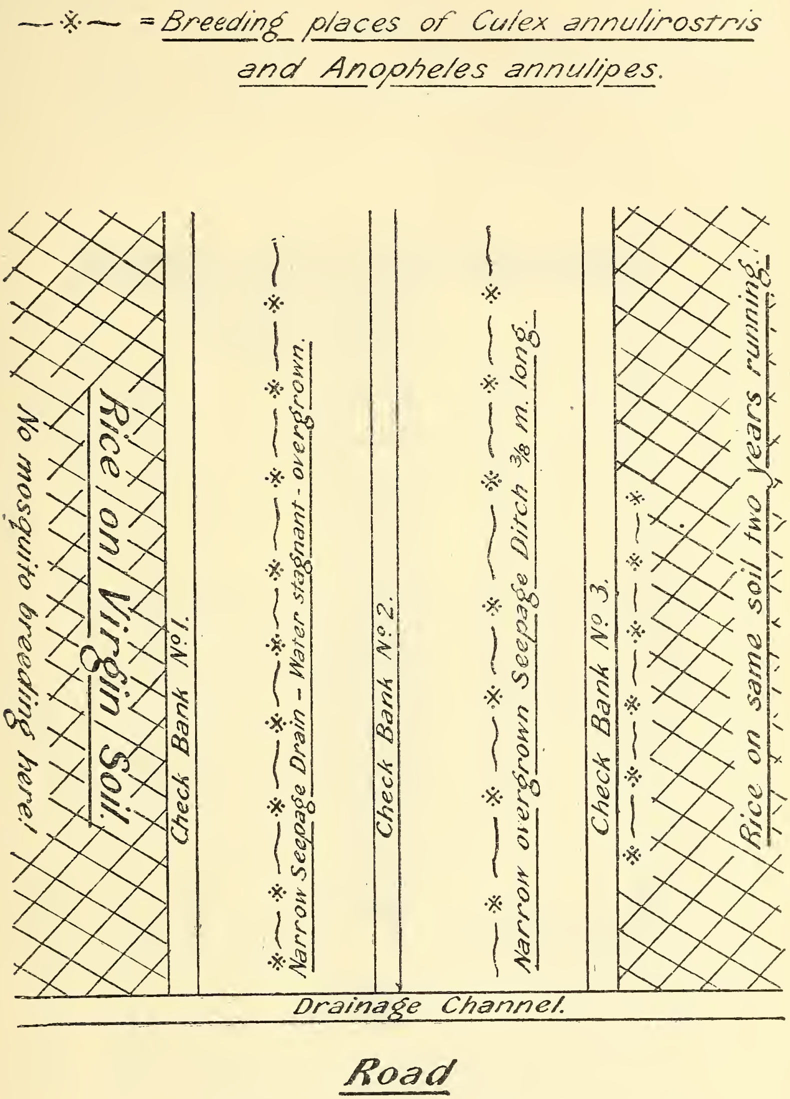
(3) Oxygen Consumed.—These figures are higher than one is used to in ordinary waters, and can only be explained by the fact that the water had been in contact for some time with a dense rice crop, as well as a large quantity of vegetable débris, and all the samples were particularly turbid. The estimation, however, was carried out on the filtered samples.

NOTE.—My thanks are due to Mr. H. Norman England, Assistant Soil Survey Chemist at the Research Station, Griffith, New South Wales, for kindly undertaking the analyses of these waters, which were made on 22nd March, 1929.



GRAPH No. 4.

To illustrate the difference of temperature of the water and pH on "red" and "black" soils respectively, the readings taken in two adjoining rice-paddocks, Farm No. 1456 (Spencer), Murrami, Yanco Area, New South Wales, during 10th January, 1929. No mosquito larvæ present. "Red" soils which are light, friable, and easily worked are apparently warmer than the heavier "black" soils. The "red" soil was flooded on 22nd October and the "black" soil rice-paddock a week later. Both were grown on "virgin" (rice) soil.



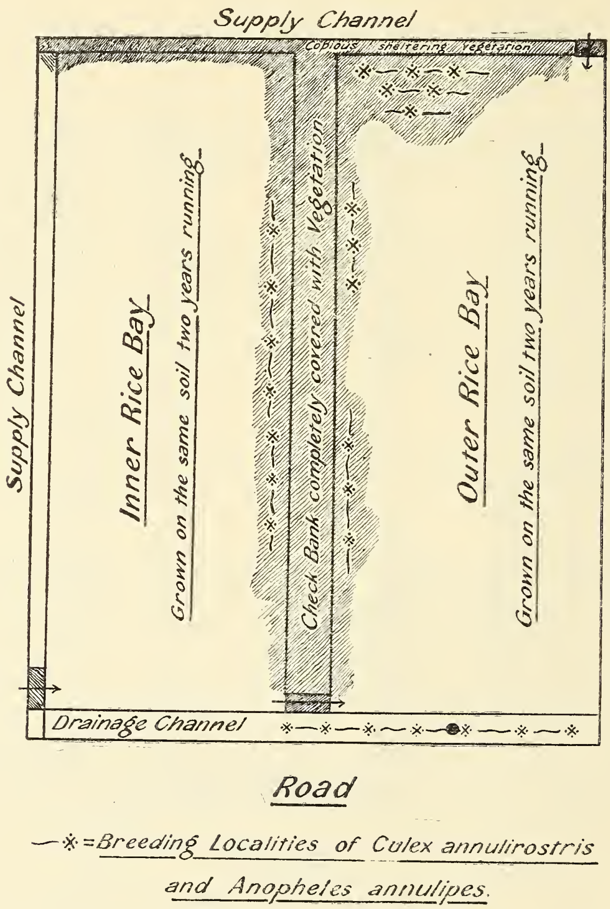
TEXT-FIGURE 5.—BREEDING IN NARROW SEEPAGE DRAINS.

No more ideal breeding place than that here selected by *Culex annulirostris* and *Anopheles annulipes* can be imagined; the places were shallow seepage drains, the distance being a matter of 3 or 4 feet between each check-bank and extending for $\frac{3}{8}$ mile in length. The food supply consisted mainly of decaying vegetation, the attractive influence of the "hay infusion" favouring the growth both of Protozoa and Bacteria. The rice-water first selected is that grown on the same soil two years running, always nearest to the source of supply.

Murrami, Yanco Area.

It is significant that rice grown on the same land two years running breeds more mosquitoes than rice grown on virgin soil. This is due to the presence of much organic matter, providing considerable food supplies. In this particular instance the whole of the shaded portions were covered in vegetation consisting mainly of lucerne and several varieties of paspalum, and it was in the shade of these, under the protection of the bank, that larvæ were found in constant association, whilst no larvæ occurred at all in any part of the actual rice-field. The breeding in the drain alongside was insignificant in comparison.

Locality: Murrami, Yanco Area.



TEXT-FIGURE 6.—MOSQUITO-BREEDING IN THE SHELTER OF THE CHECK-BANKS.

In Queensland the presence of such sylvan mosquitoes as *Culex annulirostris* and *Anopheles annulipes*, thriving among various species of *Nitella* in the field as we have seen, rules out the possibility of the Characeæ being of any practical utility.

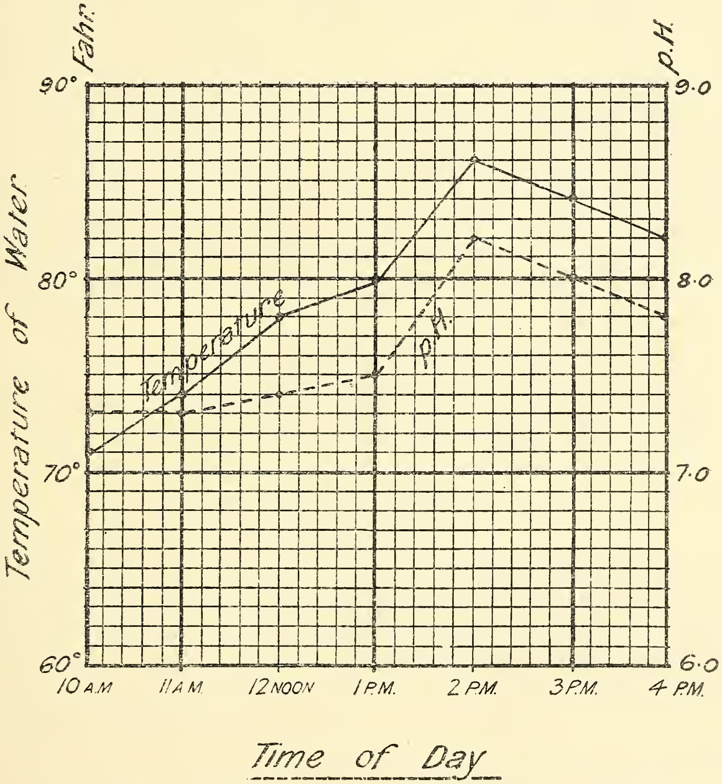
Graphs 1, 7, and 8, illustrating the relationship of the temperature of the water and pH in pools covered with Charophytes, seem to suggest that the plant has less to do with the pH than one might be led to suppose. The graphs illustrate results obtained in pools in which two sylvan mosquitoes bred, and in which—

(1) Different results are obtained in the same pool during the same periods of the day—on two different occasions a fortnight in between—the fauna and flora of the pool remaining relatively constant throughout (Graph 1);

(2) *N. cristata* was alone in evidence (Graph 7);

(3) *Nitella cristata* and *N. phauloteles* completely covered the floor of the pool, which was situated in the shade during the afternoon (Graph 8).

It is worthy of note that in all those instances investigated the pH remained fairly consistent throughout. A considerable number of readings, too numerous to publish but which show the same typical drop in pH with decrease of temperature, were taken. Not once did these particular waters record a higher pH than 8·4. This is important in view of the results obtained by Matheson & Hinman[10] with *Chara fragilis*, who state that the water daily rose to a pH value of 9·0. Now



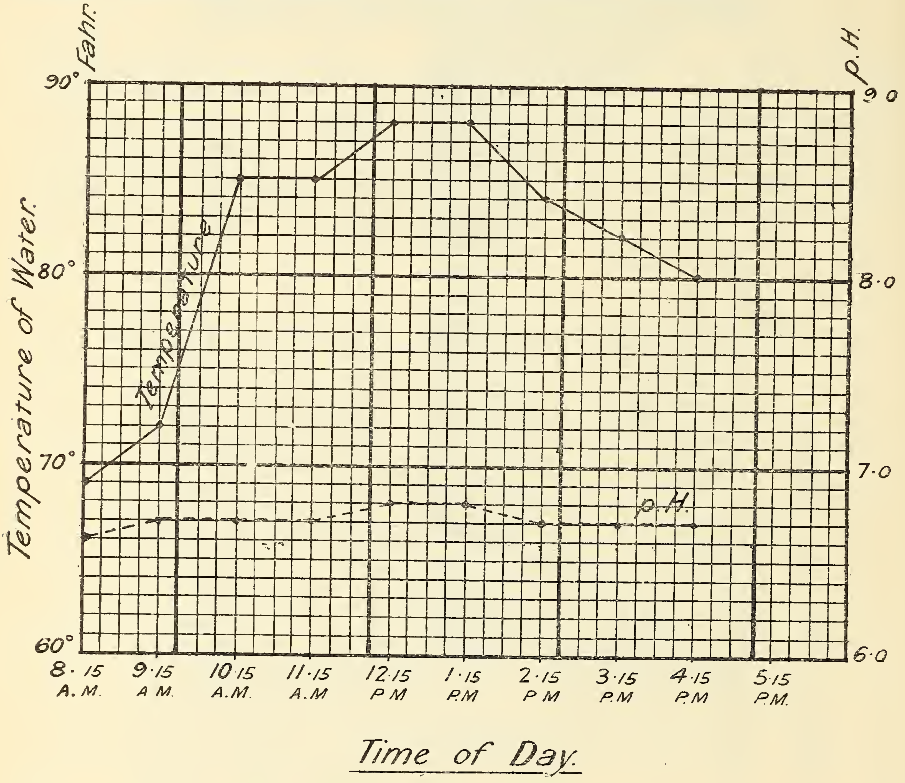
GRAPH No. 7.—pH AND TEMPERATURE OF "NITELLA" WATERS.

Illustrating the relationship between temperature and pH in pool, the floor of which was completely covered with *Nitella cristata*. *Anopheles annulipes* and *Culex annulirostris* occurred here in considerable numbers. The drop in temperature and pH commenced when the pool became enveloped in shade.

2nd November, 1928, Enoggera Creek (5-mile radius), Brisbane Area.

in our experience a pH of 9·0 is exceptionally rare both indoors and out, in *normal* waters, at any time or place. When occasionally an unusual pH is found, the cause of it can usually be referred to some known factor such as the close proximity of a pool to highly alkaline soil; when artificially produced the reason of it is not far to seek.

This difference of high pH values in different countries is a puzzling one. Why *Chara fragilis* in Queensland should yield a lower pH at the maximum point of the day than the same plant does in Ithaca (U.S.A.) is not apparent unless one believes that higher latitudes and other climatic conditions exercise a distinct influence on pH.



GRAPH NO. 8.—HYDROGEN ION CONCENTRATION INDEPENDENT OF TEMPERATURE.

The persistence with which the pH remains on the acid side of neutrality irrespective of temperature is evidence of the presence of another factor pulling in the opposite direction. It is suggested that the large numbers of iron bacteria growing in the water may have something to do with it.

The peak period is reached at 1.15 p.m., comparatively early in the day, accounted for by the fact that after that period the waterhole was completely enveloped in shade.

Nitella cristata at one end and *Nitella phauloteles* at the other completely covered the floor of this waterhole. *Culex annulirostris* and *Anopheles annulipes* were present in exceptionally large numbers in spite of the fact that the whole surface was covered with a deposit of an iron salt. *Culex annulirostris* laid egg-rafts on this scum and the so-called deterrent qualities of such a scum must therefore necessarily be called in question.

Brisbane area.

Before we can hope to apply conditions in U.S.A. to Queensland, would it not be necessary to have some definite understanding with regard to standards needing climatic adjustments? So, for instance, the mean annual range in Ithaca (U.S.A.) is 101° F.; Brisbane, on the other hand, only has a departure from the mean temperature of a range of about 10° on either side of the mean. We in Queensland do not get such extremes as are applicable to U.S.A. and Canada, hence the mean annual range is somewhere in the region of about 20° F.

If, therefore, the pH follows temperature, as is apparently the case judging by the evidence herein produced, then this question will prove of greater moment in our conceptions of the relativity of pH values, and considerable climatic adjustments will be necessary before the data obtained can be interpreted at their true value.

When the time arrives for this aspect of the question to be taken into consideration, it may also be found necessary to consider the effects of solar radiation upon our natural waters and on pH in particular. The results might astonish us. There is also another factor to be taken into consideration in dealing with natural control, and that is the limitations of the species itself and the various influences which contribute to such limitations.

In the absence of larval destructors, the physical environment assumes important proportions, but, although we know so little about the physico-chemical factors, their significance in natural control must be stressed. But over and above all these is the "deficiency of ability" of the mosquito to mature under certain existing environmental factors, and the greater importance of extending our knowledge in the field, rather than in the laboratory, is stressed.

SUMMARY AND CONCLUSIONS.

1. It is established that mosquitoes in choosing any particular breeding-place do so for very definite reasons and not in a haphazard way, and if their love of such places as have a distinct "hay infusion" attraction can be taken seriously, then it would appear as if the food factor were really the main determining one.

2. Mosquitoes tend to breed under ideal conditions in waters best suited to their particular requirements, suitable food being the primary influence in selection. Subsequent alteration of the waters due to decomposition or other causes does not necessarily affect the choice of breeding-places, for eggs are frequently laid on waters which ultimately prove to be death-traps.

3. The economic importance of *Anopheles annulipes* is still in the balance, and it is highly desirable that its real influence upon the incidence of malaria in Australia be determined, the ideal drain-ditches of the Murrumbidgee Irrigation Area being particularly productive of larger numbers of this mosquito, the control of which is in itself only a simple matter.

4. Decomposition products in the water are of vast importance in determining the duration of the developmental stages of the larvæ and the power of the larvæ to survive in the presence of toxicity. It would seem that the presence of albuminoid ammonia insures a plentiful food supply of sorts, and renders the water particularly attractive to *Culex fatigans.*

5. That larvæ can exist for an abnormal time without atmospheric oxygen is shown experimentally; since larvæ cannot exist for any length of time without oxygen, it is surmised that they are capable of making use of dissolved oxygen in the water.

6. Hydrogen ion concentration varies with the temperature: the warmer the soils the higher the pH.

7. Characeæ exert *no* lethal effect upon larvæ in the field. In the laboratory other factors are brought into play which equally influence waters in aquaria and other vessels, affecting the food supply so that the addition of supplemental food for larvæ induces them to select such waters; such larvæ grow and mature normally.

8. The waters of the rice-fields, though conducive to breeding, are not selected at the commencement of the season. As mosquitoes are turned out of the drain-ditches and other permanent breeding-places, colonisation of the rice-fields takes place anew every year. This knowledge should provide the best means towards prevention.

ACKNOWLEDGMENT.—My best thanks are due to the following for their kind hospitality during my stay on the M.I. Area; but for them many of the observations herein recorded would have been impossible:—Mr. and Mrs. Berry, Rice Farm No. 1444, Bilbul; Mr. and Mrs. Patterson, Rice Farm No. 1640, Ellimo, Yenda; Mr. Harold Tooth, Rice Farm No. 1081, Murrami, Yanco; Mr. and Mrs. C. T. Spencer, Farm No. 1456, Murrami, Yanco.

LITERATURE.

1. FERGUSON, E. W.—Notes on Insects A. Mosquitoes (including a Mosquito Survey of the Murrumbidgee Irrigation Area). Rept. of the Dir.-Gen. of P.H. N.S.W. for 1920, pp. 181-183. Sydney 1922.

2. FERGUSON, E. W.—Mosquitoes of New South Wales. 15th Report Microbiol. Lab. Gov. Bur. Microbiol. for the year 1924, 187-191. Sydney 1926.

3. HAMLYN-HARRIS, R.—The Biological Side of Mosquito Control. Med. Jl. of Aust., vol. 1, No. 4, 22nd Jan., 1927.

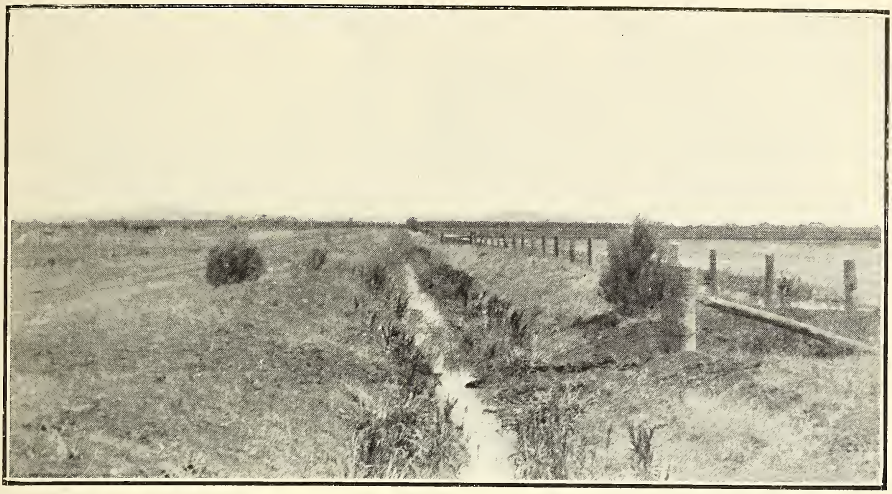
4. HAMLYN-HARRIS, R.—Notes on the Breeding Habits of *Culex fatigans* Wied. and its associated mosquitoes in Queensland. Proc. of the Royal Soc. of Q'land, vol. xl., No. 8, 26th Nov., 1928.

5. HAMLYN-HARRIS, R.—The Relation of certain Algæ to Breeding-places of Mosquitoes in Queensland. Bull. Ent. Res., vol. xviii., pt. 4, May 1928.

6. HARVEY, H. W.—Oxidation in Sea Water. Jl. of Mar. Biol. Assoc. U.K., vol. xiii., Oct. 1925, No. 4.

7. HARVEY, H. W.—Nitrate in the Sea. Jl. of Mar. Biol. Assoc., U.K., vol. xv., No. 1, Mar. 1926.

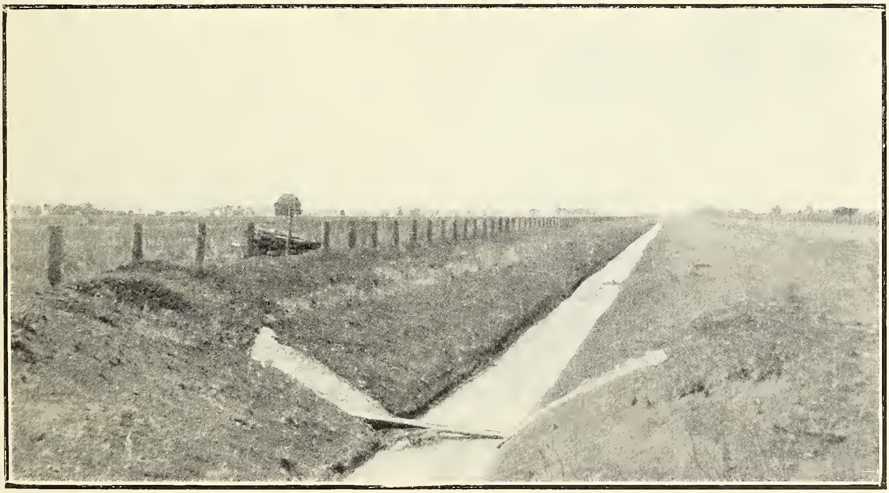
8. HARVEY, H. W.—Nitrate in the Sea II. Jl. of Mar. Biol. Assoc., U.K., vol. xv., No. 1, Feb. 1928.



DRAINAGE CHANNEL RUNNING OUTSIDE RICE PADDOCK (FARM 1444, BILBUL, N.S.W.).

This drain receives the overflow of the rice-fields and is some miles in length. During January of 1929, this ditch was responsible for innumerable numbers of *Culex annulirostris*, and to a lesser degree of *Anopheles annulipes*. *As a breeding place it is ideal;* the water is stagnant, and decaying vegetable matter provides necessary larval food which also consists of algæ and bacteria. The whole drain is suggestive of a delightful "hay infusion," so attractive to certain types of mosquitoes, and *Tæniorhynchus uniformis* taken biting at sundown on the check-banks was possibly also breeding in this ditch.

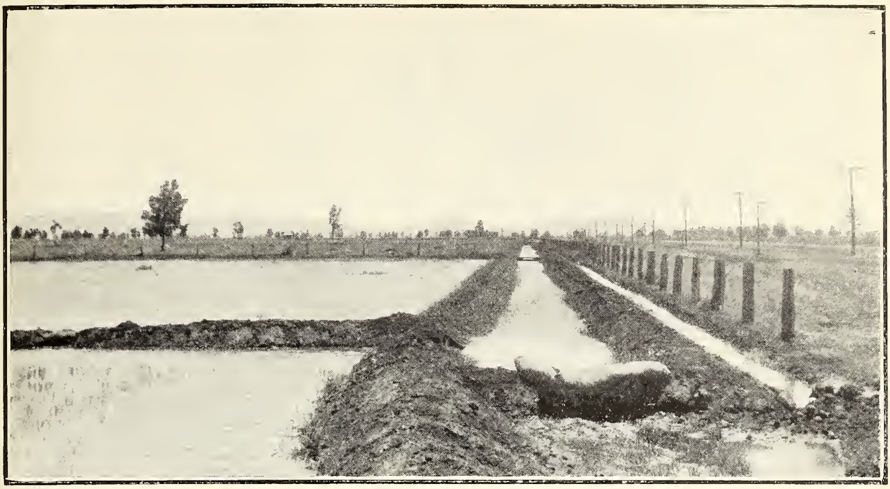
It is in drains such as these that the greater bulk of mosquitoes occurring in the rice-fields breed; the protection offered by the overgrown banks is sufficient for all mosquito purposes.



A NEWLY CLEANED DRAINAGE CHANNEL SHOWN BY WAY OF CONTRAST TO THE FOREGOING.

Whilst the sides of the ditch are kept free from weeds, the water is confined to the centre and is in constant motion; this channel is not even a potential breeding place.

Griffith Area, N.S.W.



TWO NEWLY PLANTED RICE PADDOCKS.

Showing the relationship of the supply channel and seepage pools. It is mainly in the seepage that breeding is likely to occur as soon as the channels become overgrown with vegetation. The supply channels are at all times found to be free of mosquito larvæ.

Mirrool Area.

A RICE FIELD, 8 WEEKS OLD (NO. 1444, GRIFFITH AREA).

Where readings of temperature and pH were taken throughout the course of one of the hottest days in the year (13-12-28). No mosquitoes were breeding either in the rice or in the seepage channel close by. The maximum temperature was reached at the peak period of the day (3 p.m.) in seepage water at 96° F. The readings were always taken 2 inches below the surface at the same spot in every case. In no instance did the pH rise beyond 8.6.

9. MACGREGOR, M. E.—The Influence of Hydrogen Ion Concentration in the Development of Mosquito Larvæ. Parasitology, vol. 13, No. 4, Nov. 1921.

10. MACGREROR, M. E.—The Significance of the pH in the Development of Mosquito Larvæ. Parasitology, vol. 21, Nos. 1 and 2, May 1929.

11. MATHESON, R., & HINMAN, E. H.—*Chara fragilis* and Mosquito Development. The Amer. Jl. of Hyg., vol. viii., No. 2, 292-293, Mar. 1928.

12. MATHESON, R., & HINMAN, E. H.—Further Studies on *Chara* spp. and other Aquatic Plants in relation to Mosquito Breeding. American Jl. of Trop. Med., vol. ix., No. 4, July 1929.

13. MATHESON, R., & HINMAN, E. H.—A Seasonal Study of the Plancton of a Spring-fed Chara Pool *versus* that of a Temporary to Semi-permanent Woodland Pool in relation to Mosquito Breeding. Amer. Jl. of Hygiene, vol. xi., No. 1, 174-188, Jan. 1930.

14. MATHESON, R.—The Utilization of Aquatic Plants as Aids in Mosquito Control. Amer. Nat., vol. lxiv., Jan.-Feb. 1930.

15. PRUTHI, H. S.—The Ability of Fishes to Extract Oxygen at different Hydrogen Ion Concentrations of the Medium. Jl. of Mar. Biol. Assoc. U.K., vol. xiv., No. 3, Mar. 1927.

16. PRUTHI, H. S.—Preliminary Observations on the Relative Importance of the various Factors responsible for the Death of Fishes in Polluted Waters. Jl. of Marine Biol. Assoc. U.K., vol. xiv., No. 3, Mar. 1927.

17. RUDOLFS, W.—Contributions to the Causes of Mosquito Breeding in specific places. Proc. 15th Ann. Meeting, N.J. Mosquito Extermination Society, 1928. New Brunswick, N.J.

18. RUDOLFS, W.—The Composition of Water and Mosquito Breeding. Amer. Jl. of Hyg., ix., No. 1, pp. 160-180, Lancaster, Jan. 1929.

19. SENIOR-WHITE, R.—Physical Factors in Mosquito Ecology. Bull. Ent. Res., vol. xvi., No. 3, Jan. 1926.

20. SENIOR-WHITE, R.—On the Relationship existing between Carbonates and pH and conductivity in Natural Waters. Indian Jl. of Med. Res., vol. xv., No. 4, April 1928.

21. SENIOR-WHITE, R.—Physical Factors in Mosquito Ecology, Part II. Indian J. Med. Res., vol. xvi., No. 1, July 1928.

22. SENIOR-WHITE, R.—Progress towards the Realization of Biological Control of Mosquito Breeding. Trans. 7th Cong. Far East Ass. Trop. Med. 1927, ii., pp. 718-722, 7 refs. Calcutta 1929.

23. WILLIAMSON, K. B.—Mosquito Breeding and Malaria in relation to the Nitrogen Cycle. Bull. Ent. Res., vol. xviii., pt. r, May 1928.

24. WILLIAMSON, K. B.—Chemical Factors in relation to Anopheline Breeding. Trans. 7th Cong. Far East Ass. Trop, 1927, ii., pp. 723-735, 2 figs., 2 refs. Calcutta 1929.

25. WRIGHT, REES.—On the Effects of Exposure to Raised Temperatures upon Larvæ of certain British Mosquitoes. Bull. Ent. Res., vol. xviii., part 1, pp. 91-94, Sept. 1927.

The Royal Society of Queensland.

Report of the Council for 1929.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its Report for the year 1929.

Fourteen original papers were read before the Society and published during the year. Five public meetings were held. On 9th August, Dr. C. M. Yonge, leader, delivered a lecture, in which, with the aid of lantern slides, he described the work of the British Expedition on the Great Barrier Reef. On the 30th September, Professor E. J. Goddard, B.A., D.Sc., delivered a lecture entitled "Science and Agriculture in Java." On 8th October, Professor J. A. Prescott, M.Sc., gave an address on "The Classification of Soils." On 22nd November, Professor Douglas Johnson delivered a lecture entitled "Studies in Shoreline Physiography." On 11th December, Professor H. C. Richards, D.Sc., delivered a lecture, illustrated by moving films, entitled "South Africa: Its Geology and Mining."

The Council wishes to acknowledge generous subsidies amounting to £142 10s. from the Queensland Government towards the cost of printing the Proceedings of the Society. Appreciative acknowledgment is also made to the University of Queensland for housing the library and providing accommodation for meetings. Dr. J. V. Duhig very generously donated £15 for the binding of certain valuable periodicals.

The membership roll consists of 4 corresponding members, 7 life members, and 164 ordinary members. During the year there were 10 resignations, and 7 new members were elected. Mr. H. Tryon was elected a life member of the Society.

There were ten meetings of the Council, the attendance being as follows:—E. W. Bick 8, W. H. Bryan 9, W. D. Francis 4 (granted leave of absence 31st October, 1929), C. D. Gillies 0 (resigned 3rd October, 1929), G. H. Hardy 2 (elected 31st October, 1929), R. W. Hawken 4, J. B. Henderson 6, D. A. Herbert 9, T. G. Jones 7, H. A. Longman 3, J. P. Lowson 6, E. O. Marks 3 (elected 3rd October, 1929), T. Parnell 4, F. A. Perkins 9, R. Veitch 6.

J. P. LOWSON, President.

F. A. PERKINS, Hon. Secretary.

THE ROYAL SOCIETY OF QUEENSLAND.

Cr. STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDING 31st DECEMBER, 1929. **Dr.**

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
Bank Balance, 31st December, 1928	25	4	2	Government Printer, Volume and Abstracts	285	9	0
Subscriptions	152	15	6	Hon. Secretary (Postages and Petty Cash)	15	12	5
Government Subsidy on cost of Printing	142	10	0	Hon. Treasurer (Postages and Petty Cash)	2	0	0
Sale of Reprints and Volumes	20	12	0	Hon. Librarian (Postages)	1	0	0
Donation to Library Bookbinding (Account, Dr. J. V. Duhig)	15	0	0	Hire of Cinematograph	2	0	0
Exchanges	0	6	0	Lanternists	3	0	0
				Advertising Lectures	1	14	0
				State Government Insurance	0	13	0
				Bank Charges	0	10	0
				Exchanges	0	7	8
				Cheque (B. 976134), not presented at 31st December, 1928	15	0	0
				Balance in Q.N. Bank, 31st December, 1929	29	1	7
	£356	7	8		£356	7	8

Examined and found correct.

H. J. PRIESTLEY, Hon. Auditor.

E. W. BICK, Hon. Treasurer.

ABSTRACT OF PROCEEDINGS, 31ST MARCH, 1930.

The Annual Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 31st March, 1930. The President, Professor J. P. Lowson occupied the chair and about sixty members and visitors were present. An apology for absence was received from Miss Bage. The minutes of the previous meeting were read and confirmed. The Annual Report and Balance-sheet were adopted.

The following officers were elected for 1930 :—

President : Mr. J. B. Henderson, F.I.C.

Vice-Presidents : Prof. J. P. Lowson, M.A., M.D. (*ex officio*) and Dr. D. A. Herbert.

Hon. Secretary : Mr. F. A. Perkins, B.Sc. Agr.

Hon. Librarian : Mr. W. D. Francis.

Hon. Treasurer : Mr. E. W. Bick.

Hon. Editors : Mr. H. A. Longman, F.L.S., C.M.Z.S., and Dr. W. H. Bryan, M.C.

Hon. Auditor : Prof. H. J. Priestley, M.A.

Members of Council : Dr. R. W. Cilento, Dr. T. G. H. Jones, Mr. J. A. Just, M.I.M.E., Prof. H. C. Richards, D.Sc., and Mr. C. T. White, F.L.S.

The following were proposed for ordinary membership :—Mr. A. J. Stoney, B.E.E., proposed by Dr. Herbert and Mr. Perkins ; Dr. J. M. Roe, proposed by Mr. Buhot and Mr. Perkins ; Mr. E. M. Shepherd, B.E., proposed by Mr. E. J. Wood and Mr. Perkins. Messrs. D. O. Atherton and H. K. Lewcock, M.Sc., were unanimously elected ordinary members of the Society.

The President moved and Prof. Richards seconded the following motion, which was carried unanimously :—" That a message be sent to Sir Douglas Mawson, Capt. Davis, Prof. Harvey Johnston, and the rest of their party congratulating them on their safe return, and the wonderful work achieved."

Prof. J. P. Lowson delivered his Presidential Address, entitled " Recent Psychology." On the motion of Prof. Goddard, seconded by Prof. Scott Fletcher, a vote of thanks was accorded the retiring President for his address. Prof. H. C. Richards and Mr. H. A. Longman expressed the Society's appreciation of the presence of His Excellency the Governor.

SUMMARY OF PRESIDENTIAL ADDRESS.

The main subject of the address is the repetition of the past in the present in our mental life.

The repetition of the past in the present is a universal characteristic of mental process. It is not confined to conscious memory, but is true of all our perceptions, thoughts, and actions. We can perceive only what we have learned to perceive and analysis and experiment show that the greater part even of our external experience comes from within, although it seems to us to come from without. The human mind is somewhat like a magic lantern. Consciousness is the screen on which our experience appears. But it is lit up from two sides at once, from within as well as from without. Our experience is a compound of pictures thrown from within out of the past with pictures thrown from without out of the present (through the senses), but the two harmonise so beautifully that we cannot distinguish them. In nervous breakdown, however, and still more in insanity, the inner and the outer pictures may clash and their opposite origin becomes apparent.

An important step forward in recent psychology has been the recognition of the fact that the principle of unconscious repetition of the past in the present, which makes possible the growth of every kind of knowledge and practical skill, is equally true of our emotional growth and development. Just as little in the emotional sphere as in the sphere of knowledge and action do new ways of feeling come into being out of nothing and without relation to the past. Our emotional life consists in fact very largely of the repetition in the present of emotional responses, the true origin of which is to be found in our past. It is, for example, a mistake to suppose that the disadvantageous peculiarities of character and feeling from which so many of us suffer are always inborn disadvantages. They are just as likely to be acquisitions made in those earliest years of our life which we have forgotten, and fixed by the repetition of the past which our mental constitution tends to force on us. The same is naturally true of advantageous qualities and feelings also. What we find in practice is that modes of emotional response (love, hatred, and the like) called out in the earliest years of life, tend to persist as part of the apparently fixed character of the individual. This is a fact of very great social importance, since it opens up the possibility of a form of social culture hitherto neglected. Moral education has usually taken the form of enforcing the acceptance of certain ideas and certain forms of conduct without much regard to the nature of the motives which actually induce the child to accept them. The result has often been to cripple rather than further emotional growth. We now recognise that a child's emotional and moral inheritance cannot be expected to unfold and develop normally in unsuitable conditions any more than a plant will develop normally in the absence of sunlight, air, and suitable soil.

Passing now to psychoanalysis.—The practice of psychoanalysis introduced by Professor Freud, of Vienna, has thrown the facts just mentioned about our emotional life into sharp relief ; but psychoanalysis has also made special contributions of its own which reinforce the importance of these facts. Fifty years ago another Viennese physician, Josef Breuer, made the discovery that consciousness does not necessarily accompany our mental processes. Under certain circumstances particular experiences lost to conscious memory may nevertheless persist unconsciously and exert a powerful and irrational influence over subsequent emotional life. Shell-shock during the war furnished many illustrations of this. Thus the idea of unconscious mental process under repression came into being, one character of such process being the compulsive repetition of past emotion, not in harmony with, but in defiance of, reason and the present.

It was this observation of Breuer's which, in the hands of Professor Freud, lead to the gradual development of the modern psychoanalytic method. The value of the method itself is not seriously disputed, but the results attained by its use have been the subject of much dispute. It is often argued, for example, that they are exaggerated. My own experience leads me to believe that the acceptance of the main position actually held by Freud is only a matter of time, but I must confine myself to a single central feature of it.

Analytic investigation appears to show (in conformity with what I have said above) that the first appearances of altruistic feeling in infancy—that is to say, the first affection felt towards a fellow creature clearly distinguished from the infant himself—constitutes a cardinal step in emotional development, since the feelings then called out form the germ out of which all later social affections will have to develop. Hence it is of the greatest importance that this particular step in development should go forward normally. But at the same time that this became apparent a further most important fact appeared also. Our earliest affections are not only the germ of later social feeling, they contain also the immature but powerful determinants of later sexuality. This close association between the first appearances of sexual feeling and the first appearance of affection in the wider sense is not very surprising, since it is paralleled by other features of our development, but it is naturally somewhat repugnant from the adult point of view, since the earliest affections of an infant are naturally directed towards those who stand nearest to it—that is, towards the nearest members of its own family. The situation is further complicated by the fact that most of the manifestations of sexuality in infancy undergo repression (in the technical sense) at the commencement of childhood proper. Apart from analysis they remain excluded from conscious memory. Nevertheless, the influence which they may exert on the sexual life of the individual at adolescence and subsequently is sometimes of the last importance. Many sexual abnormalities find here their explanation, in the compulsive and irrational force exerted by infantile repressed experience. On both these counts then—social and sexual—we hold that infantile experience is the most powerful and important determinant of adult life and character.

Abstract of Proceedings, 28th April, 1930.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 28th April, at 8 p.m. Dr. Herbert in the chair, and about twenty-five members present. Apologies for absence were received from Messrs. Henderson and Lewcock. The minutes of the previous meeting were read and confirmed. The following were proposed for ordinary membership:—Messrs. E. A. O'Connor, M.Sc., and M. White, M.Sc., proposed by Dr. Jones and Mr. Perkins; Dr. W. H. Steel, proposed by Mr. Perkins and Prof. Lowson. Misses F. E. Scott and E. M. Ferricks were proposed for associate membership by Messrs. Perkins and Cayzer. Messrs. A. J. Stoney, B.E.E., and E. M. Shepherd and Dr. J. M. Roe were unanimously elected ordinary members of the Society.

Mr. H. A. Longman exhibited two somewhat abraded otoliths of a freshwater catfish, *Tandanus* sp., which had been found in alluvium at Lake's Creek, Rockhampton, by Mr. F. Jardine, who had sent them to the Queensland Museum. Generic identification was established by direct comparison with otoliths or "ear-stones" taken from recently captured catfishes.

Dr. E. O. Marks exhibited the anterior half of a stone axe, found near the junction of Ewen Creek and Stanley River, near Peachester. The cutting edge had been fashioned entirely by chipping. This exhibit was commented on by Mr. Longman.

Dr. W. H. Bryan read extracts from a paper by E. C. Tommerup, B.Sc., A.A.C., entitled "A Geological Reconnaissance of the Linville-Nanango District."

This paper deals with the geology of a large area situated between Linville and Nanango, Queensland, the information being gathered during numerous journeys made by the writer while engaged in making traverses of the district as an officer of the Queensland Forest Service.

The writer has attempted to correlate and classify the various rock formations of the district, but does not regard the classification as either complete or final.

The oldest rocks in the area are representatives of the Brisbane Schists which occur between Yarraman and Wondai. Next in succession (between Yarraman and Esk) there are several outcrops of slates which probably belong to the Gympie Series. Whether these were deposited *in situ* or were faulted into their present positions is not clear.

These were followed by the Andesitic Stage of the Esk Series, which is typically developed near Marbletop, east of Nanango. The writer was able to follow the massive andesites and andesitic agglomerates of this stage from Goomeri to the head of the Brisbane River and beyond Mount Stanley at least as far as the junction of Avoca Creek with the Brisbane River.

The overlying Shale Stage of the Esk Series was examined by the writer at a number of different localities within the area described, among them being Upper Yarraman Creek, where a small seam of coal is included in the section. Many of the conglomerates associated with the shales contain numerous pebbles of milky quartz, jaspers, and other representatives of the Brisbane Schists, together with others, derived apparently from the Gympie Slates.

The igneous rocks of the area fall naturally into three groups—viz.: (*a*) Granodiorites, (*b*) Porphyrites, (*c*) Basalts. The granodiorites are younger than the Gympie Series, which they intrude, but are older than the overlying Esk Series. The age of the porphyrite intrusions is not clear. They are apparently closely associated with the granodiorites, although they are probably somewhat older. On the other hand, they may possibly prove to be related to the Andesitic Stage, which is restricted to the eastern part of the area. The basalts outcrop along the Cooyar Range and elsewhere, and overlie the Shale Stage of the Esk Series.

The paper is illustrated by a sketch-section from Tarong to Taromeo, and by geological and contour sketch maps.

Miss Dorothy Hill, M.Sc., read a paper entitled "The Development of the Esk Series between Esk and Linville, with Reference to the Possible Occurrence of Workable Coal."

In the Brisbane Valley, between Esk and Linville, a series of Triassic rocks is trough faulted along the north-westerly grain of the country into the Palæozoic (including Permo-Carboniferous) formations. These Triassic rocks, the Esk Series, are freshwater basin deposits laid down by rapidly changing currents, with intensive contemporaneous volcanic activity. The Lower Esk Series is typified by very intense andesitic activity, with the formation of a great thickness of peculiar andesitic boulder beds, with sedimentary deposits being formed during periods of temporary cessation of volcanic activity. The strictly conformable Upper Esk Series, however, is typified by a thick development of rapidly varying sedimentary deposits, with interbedded flows and tuffs resultant from intermittent trachytic activity. Above the Upper Esk Series the Bundanba sandstones, now all eroded away except from the southern part of the area west of Esk, were deposited without angular unconformity.

In addition to the trough faulting, the Esk Series has been strongly affected by sharp north-westerly directed anticlinal fracturing, accompanied by the intrusion of an important series of hypabyssal rocks, the Brisbane Valley Porphyrites, closely related in mineralogical type to the flows and tuffs of the period of sedimentation. The time relations of the trough faulting and anticlinal fracturing are unknown, but they both occurred before the extrusion of the Tertiary rhyolites.

The conditions of deposition and the type of folding of the Esk Series do not promise well for the occurrence of a large field of workable coal, but some of the synclinal areas are worth more detailed mapping on the chance of the discovery of a deposit large enough to support a small colliery.

These papers were discussed by Prof. Richards, Drs. Bryan, Whitehouse, and Marks, and Messrs. Denmead, Bennett, and Dunstan.

A paper, "Essential Oils from the Queensland Flora, Part 1, *Baeckea virgata*," by T. G. H. Jones, D.Sc., and M. White, M.Sc., was laid on the table.

1,560 ccs. of oil, representing a yield of ·88 per cent., were distilled from 353 lb. of the leaves. The constants recorded for the oil are— $[d]_D = +16{\cdot}5$; $N\frac{20}{D} = 1{\cdot}4742$; Acetyl No. = 41; Ester No. = Nil; Density = ·9021.

Examination of the oil showed the presence of d α-pinene 50-60%, cineol 30%, with pino-carveol, aromadendrene, and a sesquiterpene alcohol in smaller quantities.

Prof. H. C. Richards communicated a short paper, "A Record of Graptolites from Mount Isa," by R. A. Keble.

A sample of fine, thinly-bedded sandstone with some of the laminations completely silicified and showing galena, and with some of the others more or less stained with ferric oxide, was found last summer on a spoil dump at Mount Isa by Mr. J. O'M. Lyons, and was subsequently handed to Mr. R. A. Keble by Mr. E. Broadhurst.

Mr. Keble regards the face of the specimen as showing graptolites preserved either as impressions or as films light-red in colour.

There are about fifty polyparies in all, poorly preserved, but many showing both proximal and distal extremities, and one or two showing thecal details.

They all belong to the Monograptidæ, and, although absolute specific determination is unwise, Mr. Keble has no hesitation in citing *Monograptus cf. halli* Barr and *Monograptus cf. undulatus* E. and W.

On this evidence he regards the age of the Mount Isa beds as being Silurian, and mentions that *M.* cf. *halli* occurs in shale approximately 1,000 feet above the base of the Silurian in Victoria at Jackson's Creek and on the Wood's Point Goldfield. He also regards the European equivalent of the Mount Isa beds as approximately zone 21 near the top of the Llandovery.

Especially since the finding of the Cambrian trilobites at the Templeton River the Mount Isa beds have been regarded very generally as Pre-Cambrian in age. On this account, and owing to the association of ore-bodies of much importance, the determination is of considerable interest.

In communicating the paper Professor Richards summarised the evidence for the existing general idea as to the Pre-Cambrian age of the Mount Isa beds, and especially considered the relationship between these steeply dipping beds and the gently undulating fine grits of Middle Cambrian age at the Templeton River a few miles to the west of Mount Isa.

The results of the traverses made by Messrs. Shepherd and Ridgway, of the Queensland Geological Survey, and of Mr. J. B. Wadley in the same region were considered, and possible interpretations of these in terms of a Silurian age for the steeply inclined Mount Isa beds were put forward.

Considerable discussion took place, and general disagreement with the determination of the specimen as graptolitic in character was expressed by several members, especially Dr. F. W. Whitehouse, Mr. B. Dunstan, and Mr. E. C. Saint-Smith.

The firstnamed considered the specimen organic, but he could not believe it to be a graptolite, particularly a species of *Monograptus*. Messrs. Dunstan and Saint-Smith regarded the specimen as purely inorganic, and pointed out that much search had been made for graptolites and other fossils at Mount Isa, and, although material similar to the specimen under discussion had been seen, the structures were considered to be purely inorganic.

Abstract of Proceedings, 26th May, 1930.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 26th May, at 8 p.m., the President, Mr. J. B. Henderson, in the chair, and about twenty-five members present. An apology for absence was received from Miss Holdsworth. The following visitors were also present:—Professor Sir T. W. Edgeworth David, Professor E. W. Skeats, Dr. P. Marshall, Dr. L. K. Ward, Dr. C. Fenner, Mr. J. F. Bailey, and Professor Summers. The minutes of the previous meeting were read and confirmed. The following were proposed for ordinary membership:—Mr. F. Barker (proposed by Messrs. Watkins and Herdsman) and Mr. J. B. Wadley (proposed by Dr. Marks and Mr. Perkins). The following were unanimously elected members of the Society:—Misses E. M. Ferricks and F. E. Scott, Dr. W. H. Steel, and Messrs. E. A. O'Connor and M. White.

Mr. C. T. White exhibited a specimen of the fruit of *Parinarium laurinum* A. Gray picked up on the beach at the southern end of Moreton Bay by Mr. Densil Curtis. Fruits of this tree, which is a native of the Solomon Islands and New Guinea, are sometimes picked up on the Queensland beaches, but the species so far as known has not yet succeeded in establishing itself here.

Dr. E. O. Marks read a paper entitled "The Physiographical Significance and Non-Migration of Divides."

Where, owing to comparative shortness or other denudational advantage, one stream is more active than its neighbour, it will erode its basin more rapidly and encroach on the neighbouring basin. This shifting of the divide, known as migration or headward erosion, is generally recognised as a very active physiographical principle, and on it is based the theories of river-capture and rearrangement of drainage which figure largely in modern physiography.

In this paper it is pointed out that, according to the theory, any originally straight divide must be made crooked by the irregular action of this headward encroachment. Consequently any straight divide must have a tectonic origin and still be in its original position.

The Blackall-D'Aguilar ranges form such a straight divide, separating the group of numerous short streams running eastwards into the sea from the headwaters of the Stanley and Mary rivers. On Mount Mee and Blackall tablelands the divide is at 1,500 feet elevation, but for 10 miles between these is about 500 feet. Here the rocks are soft and differential denudation obviously accounts for the lower elevation and different character of this part of the divide. Although the short streams have courses entirely on soft sandstone country, while the Stanley waters have 180 miles to go largely over hard rocks, and although there is clear evidence of the lowering of this part of the divide by denudation at least 1,000 feet, there has been no migration, and this in a situation where it would necessarily have occurred had the theory been correct.

Other straight divides confirm this absence of migration in situations where the theory would require it, except to such a minor degree as to render it utterly incapable of the results claimed for it.

It is necessary, therefore, that all that part of physiographical theory depending on the migration must be seriously modified if not entirely discarded.

Some inquiry is made to discover the flaw which renders the theory inconsistent with the observed results of these nature-performed experiments.

This paper was discussed by Professor Sir Edgeworth David, Drs. Ward, Fenner, Marshall, and Bryan, and Messrs. Bennett and Jones.

Mr. Perkins read extracts from a paper by B. B. Grey entitled "Chaetognatha from the Society Islands."

The *Chaetognatha* discussed in this paper were collected in sixteen hauls, irregularly spaced over a period of twelve months. Ten species are represented, belonging to two genera, *Sagitta* and *Pterosagitta*, including *S. oceana* n. sp. A table illustrating the coincident occurrence of the species is included. *Sagitta oceania* n. sp. is described as new to science, the description being supplemented by several text figures. The fertilisation of the *Chaetognatha* is discussed, special reference being made to observations on *S. oceania* and *S. enflata.* A brief account is given of the parasites found in four species of *Sagitta.* A meal taken by *S. enflata* is described in detail, the meal being a specimen of *S. fridrici.*

The following paper was laid on the table:—"Essential Oils from the Queensland Flora, Part 2, *Agonis abnormis,*" by T. G. H. Jones, D.Sc., and M. White, M.Sc.

Examination of the essential oil obtained from the leaves of *Agonis abnormis* (yield ·6 per cent.) has shown that it possesses the following constants:—

$d_{15 \cdot 5}$, ·9040, n^{20}_{D}, 1·4905, [α]D, + 9, Ester number 7·4, Acetyl value 16, Acid number 1·7, and is composed of a mixture of d α-pinene 30%, aromadendrene 60%, and a small percentage of sesquiterpene alcohols. The aromadendrene fraction is being further examined and at least two sesquiterpenes are present.

Abstract of Proceedings, 30th June, 1930.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 30th June, at 8 p.m. The President, Mr. J. B. Henderson, in the chair, and about twenty members present. The minutes of the previous meeting were read and confirmed. Messrs. F. Barker and J. B. Wadley were unanimously elected members of the Society.

A paper, entitled "The Genus Oxyscelio: Its Synonymy and Species, with the Description of One New Genus," by Mr. A. P. Dodd, was laid on the table.

This paper discusses the characters of the Scelionid genus *Oxyscelio* Kieffer, erected with *O. foveatus* Kieffer from Java as the genotype. The genera *Camptoteleia* Kieffer, *Dicroteleia* Kieffer, and *Xenoteleia* Kieffer are regarded as synonyms of *Oxyscelio,* the reasons for making these alterations being given at length. Many species originally described or formerly placed in the genera *Sceliomorpha* Ashmead, *Hoploteleia* Ashmead, *Psilanteris* Kieffer, and *Scelio* Latreille are transferred to *Oxyscelio,* which will now contain 32 listed species from Ceylon, the Philippine Islands, Java, and Australia.

The characters of *Oxyscelio* are compared with those of related genera. A new genus, *Bracalba,* is erected to contain *Chromoteleia nigrescens* Dodd and two new species, *Bracalba laminata* and *B. cuneata,* all from Australia, *B. laminata* being selected as the genotype.

Dr. L. S. Bagster conducted some very interesting experiments with liquid air, and showed a metallic spectrum on the lantern screen.

Mr. E. J. Wood, M.Sc., exhibited specimens of the following diseases of sugar-cane from the collection of the Bureau of Sugar Experiment Stations:—(1) Physiological: Chlorosis (deficiency), banded chlorosis (the effect of cold moist nights). (2) Virus: Two specimens showing Mosaic (Fiji) disease, which, though not shown by the experimenter to be transmitted by inoculation or by insects, has X bodies which seem to indicate its virus nature. Dwarfing is a disease which seems to be new to science. It has not been reported from any other country, and 66 stools of it are known. It resembles Fiji disease in its symptoms, except that the galls are replaced by chlorotic areas somewhat similar to Mosaic. It is a phloem disease and is transmissible through sets, as has been proved by the writer, who is at present working on the etiology of the disease. Its symptoms suggest a virus disease, but artificial inoculations have not yet succeeded. (3) Bacterial: Gumming (*Bacterium vascularum*); Leaf Scald (*B. albilineans*); and Top Rot, a bacterial disease not confined to the vascular tissue. (4) Fungal: Downy Mildew (*Sclerospora sacchari*), Pokkah Boeng, and Knife Cut (presumably *Fusarium moniliforme*). A number of root diseases of fungal origin were exhibited. Peg Leg is a butt infection of the Bundaberg-Childers areas and clayey Mackay soils. *Schizophyllum commune* is a secondary parasite of little importance. (5) Phanærogamic Parasites: *Striga* spp., which are short-lived, flourishing from December to February. (6) Teratological: Hairy Root, a rare abnormality.

Dr. D. A. Herbert exhibited: (1) Haustoria of *Olax retusa*, a phanærogamic parasite attacking *Gahnia* sp.; the haustoria were the size of a pinhead, and were collected at Burleigh, June, 1930. (2) A French bean seed with two embryos. (3) *Phragmidium disciflorum*, a rust of the rose on the variety Star of Queensland (uredospore stage). (4) A section of a stem of a liana, *Vitis acetosa*, with exceptionally long and wide vessels.

On behalf of Mr. E. C. Tommerup, B.Sc., specimens were exhibited of Hoop Pine (*Araucaria Cunninghamii*) showing heat girdling, which he has investigated in conjunction with Mr. R. B. Morwood, M.Sc. The stem and crown die, the roots remain vigorous and often throw off coppice leaves at ground level. At the ground level, however, a collar-like constriction is formed, and though the bark is unbroken the water supply is evidently cut off and the tree dies. Plantation trees of two or three years' establishment may be affected. The girdle is often associated with slight swellings above and below the constriction; when the bark is peeled away, dark necrotic rings may be seen above and below the lesion. This disease has been reported from Reserve 151 Neumgna in the Bunya Mountains Area, and from Reserve 220 Kilkivan. Both these areas are on the ecological limit of the rain forests and only receive about 35 inches of rain per annum, with a mean summer temperature of approximately 80 deg. F. Although Bunya Mountains area is one in which the pines are frequently affected by fungal growths, it is considered that this condition exists because the trees are struggling for a living and are more susceptible to fungal attack than are vigorous trees, rather than that the meteorological conditions of this locality are favourable to fungal incubation. The plants attacked are nearly always in exposed situations on heavy soil. Several possible factors were considered, such as wind, damping, fungus, insect injury, frost, &c., but it was eventually decided that it was primarily due to the heating effect of the soil when exposed directly to the sun's rays. Similar diseases are recorded from U.S.A. with other conifers.

Dr. J. V. Duhig, on behalf of Professor Goddard and himself, showed two fish of the species *Galaxias o'connori* (Ogilvy) which had suffered from melanosis. Dr. Duhig showed lantern slides of sections of the skin of the fish. The pigmentation was shown to be due to heavy deposits of what is believed to be melanin about the walls of rounded or oval subepithelial cysts, which are lined with epithelium and are, in reality, processes budded off from the skin epithelium. Another section showed these cysts to contain a parasite, which Dr. Goddard stated to be the metacercaria stage of a trematode, *Clonorchis* (? species). A section was shown demonstrating the ventral sucker by which the genus could be identified. The fish is the second intermediate host of the parasite and the authors propose to continue their investigations in the direction of feeding experiments in order to secure the adult worm. To this end they desire specimens of sick fish which are well pigmented. The exhibit had a double interest, in that it raised the problem of melanin production and the subject of the exhibit was an indigenous species to which little attention had been paid.

Mr. C. T. White exhibited specimens of *Datura ferox* Linn. from Clermont, Central Queensland. The species, which is supposed to be a native of Spain and Sicily, was first collected in Queensland at Macalister, Western Darling Downs, by E. W. Bick about March 1916. Since then it has spread to other places, but Clermont represents the northernmost locality so far recorded.

Professor H. C. Richards, D.Sc., exhibited several beautiful specimens collected by Mr. A. N. Falk of the zeolite Natrolite, from vughs within the weathered olivine basalt on the Main Range some 2 to 3 miles south-east of Toowoomba. He offered remarks upon the origin of the mineral, its crystalline habit, and how it may be distinguished from other zeolites.

Mr. E. W. Bick exhibited a specimen of flowers of *Spathodea campanulata,* the tulip-tree of West Africa. The unopened flower-buds of this species contain a considerable quantity of water of glandular origin. The plant is sometimes known as the fountain-tree on account of the behaviour of the buds when punctured.

Mr. J. E. Young exhibited matted fibrous roots of *Casuarina suberosa,* which had grown in a blanket-like mass in the crevices of consolidated sand on Stradbroke Island.

Abstract of Proceedings, 28th July, 1930.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 28th July, at 8 p.m. The President, Mr. J. B. Henderson, in the chair, and about thirty members present. Apologies were received from His Excellency the Governor, the Premier, the Minister for Agriculture, and Mr. White. The minutes of the previous meeting were read and confirmed.

A paper, entitled "Two Interesting Queensland Eucalypts," by Messrs. W. F. Blakely and C. T. White, was laid on the table.

Two previously undescribed eucalypts are named. *Eucalyptus Curtisii* collected on sandstone hills at Plunkett, south-east of Queensland, represents a new subseries Leptospermæ of Bentham's series Normales. The chief characters which necessitate the formation of a new subseries are the terminal more or less corymbose panicles, the toothed calyx-rim, and the narrow rugose seeds. The tree is a small one of Mallee-like growth, with smooth silvery or leaden-grey bark. The other species, *E. tenuipes,* is a stringybark or mahogany found in parts of Central or Southern Queensland, and previously named by Maiden and Blakely as a variety of the widely distributed *E. acmenioides,* Schauer.

Mr. A. P. Dodd gave an address on "The Biological Control of Prickly-pear." The first step was taken in 1912, when a Travelling Commission made a world tour, and on its return submitted a very valuable report in which it recommended the introduction of certain insects and diseases from America. Since 1919 many of these insects have been carefully studied both in America and Australia, and ten species have been established in Queensland and New South Wales. Of these, the most important are *Chelinidea tabulata, Tetranychus opuntiæ, Dactylopius tomentosus,* and *Cactoblastis cactorum,* and their propagation and distribution has been the main feature of the work during the last few years. *C. cactorum* has been remarkably successful, and it is anticipated that within twelve months further distribution will be unnecessary .

Mr. H. K. Lewcock gave an address on "The Role of Diseases in the Biological Control of Prickly-pear."

Investigations have shown that the biological control of prickly-pear in its native habitats is not due to any one pest or group of pests. Each cactus region has its own combination of cactus enemies which serve to keep the cacti under control. In every such region the components of the cactus enemy complex embrace various species of insects, various fungous and bacterial diseases and, occasionally, certain species of rodents and other small animal life. These pests react differently to changes in their environment, so that the cactus enemy complex is never static but changes considerably at different seasons of the year. In general, the insect pests are far less sensitive to external conditions than are the fungous and bacterial diseases, and are, therefore, more or less in evidence throughout the entire year. On the other hand, certain types of diseases are definitely seasonal in their incidence and may be entirely wanting except during limited periods when conditions are favourable for their development. In the prickly-pear infested areas of Queensland, the successful introduction and establishment of such insect pests as cochineal and *Cactoblastis* has resulted, within recent years, in an amazingly rapid destruction of large tracts of dense pear. However, it has long been evident that this destruction is not due solely to the depredations of the insect pests, but that very valuable assistance is rendered by rots and other types of disease. In other words, the destruction of the pear pest in Queensland is being effected by a complex of insect, bacterial, and fungous parasites in a manner strictly analogous to the way in which the Cactaceæ are controlled by biological agencies in their native habitats. Because of the abundance of water in their tissues, succulent plants, such as prickly-pears, are particularly susceptible to attack from soft or wet rot diseases arising from either fungous or bacterial infections. Hence, it is not surprising that by far the most destructive of the diseases known to attack Opuntias, either in Australia or other countries, is a soft rot bacteriosis. Under favourable conditions this disease spreads rapidly throughout the entire plant, causing the complete collapse of the trunk and limbs as well as of individual cladodes. Diseases of this character are of the greatest value in destroying the pear, since insect pests, such as *Cactoblastis,* are forced to migrate from the rotted areas to healthy tissue, and thus bring about a rapid and widespread dissemination of the disease-producing organism. In fact, it is becoming increasingly evident from field observations that the extent of spread and, in consequence, the ultimate value of such a disease, is dependent on the numbers and vitality of suitable insect vectors during periods of weather favourable for the development of the disease. In addition to the soft rot bacteriosis, a number of other diseases occurring on prickly-pears in Australia were described. For convenience in presentation, these diseases were roughly grouped according to the types of injury that they commonly induce. Four such groups were distinguished. In the order of their relative importance under Australian conditions they are—(1) Fungous soft rot diseases such as that caused by *Schizophyllum commune,* (2) dry rot diseases which are probably chiefly in the nature of physiological disorders, (3) anthracnose diseases such as those caused by the fungi *Phyllosticta concava* and *Glœosporium lunatum,* and (4) the so-called "sun scald" diseases which may be caused by a variety of weakly parasitic fungi.

Mr. Bennett, Dr. Herbert, Prof. Richards, and the President took part in the discussion which ensued, and the meeting terminated with a hearty vote of thanks to the speakers.

ABSTRACT OF PROCEEDINGS, 1ST SEPTEMBER, 1930.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 1st September, at 8 p.m. The

President, Mr. J. B. Henderson, in the chair, and about 130 members and visitors present. The minutes of the previous meeting were read and confirmed.

Dr. R. Hamlyn Harris read a paper entitled "The Character of Certain Breeding Places of Mosquitoes in Australia."

Studies into the possible breeding places of mosquitoes are here continued, and it is sought by patient attention to factors involved to determine the methods underlying selection. The pH Concentration seems an elusive factor, as is shown by the way in which temperature of the water and the warmth of the soils tend to determine it in a large measure. The warmer the soils the higher the pH. That the food factor plays an enormous part in the selection of breeding places is still further emphasised by careful observations in the field.

Sylvan mosquitoes undoubtedly tend to neglect waters in which a rich protozoal and bacterial fauna is missing. Mortality amongst mosquitoes in water in which a high decomposition rate is in progress is very noticeable, particularly in such instances where the death rate can be definitely traced to the toxicity of decomposition products. The ability of *C. fatigans* larvæ to live for some time in water provided with a constant CO_2 blanket is incomprehensible, unless it is possible for dissolved to take the place of atmospheric oxygen.

The effects of the Characeæ in the field in Queensland are negligible; pH varies with the temperature, but sylvan mosquitoes breed freely between the narrow limits, usually in waters on the alkaline side of neutrality.

Work done on the Murrumbidgee irrigation area shows quite clearly that as the colonisation of the rice fields takes place every year, it should be possible to control mosquitoes effectively by clearing mosquitoes out of the drain-ditches and other permanent breeding places at present in vogue. This would, at all events, tend to reduce to an enormous extent the incidence of mosquitoes on the Murrumbidgee irrigation area of New South Wales.

A vote of thanks, moved by Prof. Goddard, supported by Dr. S. F. McDonald and His Excellency the Governor, was carried by acclamation.

Abstract of Proceedings, 29th September, 1930.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 29th September, at 8 p.m. The President, Mr. J. B. Henderson, in the chair, and about 40 members present. The minutes of the previous meeting were read and confirmed.

Dr. L. S. Bagster gave a very interesting address on "The Sugar Industry." The address was accompanied by several exhibits, and illustrated by lantern slides.

A vote of thanks, moved by Prof. Murray, supported by Messrs. Watkins and Bennett, and the President, was carried by acclamation.

Abstract of Proceedings, 27th October, 1930.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 27th October, at 8 p.m. The President, Mr. J. B. Henderson, in the chair, and about 100 members and visitors present. Apologies were received from the Premier, Hon. A. E. Moore, Hon. N. F. Macgroarty, Hon. H. E. Sizer, and Mr. Collins, M.L.A. The minutes of the previous meeting were read and confirmed. Mr. W. M. L'Estrange was proposed by Dr. E. O. Marks and Mr. F. Bennett for ordinary membership.

Mr. O. A. Jones exhibited (a) a stone axe which was found in tin wash about 15 feet deep at China Camp, near Cooktown; (b) a quartz crystal with exceptionally large grains of Cassiterite included, from the same locality.

Professor H. C. Richards delivered a very interesting address on "The Development of a Mining Industry by Modern Scientific Methods."

A vote of thanks moved by Mr. L'Estrange, seconded by Mr. Longman, and supported by Dr. Robertson, Messrs. Bennett, Gipps, Ball, and the President, was carried by acclamation.

Abstract of Proceedings, 24th November, 1930.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 24th November, 1930. The President, Mr. J. B. Henderson, in the chair, and about fifty members and visitors present. The minutes of the previous meeting were read and confirmed. Messrs. W. M. Kyle, M.A., and W. A. McDougall were proposed for ordinary membership by Mr. Perkins and Dr. Herbert. Mr. W. M. L'Estrange was unanimously elected an ordinary member of the Society. The business for the evening was a discussion on "The Distribution and Classification of Queensland Soils."

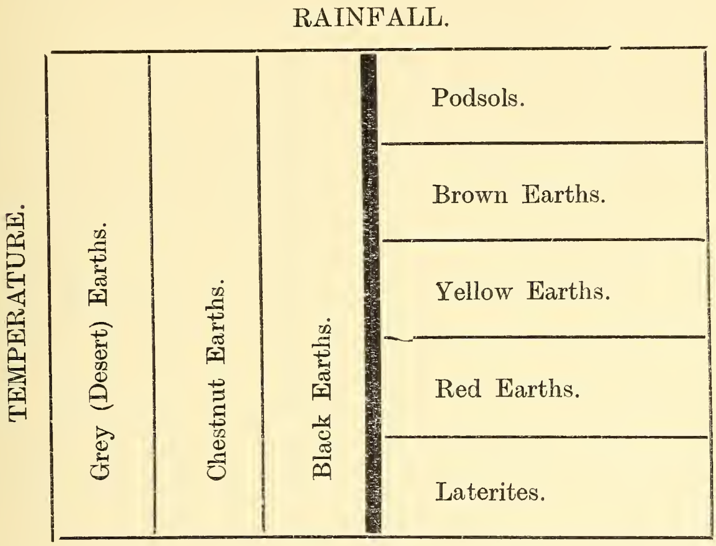
Mr. H. J. Hines dealt briefly with the descriptions of soil in common use, and showed that none of them by itself was capable of describing fully any type of soil. However, sufficient agricultural experience had accumulated in the State to warrant the attachment of considerable importance to common descriptive terms. He then outlined the method of profile description and the generalisations proposed by the Russian and American investigators. Attention was drawn to the soil map of Australia recently published by Professor Prescott, wherein types in Queensland were compared to those established in Russia. Further field investigation supplemented by laboratory determinations of "single value" soil characteristics had suggested that greater weight should be placed on the geo-chemistry of the parent material, vegetation, topography, and drainage than was apparent in Russian views. He suggested that these could be harmonised by considering the process of rock weathering in simple terms of mass action: by considering the process simply as an hydrolysis. The rock-mass could be looked on as a mixture of substances, part of which (A) were relatively easily decomposed, and part (X) undecomposable, or decomposable with difficulty. This mixture reacting with water would eventually form the hydroxides of the alkalies and alkaline earths, silica, and oxides of alumina and iron. The reaction proceeded through several stages producing the common soil materials. As an equation it could be written—

$$\overset{A}{[m\,SiO_2\,Al_2\,O_3\,Fe_2\,O_3]} + X + n\,H_2O \rightleftarrows [\text{Clay}] + X + \underset{\text{soluble}}{\underset{\downarrow}{mOH}} \rightleftarrows Al_2O_3 \text{ etc.} + X$$

If at any one stage the reaction in the direction of the right-hand side proceeded so slowly that apparent equilibrium was reached, a definite soil type could be discerned. The stage reached would depend both on the active masses of the reactants and of the products of the reaction. The active mass of A corresponded with the basicity and slight solubility of the rock; that of the water with the soil water and was thus determined by climate, topography, and texture of soil. The products of reaction of most importance were the alkali and alkaline earth hydroxides which became converted into carbonates, but were capable of yielding ions of the alkali and alkaline earth metals. Their removal was effected by drainage, and was thus dependent on precipitation, topography, vegetation, and soil texture. Hence, if rock type and topography in any area were average, climate and vegetation would dominate the formation of soil type. The further action of water was seen in the downward translocation of the clay minerals, which might proceed slower than, as fast as, or faster than chemical decomposition according to the texture of the soil and its water relationships. This generalisation appears sufficient to explain the frequent occurrence of intrazonal soils in Queensland. As an example the black earth (tchernosem) of Queensland was taken. It developed on the Cretaceous plains as a grey-brown earth; the strip of desert sandstone broke the continuity of the zone eastwards. In the Peak Downs district the true black earth developed on the more basic rocks. Here brigalow and belar thickets began to invade the grassland. The black earth then still retained its characteristic layer of calcium carbonate though becoming lighter in colour. With the advent of rain forests, however, the calcium carbonate disappeared. Highly basic rocks became deep red loams, less basic rocks brown loams with red-clay subsoils. More acidic rocks gave yellow earths and an open forest vegetation. Attention was drawn to Keen's demonstration that the maximum effective capillary rise of soil water was about 3 feet. It was pointed out that the calcium carbonate layer in the black earth occurred at a depth of about 3 feet, and hence would serve to maintain the upper soil layer in equilibrium with calcium ions. If this layer became deeper or were removed through any cause, further decomposition of the primary clay became possible. In the case of the deep red loams this was more rapid than peptisation and downward translocation. Values for oven-dry moisture and ignition loss suggest a change from the montmorillonite group of minerals to those of the kaolinite group with liberation of sesquioxides.

Dr. W. H. Bryan dealt with the several factors which influenced the production of soil types. With reference to the climatic factor, he pointed out that the obvious parallelism of the soil zones of Russia with pronounced climatic belts was explained by the fact that temperature and rainfall both varied with the latitude, the result being a series of regular zones. In the United States of America the major soil-belts made no such regular pattern, and it had been suggested that this lack of regularity was due to the fact that, while the temperature varied from north to south, the rainfall varied from east to west. Some authors had expressed the opinion that this lack of parallelism in the two climatic factors should lead to a checkered arrangement of the principal soil types, but such a pattern was not shown by the soil map. Several attempts had been made to reconcile the distribution of soils in the U.S.A. with the principle of climatic control by the use of composite factors based on the temperature-rainfall ratio, but these were unsatisfactory for several reasons. A study of the American soil map suggested a simple explanation of the nature of the climatic control which in spite of its simplicity seems to have been overlooked. It appeared that where the annual rainfall exceeds a certain amount (approximately 25 inches), temperature becomes the controlling factor, and that where the precipitation falls below this value temperature is relatively unimportant and rainfall is the decisive factor. This generalisation was expressed diagrammatically as follows:—

Diagram to show the relationship between some soil types and the two climatic factors.



Heavy line represents 25 inches rainfall.

If this arrangement does in truth represent an important principle of the relationship of climate to soil type, then it should also be applicable in areas other than U.S.A.—e.g. Russia. The climatic range of Russia would occupy a diagonal strip across the diagram, and would provide the correct sequence of soil types. An arrangement somewhat similar to that of the U.S.A. might be predicted for the soils of Eastern Australia, but the pedalferic soils would be confined to a narrower strip. Referring to Professor Prescott's soil map of Australia, Dr. Bryan suggested that many of the soils of Queensland tentatively shown as Podsols were more probably the equivalents of the Yellow Earths of the U.S.A.

Professor J. K. Murray dealt with soils from the point of view of agricultural experiments.

Dr. D. A. Herbert pointed out the importance of a study of soils with regard to plant ecology.

Professor H. C. Richards recommended for the consideration of the Council of the Society that a committee be formed to collect data and to prepare an account of the soils of Queensland for submission to the Third International Congress of Soil Science.

Publications have been received from the following Institutions, Societies, etc., and are hereby gratefully acknowledged.

ALGERIA—

Societe de Geographie et d'Archaeologia d'Oran.

ARGENTINE—

Universidad Nacional de la Plata.

AUSTRALIA—

Department of Agriculture, Melbourne.

Department of Mines, Melbourne.

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The Bristol Museum and Art Gallery.

Imperial Bureau of Entomology, London.

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Frederick Phillips, Government Printer, Brisbane.

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OF THE

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The Royal Society of Queensland.

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VOLUME XLIII.

Vol. XLIII., No. 1.

Proceedings of the Royal Society of Queensland

Presidential Address

By J. B. Henderson, F.I.C.

(*Delivered before the Royal Society of Queensland, 30th March,* 1931).

You have heard from the Annual Report that despite the difficult year through which the State has passed and the fact that we have had no subsidy from the Government during the latter half of the year, satisfactory work has been done and the printed volume shows a record of good and varied progress.

I regret to have to record the death of one of our members during the year, Mr. R. C. Cowley, who, while he did not take a very active part in our proceedings was an interested member for many years. Mr. Cowley was in charge of the Liverpool College of Pharmacy from 1893 till he left for Queensland in 1908, and was the prime mover in putting the Queensland College of Pharmacy in its present position. He published many papers in the Pharmacy journals in England and Australia.

During the year the Council appointed a Committee consisting of Dr. Bryan, convener, and Messrs. Herbert, Hines, Kerr and Murray to prepare a report on the soils of Queensland for submission to the 3rd International Congress of Soil Science in 1935.

Among scientists the most outstanding feature of the year was the meeting of the Australasian Association for the Advancement of Science in Brisbane in May. Members attended from all the States, from New Zealand and a few from Overseas. Of the work done a part has been published in the Proceedings of the Association, but possibly the most important part, the stimulus received by workers through meeting with fellow workers, never appears on the printed record. Advantage was taken of the occasion to hold meetings of various scientific societies with Interstate membership such as the National Research Council, the Great Barrier Reef Committee, the Pharmacists, the Institute of Chemistry and others. A meeting of importance to us was held at which representatives were present from all the Royal Societies in Australia. The principal question raised was the possibility of having a united Australian Royal Society with Proceedings published at one centre, thereby giving the volumes greater importance and possibly retaining here papers by Australian workers at present published in England or elsewhere. While that in itself would be a good thing, it would inevitably result in the Royal

Society library at one centre containing all the exchanges, leaving the others to purchase the 200 yearly volumes which are now received as exchanges and possibly would also result in the loss of State subsidies which materially help in printing the proceedings. These were considered sufficient reasons for justifying a recommendation that no further action be taken in this matter at the present time.

During the year the Great Barrier Reef Committee have carried on since the Expedition returned to England and while, owing to financial stringency, very little new research work could be undertaken, the Government is still consulting the Committee and utilising the special knowledge of some of the members in dealing with matters relating to the Barrier Reef, for example, in more effectually preserving certain islands as Sanctuaries and Reserves.

The work of the Council of Scientific and Industrial Research in our State during the year has been noteworthy, if not spectacular. The report of Dr. Jean White-Haney on the Noogoora Burr was published, and although this investigation was only to "state the problem," it is the first time our ignorance and knowledge of this pest plant has been summarised. Some suggestions were also made in the report of possible lines of attack on this Burr. The investigation into the Flying Fox Pest, also only to "state the problem," by Mr. F. N. Ratcliffe, has been pushed along during the year and is now practically completed. Mr. Ratcliffe's report we hope will supply the Council of Scientific and Industrial Research with sufficient data to decide whether or not it is worth while to attempt to control these pests, and, if it is considered worth while, that the most promising lines along which to work may be indicated. Mr. W. J. Wiley, one of our old Queensland students, on return last year from two years' Research Scholarship work in Dairy Chemistry in England, was started on an investigation into the alleged "Wood Taint in Queensland Butter" and is still engaged on that work. The intensely interesting investigation by the Division of Animal Nutrition into the special feeding of sheep in Queensland was continued during the year, so also was the investigation into the Buffalo Fly menace in North West Queensland. The negotiations for the establishment of a large permanent Cattle Research Station in Queensland were continued and judging by the latest published reports there are prospects of its successful establishment in the near future.

The work of Prickly Pear destruction still goes on apace and while no great area of dense pear has been completely cleared the total weight of pear on the infected area is decreasing very rapidly. The problem of secondary growths and of the growth of subsequent seedlings has not yet seriously arisen. It will almost certainly have to be faced and the primary work—the biological work—of this new phase must be done by the scientists. The problem will not be nearly such a difficult one as that of the first clearing and I have not the slightest doubt of its successful solution. More especially am I confident of such success because the Prickly Pear Land Commission has shown such eager efficiency to apply the methods worked out by the scientists that any scientific worker can now be certain of a sympathetic hearing and have his methods tried out. When we think of the enormous difficulty scientific workers had, not so many years ago, in trying to convince any Government of the advantages to be gained by scientific control, of the years of waiting for action to be taken, and then think of the rapid, thorough, efficient and large-scale manner in which the Prickly Pear Land Commission attacked the pear with the weapons provided by the scientists, we heartily congratulate the Commission on their work and look forward without fear to the future. It is of course essential that the arduous work of both the scientists and the Commission be maintained and there must be no slackening off in the fight because we have gained the first few rounds. Our Society can look back with pleasure on the fact that every member of the Board which first formulated the successful policy of parasitic attack on the pear and had that policy adopted by the Government, was a member of this Society.

Our Library during the year has, in the absence in England of the Librarian, Mr. Francis, been well looked after by Mr. Hardy, to whom our best thanks are due. The volumes are now better stored and better indexed and therefore more accessible than they have ever been previously, though the Librarians report that there is still much that should be done. The position of Librarian to the Royal Society is no sinecure.

In considering the question of a presidential address, I thought it would be of interest to look over the list of Presidents during the 47 years the Society has been in existence. We have in that time had 41 different presidents, four having occupied the presidential chair on two occasions, one on three. Sir Augustus C. Gregory was our first President and Dr. J. Bancroft was our second. It is noteworthy that in his presidential address Dr. Bancroft pleaded for the establishment of a University and suggested the Botanic Gardens and Government House domain as a suitable site—that was 45 years ago. Then came L. A. Bernays and the Hon. A. Norton, followed by C. W. De Vis who occupied the chair for two successive years. Next came Saville Kent and F. M. Bailey, both of world-wide repute. By the way, Mr. Bailey's son, Mr. J. F. Bailey, was President in 1909 and his grandson, Mr. C. T. White, in 1921—three generations of botanists. Mr. Bailey was followed by Miskin and the Hon. A. Norton in one year. Next came Dr. J. Shirley and Dr. R. L. Jack, Drs. Taylor and Lauterer, then C. J. Pound, the oldest of our Presidents still living, S. B. J. Skertchly and J. W. Sutton. In 1900 came Dr. J. Thomson, then Dr. W. R. Love and the Hon. J. Cameron. The remaining Presidents with the exception of Dr. John Shirley, W. R. Colledge and P. L. Weston are all still to the fore, and are known to us all. It will be noticed that the list includes nearly all the residents of Queensland who have been doing scientific work of any prominence, besides some who, while not scientific workers themselves, were keenly interested and sympathetic and whose help was much appreciated by the Society.

To show the varied attainments of our Presidents it might be noted that the Chair has been occupied by a biologist 10 times, medical 9, geologist 7, chemist 6, general scientist 4, botanist 3, engineer 3, pastoralist 3, physics and mathematics 1 each. Since the establishment of the University in 1910 about half of our Presidents have been members of the University Teaching Staff.

* * * * * * * *

I propose to address you to-night on some phases of individual and national life where science and scientific methods are not being applied, where science has provided knowledge and full advantage has not been taken of that knowledge.

At present there is an enormous mass of new knowledge being collected every year. Some of this is quickly put into use by the general community, but unfortunately a large proportion of it lies dormant in the records of the scientific societies. Fortunately for science, for scientists and for humanity, the average research worker is not interested in how much money he can make out of research work, so when he gets his results published he is quite content that " that is a good job finished and published," and he gets on with another investigation.

That this attitude is well known even to politicians is shown by an incident that I happened to come across a good many years ago. A recommendation had been put before a certain Minister for the appointment of a scientist and the salary recommended was £800 per annum. The Minister wrote a note " approved, but it is well known that scientists work for love of their work rather than for money—make the salary £500," and £500 it was accordingly.

So the scientist goes on with his work and other scientists add to it, and the mass of knowledge grows, but much of it does not get beyond the libraries. Recently the scientifically trained commercial men and the commercially trained scientists have been hunting through this treasure ground and as we all know have acquired much valuable treasure by transmitting the information so acquired into coin of the realm.

And yet there is still unlimited room for further research, and urgent need for reducing our ignorance on many matters connected with agriculture, industry, and other phases of our national life in Queensland.

I intend to-night to mention a few of the many directions in which the community is suffering through allowing the work of the scientists to lie idle or through neglecting in attacking problems to make use of the organised common-sense methods of work so successfully used by the scientists.

Some one once said that Science was merely " organised common sense," or as I saw it put lately " specialised common sense." The distinction between " common sense " and " organised common sense " is perhaps not very clear at first sight, but an illustration will help to make the meaning clearer. Any one with " common sense " can see that, to put it shortly, the sun rises in the east in the morning and circles round the stationary earth to rise once more in the east. But " organised common sense " knows that there are many more facts concerning the case than those seen by the eye. Those seen by the eye are what are generally called " obvious," but they are very misleading if taken as a full statement of the case. Science or " organised common sense " has studied the case, finds there are many much more important factors to consider than those seen by the eye and completely reverses the "obvious" decision by stating that the rotating earth circles around the sun.

It is this demand of the scientist that in considering any question all known facts related to a problem, however contradictory they may appear to be, shall first be collected and considered, which has led to the saying that "a problem correctly stated is a problem half solved."

It is rather interesting to look around at some of our problems in Queensland and to see if we are applying either all the known facts or the best known methods to insure that we shall get the best possible results from our efforts.

In the science of medicine some of the methods used are lagging behind the actual knowledge available. In no respect is this so outstanding as in the matter of diet. With all the advances of modern civilization, the last 60 or 70 years we are told has seen a drop rather than an increase in the health of the ordinary adult. The expectation of life has been enormously increased in infancy—it has not increased in adults. Yet the adult is better clad, is better housed, has much better sanitary surroundings and much better working conditions than he had before. With all these plus factors added, what are the minus factors which overbalance them? Undoubtedly a badly balanced diet is by far the most important factor. The shocking statistics of the health of all men examined for the A.I.F. in a land of plenty like Australia where a lack of total amount of food was practically unknown, shows how badly that generous ration was balanced by even the young men. And Australian statistics were not so bad as those in England.

In considering the general health of the individual I would emphasise that we are apt to judge by a very low standard, that of the average child or adult as we know them, instead of by that standard which could be readily attained by any normal individual living on a balanced diet and taking regular exercise.

For hundreds of thousands of years human beings were used to certain kinds of food, and until last century there was very little real change in the foods eaten by man. Foods were rarely "manufactured" in the modern sense of that term. Most meat was eaten fresh, some was salted; no meat was "tinned" nor was any "preservatised." Starchy foods were difficult to obtain, mostly grown in cereals, and were eaten in a form which digested slowly, while sugars were unknown except in the form of honey. Nowadays all sausage meat, corned meat, hams, practically all beers and soft drinks and all dried fruits, contain preservative and the Law Court Records regularly show convictions for the presence of excessive proportions of these poisons. Grain foods, from which we derive most of our Vitamin B, are rarely sold as our forefathers had to eat them—crushed whole grain. Nowadays the germ and outer part of the grain are removed before selling, taking away at the same time practically all the vitamins, enzymes and other chemically active substances. For many years, as the general characteristics of the remainder of the grain were not much altered it was thought that the resultant white flour was just as good a food as the whole grain, an idea not yet extinct. The modern medical biochemists have shown us that the extremely minute proportions of vitamins, enzymes, and other highly potent substances which exist in grains and other foods are just as important and as absolutely essential to health as are the bulky main constituents. It is just as harmful to interfere with the supply and proportion of these minute traces of chemicals as to interfere with the supply and proportion of the carbohydrates or proteins.

Crushed grains were eaten by man for hundreds and thousands of years, in fact up to until about 60 years ago, as crushed whole grains, and his internal manufacturing laboratory has become adapted to work on the complicated mixture. Now we ask that laboratory to elaborate all the hundreds of chemicals required to keep the body in sound health without a fair proportion of some essential constituents of the raw material and with the large extra proportion of carbohydrates in a too easily assimilated form. No wonder it ceases to function perfectly.

And similarly we take " fruit " out of a tin, minus all or practically all of its vitamins, mix it with a custard which is artificially coloured, and artificially flavoured prepared starch, not eggs and milk as it should be, and recommend such fruit and custard as a " cooling food." As a matter of fact it is an utterly unbalanced food, and far from being cooling, is useful only as providing heat. It is just about the last thing in the way of food that should be given to growing children. And similarly we have such unbalanced foodstuffs as preservatised dried fruits and dried vegetables, cakes made from prepared starch and prepared sugar, and many others. No wonder our children, despite the fact that they are rarely short of *quantity* of food, often fall much short of the physique which they should have in a climate and with a food supply like we have in Australia. How long it is going to take the community to absorb and apply the simple foundation facts of a balanced diet is hard to foretell.

Take one phase of it—the growth of bone, taking the most striking phase of bone growth, that of the teeth. The factors in bone and teeth growth have been well known for a considerable time. The records show that there are four main factors which must be included in an ordinary diet if good teeth are to be maintained : (*a*) sufficiency of vitamins, particularly of Vitamin D. (*b*) a sufficiency of lime ; (*c*) a sufficiency of phosphorous and (*d*) (a rather unexpected factor) the lime and phosphorous must be balanced. At once the question arises—how are we to arrange our food so that these four factors will all be balanced, and the medical biochemist replies : " By eating natural foods—the balance is already there."

The position in regard to teeth was strikingly put some time ago by a well-known dentist in Brisbane when addressing a public meeting on the care of the teeth. He said that all the dentists in Australia working all their available time every day could not keep the teeth of the children in Australia in good condition. American accounts show that immigrants from the country districts of Scandinavia on arrival generally have perfect teeth, but a few years of American diet soon put them about on the low dental level of the average American. About 25 years ago a medical friend showed me an article in the " British Medical Journal " by a London medical professor who had prescribed a diet for seven babies of friends of his.

The children grew up strong and healthy and at the end of seven years each child had perfect teeth and not one had ever used a toothbrush.

There is not a working man who shows a dog at a Dog Show unless the dog has perfect teeth—every dog fancier, without recourse to medical advice, knows how to balance a ration for his dog. But there is probably not a family in Brisbane with children whose teeth are anything like perfect, practically nobody knows any balanced ration for a child, nor does any one seem much concerned. A balanced diet or ration has a very wide range in variety of food and a fairly wide range in proportions and amount ; it is already known and has been known for years, but is taught in neither primary school, secondary school nor university. Let us hope, for the sake of our self respect that some day soon parents will know how to feed their children as well as they feed the dog, so that the boy need not be envying the good teeth of his canine friend.

Many of you must remember Professor Metchnikoff's famous investigation with regard to the long-lived Bulgarian peasants. He found that in their case the characteristic flora in the lower intestine was, in addition to the coli, the harmless lactic acid bacillus working in an acid medium as in the case of our infants, whereas in ordinary civilised people the characteristic bacteria in addition to coli are of the objectionable Gaertner type (streptococci, spore bearing bacilli, other Gram-negative bacilli) and work in an alkaline medium. Hence was derived his theory of autointoxication which looked so sensible and his suggested cure by the consumption of large quantities of lactic ferment in milk. He had a small proportion of brilliant cures, but the large majority of patients were not much the better of the treatment. Unfortunately, Metchnikoff was not a chemist and did not realise that to establish the lactic ferment in an alkaline lower intestine was impossible. A suitable diet is essential containing a proportion of slowly digesting material, mainly starches, which will not be entirely absorbed in the upper intestine but will last into the lower intestine to act there as food for the lactic acid bacilli. Lately the work of Bach and Wheeler in England who have followed up his theory has been extremely successful in curing or relieving chronic diseases such as neurasthenia, rheumatoid arthritis, chronic rheumatism, chronic colitis, chronic headache, anaemia, sciatica, etc., by means of a toxin to clear out the old established bacteria in addition to the altered diet, and without the use of "medicine." Bach and Wheeler state : "Now if an ordinary man or woman, in so-called ordinary health, will live for some weeks on a special diet, changes will ensue in the appearance and general character of the faeces. The diet must be of food as largely as possible uncooked. Raw fruit with good quantities of nuts (well masticated), vegetables, salads, dairy produce, wholemeal bread, cereals, milk puddings ; and for fluids, water, weak tea, milk ; wines of all kinds are permissible, but not spirits. After a variable time, covering in any case some weeks and often running to months, the character of the faeces will change. They will become bright yellow, soft, semi-solid, entirely odourless and acid in reaction. Bacteriologically there is a great diminution in all organisms that thrive in an alkaline medium, namely, B. Coli, Streptococci and spore-bearing bacilli. Of the utmost importance is the appearance of the Lactic acid bacillus, virtually non-existent in the alkaline stools, but multiplying in response to this diet until it may constitute as much as 30 per cent. of the total bacterial flora. If the individual has habitually eaten much meat or otherwise departed from this special diet in ordinary life, or is heavily infected with the non-lactose-fermenting bacilli, he (or she) may take a long time to effect these changes in faecal characteristics and may never exactly reproduce those described. But whoever will faithfully follow the diet will achieve them in a greater rather than in a lesser degree." (*See* "Chronic Disease," p. 11, Bach & Wheeler). They find, however, that "intestines once thoroughly infected are seldom if ever cleared by diet alone ; some anti-bacterial measures are needed in addition."

Then there is the question of disinfecting wounds. During the war iodine was found to have several grave defects as a disinfectant and much research was made for substitutes. Several were discovered which were so superior to iodine that the use of iodine for disinfecting wounds or skin was superseded. Two of the best were Chloramine T, a bleaching powder derivative, and Acriflavine one of the dyes. And yet these two so far as I can learn are only occasionally used in Queensland.

Much of the work done years ago in preventive medicine also lies unapplied by the authorities, but time forbids incursions into that important field.

But there is one remark I would like to make about a branch of this subject on which the public through ignorance wastes much money and much health every year. About 30 years ago Professor Robt. Hutchinson in one of his famous lectures made a statement, which is as true to-day as it was then, that "no patent food and no patent medicine is worth the money asked for it." This statement was made through his knowledge of diet and medicine, but his statement has been swamped by the advertisements of the manufacturers through their knowledge of the weakness of human nature.

In engineering, the value of softening water used for steam raising has been known for many years. This was first done, as you know, by the old Clark process, while later on soda was used in conjunction with lime, giving much better results with certain waters. One trouble about the process was that it was difficult to run without chemical supervision. With a chemist on the works, it was simple and occupied little of his time, without a chemist there was often trouble. About 30 years ago it was found that hard waters when passed through certain substances of the zeolite type give up their lime and magnesia to the zeolite, each molecule of lime and magnesia in the water being replaced by one of soda from the zeolite, the water becoming quite soft. When the zeolite became exhausted a saturated solution of common salt was run through it, which washed out the absorbed lime and magnesia and replaced them with soda and so regenerated the zeolite.

When first introduced, only artificial zeolites were used and these were too expensive for general use. Shortly after the war the cost of the zeolites was much reduced, natural zeolites were found which were easily prepared for use, and the cost of the process now compares well with that of the lime soda process, while the supervision is easier.

Here is a case where the system was adopted for a large institution with two large boilers about two years ago. The water was very hard, about 34° Clark, with magnesium chloride present as well as the usual carbonates. Both boilers were being heavily incrusted by the carbonates and corroded by the magnesium chloride. They leaked badly, were continually having tubes replaced, and the boiler inspector had cut down the permitted pressure from 165 lbs. to 135 lbs. per square inch, and had stated that he would probably condemn the boilers altogether in two years' time.

A zeolite process was installed. The old incrustation soon scaled off and was blown out, the old corrosion marks ceased deepening and showed a smooth surface, all leaks ceased, no more new tubes have been put in, the coal consumption has been cut down about one ton per day, the water evaporated has largely increased and the hot water supply has also increased. The saving in repairs has been about £300 per annum and the boiler has been granted a new lease of life. Also the softened water used in the large laundry has saved about £80 per annum in soap.

Of course there is always a fly in the ointment. The boiled water in this process becomes strongly alkaline from the sodium carbonate which replaces the lime and magnesia compounds, and some caustic soda is formed in the boiler. Unless frequent blowing off is practised the solution causes corrosion and the strong alkali also causes embrittlement of the steel. In this case things were going so well that an attendant was tempted to save heat by not blowing off regularly. The concentrated solution caused corrosion in a plug, blew it out and blew the boiling alkaline water and steam into the engine room. Fortunately no one was seriously injured but every scrap of paint on the machinery and in the room was taken off by the hot caustic soda solution. So even this simple process requires common sense in using it.

Still there are many steam users in Queensland who suffer the heavy losses entailed by the use of hard water for steam raising when very great savings can be made in fuel and in boiler maintenance by the adoption of a by no means new process.

In architecture, with regard to lighting it is most remarkable that practically the only people who have ever taken full advantage of the knowledge of lighting are the theatre owners. Who ever saw a public hall or a church that did not present glaring lights before the eyes? Can one imagine a theatre with bright lights stuck around the walls and near the stage, or a church or hall without at least one or two bright lights catching the eye when watching the speaker? There is no excuse but ignorance nowadays, with the electrical supply so easily available, for anything but perfect lighting in halls and churches and all public buildings.

Also in ventilation, modern knowledge and facilities for supplying pure cool air are generally ignored. Even in Queensland where we can usually have all windows open and the driving of fresh air through a room is no problem at all, we often see fans in the ceiling throwing the hot vitiated air down on the heads of the audience and stirring up the dust and bacteria from the floor—altogether as useless and insanitary an attempt at getting cool pure air as incompetence and ignorance could devise.

In the consumption of fuel there is still room for much better use of the mass of knowledge that has been acquired as to how to get the best results from the burning of coal. One or two of our largest consumers of coal make good use of that knowledge, and have a fairly complete control of their work. They determine carefully the destination of all the B.T.U.'s for which they have paid. If more than a certain minimum proportion of these valuable heat units escape up the chimney or in any other way without evaporating their quota of water then somebody hears about it. The scientific engineer is a hard task master to the coal—he gets out of every pound of it the last possible heat unit, trying to make every one of them, which he can't, penetrate the steel of the boiler and heat the water to boiling. Then he grudges the fact that such a number of them dodge him as regards work by going " latent," but nowadays he catches most of these later on.

In metallurgy in Queensland we have with few exceptions been stagnant in our methods for many years, the natural result being that our metalliferous mining industry has been moribund for some time. As a result of the adaptation of old knowledge with splendid results in Australia let me remind you of a case quoted by Professor Richards in his lecture here in October last. He pointed out to us how by making certain changes at Mt. Lyell the total cost of producing the copper had been lowered by £50 per ton of metallic copper without lowering the proportion recovered. No new research was required to make that saving. Most of it was made by the use, with some modern improvements, of an oil flotation process that has been known for about 30 years. Mt. Lyell had previously passed the ore through the blast furnace, fluxing off the silicates as slag and treating the resulting matter in converters. By the process now used the cost of the blast furnaces, particularly of the costs of fuel and of fluxes, have been reduced enormously.

At Mt. Isa, in North Queensland, there is a huge mass of comparatively low grade lead-zinc ore. This was taken up some years ago but the problem of economically separating the lead and zinc sulphides made the earlier owners give up the proposition. The present owners have adopted the old oil flotation process with a few modern improvements. I have not the full details of the process, nor is this an occasion to describe them, but briefly outlined the process is as follows : The whole bulk of the ore as it is taken out is crushed to a definite degree of fineness. If treated at once by a flotation process both the lead and zinc sulphides would be floated off together, and the smelting of these mixed sulphides is not an economical proposition. So to the pulped ore is added a chemical solution which prevents the zinc sulphide from being floated, but does not affect the lead sulphide. Practically the whole of the lead sulphide is floated off with only a very small proportion of zinc sulphide. The pulped ore freed from lead is then treated with a second solution to neutralise the first and the ore is " floated " a second time, a good recovery of zinc sulphide being obtained with only a negligible proportion of lead sulphide. By making use of this modern variation in an old process it seems as if we are going to have in Queensland one of the largest silver lead mines in the world running successfully before the year is out.

As Professor Richards also pointed out we have had in Queensland more than our own share of high-grade gold ores and copper ores, but it is not likely that there are a large number of that class left. We have not even one going at the present time. But suitable low grade ores pay much better, and for a longer time than the small rich deposits. It is almost certain there are many such in Queensland. The knowledge is here as to how to work economically, but there is as yet only the beginnings of interest in that problem. I have spoken to most of our Queensland geologists and also to several visiting geologists on the probabilities of our having in Queensland large deposits of low grade ores suitable for treatment. I have not yet met one who is not quite confident that such deposits are there, and could be found if looked for by qualified prospectors.

It is probably in Agricultural and Pastoral Industries that we suffer our greatest losses through not making use of knowledge which is being applied elsewhere. We had last year about 23,000 dairy farmers in Queensland, with about 680,000 dairy cows. The production of butter was 87½ million pounds weight, cheese 14¼ million lbs., condensed milk over three quarter million lbs., the total value of the milk being about £8,000,000.

The average yield per cow in Queensland is about 145 lbs. of commercial butter per annum, while the Agriculture Department knows that 260 lbs. average is attainable—has been obtained in herds here. As Denmark averages 299 lbs. commercial butter, 260 does not seem a very high standard at which to aim. If the yield of the present number of cows could be raised to 260 lbs. the extra production would be practically 70,000,000 lbs. of butter which at the average price of 1/3 per lb. would add another £4,360,000 to our Queensland dairymen's incomes.

I do not know of any single research which could definitely promise such savings in a few years as the applying of known good methods of dairying. The average yield is going up slowly, there is nothing but ignorance to prevent it being doubled in a few years. Even then the average yield would be below that of Denmark. To put those statistics in another way, the average yield per cow last year, which by the way was a record good year, was worth about £10, while quite a number of farmers are known to have averaged over £25 per cow for their whole herds.

In addition to the enormous increase which could be made in the yield there are very many farms where a considerable saving could be made in the costs of production. I recently heard of one comparatively small farm where it was decided to rebuild the 40 year old milking yards. The new yards were carefully designed as to relative position of milking yards, separators, and separated milk feeding troughs for the calves. A saving of 1½ hours labour per day was made, equivalent to 68 days of 8 hours each in the course of the year.

Statistics show we are improving, but very slowly. There have of late been several marked attempts by members of the industry to hasten forward the use of better methods. The reformers have plenty of scope for making striking reforms and advances, and deserve the best wishes of every one for speedy success in a difficult task—the education of adults.

Sir Arnold Theiler and Dr. J. B. Orr were here a few years ago, probably the two greatest authorities at the present time on animal husbandry. They came at the request of the Commonwealth Government, Council of Scientific and Industrial Research, to give advice on the best means of assisting our stock industries. Dr. Orr, the specialist on animal nutrition, after seeing a considerable area of each of the States stated that "the yield of animal products in Australia available for export could be doubled in a few years" (page 66 (2), 3rd par. of report). Now that is the published opinion of a man who knows his subject thoroughly. As the latest Australian return for animal exports at the time he wrote (1928) showed a value of 79 millions, we have awaiting us by the application of knowledge requiring no research to make it available, an additional income of something like 80 millions per annum. It is not suggested that that would be all profit, and these values are subject to considerable variations, but it would provide quite sufficient to convert our recent adverse balances into bank credit balances and cancel the adverse exchange rates.

With regard to sheep there is time to note only one matter. An investigation was carried out by a sub-committee of the Council of Scientific and Industrial Research some years ago and the best method of jetting sheep with arsenic solution was determined, as a prevention of blow-fly attack. We had ample evidence then that the method gave complete protection in ordinary seasons and good protection even in bad blow-fly attacks. Lately I have seen statements published of heavy losses incurred through blow-fly attack. If that is so then the jetting method prescribed was either not used or not properly used. The protection generally lasted, depending on the rainfall, for about two to three months and the cost was about $\frac{1}{5}$d. per sheep. One pastoralist who had interests in several large sheep properties told me that in the aggregate his company had saved many thousands of pounds by the use of the method. That statement was made within two or three years of the first publication of the method. If large losses are now being incurred through blow-fly attack it is another instance of "unused knowledge."

In the course of my enquiries many other cases of "unused knowledge" in Agriculture have been pointed out to me, but time forbids the mention of any more of them.

In no direction does our lack of organised common sense methods show up more disastrously than in our extraordinary method of selecting our rulers, no test of fitness being required, and in no direction are we suffering more for our inefficiency. I am not a party politician, and am not attacking politicians, but am laying the blame on ourselves for our lack of method in dealing with this problem. Democracy ought to mean national efficiency. Unless we alter our methods, it looks like being national inefficiency.

And the methods of our legislators in ruling us, not of one party but of all of them, are not always those of "organised common sense." In not very distant days we all knew that a certain proportion of workers were continuously badly paid—were in fact generally short of proper food and clothing. So various methods were tried to solve the problem, all of them failing to give satisfaction. But no one tried appointing a number of trained economists to enquire into the whole problem and find out what would be a fair return to the worker, in relation to the cost of living, to the value of the work to the employer, and to the value of the work to the nation, and also to consider all the other factors bearing on the problem. Instead of that method certain laws were passed and Courts were appointed with very great powers in certain directions and very limited powers in others. We all hoped for good results, but the results, while showing very much improved rates of pay for certain classes of workers, left others worse off than before, as they could not get before the Court, got no increase in earnings, and the costs of living were increased. I give herewith a few examples out of hundreds to better illustrate the position we have achieved :—

Industry	Occupation	Award or not	Weekly Earnings
Meatworks	Slaughterman	Award ..	£7 12 0 to £14 6 8
	Labourer ..	Award ..	£5 10 0 to £7 12 6
Wool	Shearers ..	Award ..	£12 12 0 to £14 0 0
	Shearers' Cooks	Award ..	£9 0 0 to £10 0 0
Sugar	Cane Cutters	Award ..	£9 0 0 to £14 0 0
Mechan. Engineering	Turners and Fitters ..	Award £5/1/-	£5 1 0
State Service ..	Unclassified Officers ..	Award £300 Per Annum	£5 15 4 less 10%
	Typists ..	Award £230	£4 8 5 less 10%
Day Labour ..	Labourer ..	Award ..	£3 17 0
Rural Workers ..	Farm Labourer	No Award ..	£1 0 0 to £2 0 0+keep
Domestic Service	Boarding House ..	Award ..	£1 12 6 to £3 3 0+keep
Domestic Service ..	Private House	No Award ..	£1 0 0 + keep

These rates are all recent. I do not quote these to discuss the question as to whether any or all of these award rates are or are not justifiable. The point I wish to bring out is that the nation has made no attempt whatever to treat all its workers alike. The problem has not been examined in its entirety, and quite clearly the result has been that either certain workers are receiving too much, or other workers doing at least equally skilled work and work of equal national importance are receiving too little. The problem is going to be more difficult to solve than problems in physical or biological science as the psychological element, the variable human factor, is an important one. Nevertheless the skilled economists are the only people qualified to deal with this intricate problem and to solve it not only to the satisfaction of any one type of worker, or of any parasitic industry, but to solve it in the interests of the whole nation. There has been a tendency within the last two years, when our rulers realised how dangerous the national position had become, to consult the economists. It is to be hoped that the methods of the economists, if and when given a fair trial, will be found as successful in this case as for example the methods of the biologists were in the case of the prickly pear problem.

I have now called attention to a few of the very many directions in which we are suffering through failure as a people to take advantage of knowledge provided freely to us by searchers after truth. The list could be added to by every member present, but I hope I have said sufficient to make it clear that, while stressing the need for more and more research, there is also a necessity that we should see that the work already done should be utilised.

When Dr. J. B. Orr, to whom I have already referred, was in Australia he stated (page 68 (3) last par)—"The great need of Australian husbandry in its present state of development is not so much research in nutrition as the application of existing knowledge to pressing practical problems." And that remark was made while Dr. Orr was stressing the great need for further research. He was pointing out what all applied scientists have realised for a long time, that great as are the savings which could be made in Australia through the acquiring of more knowledge by research, and the subsequent application of that new knowledge, in addition to these savings still greater savings could be made by applying "unused knowledge" which has already been successfully applied elsewhere. And the returns from the application of unused knowledge are much more quickly received ; such methods can be applied at once without waiting for small scale experiments.

As a Society it is not our duty to see the application of science to industry, but certainly we have no desire to see much of the new knowledge which our members and others have laboriously collected from the darkness of the great unknown, at once returned to an almost equal darkness among the dusty archives of scientific libraries. It is clearly the duty of each industry to educate the members of that industry to increase their yield of products, and that at lower relative costs. It is only by so doing that we have any chance of selling our products at a profit on the world's market, and unless we can do that we have no hope of meeting our enormous debts, or, which to some people seems even more important, no hope of contracting more debts.

Fortunately some of our industries are making efforts to make more use of known methods, but it is doubtful if the general rate of advance has yet reached the rate of accumulation of new knowledge. The scientists are doing their part ; it rests now with the industrialists and others to devise means of taking full advantage of the knowledge so lavishly provided by the scientists.

Two Previously Undescribed Queensland Myrtaceae

By C. T. White (Government Botanist, Brisbane).

Plates I.-II.

(*Read before the Royal Society of Queensland, 27th April*, 1931).

Darwinia Porteri sp. nov.

Frutex glaber. Folia opposita, ramulorum apicem versus conferta ; linearia vel anguste spathulata, saepe falcata vel subfalcata, plerumque 1 cm. longa, 1.5 mm. lata, ad apicem acuta, basem versus gradatim angustata, breviter petiolata. Flores terminales binatim dispositi ; pedicellis 2 mm. longis ; bracteolis 7 mm. longis. Calyx 1 cm. longus ; tubo 6 mm. longo, alte 5-costato ; lobis 4 mm. longis alte laciniatis. Petala subrotunda, 3.5 mm. longa. Stamina 2.5 mm. longa ; filamentis applanatis ; antheris subglobosis ; staminodiis 1.5 mm. longis, applanatis. Stylus 2 cm. longus, infra stigma barbatus.

Shrub, glabrous in all parts. Leaves opposite, crowded towards the ends of the branchlets ; linear or very narrowly spathulate, straight or falcate, mostly 1 cm. long and 1.5 mm. broad ; apex acute, base gradually tapering to a short petiole. Flowers in pairs at the ends of the branchlets on pedicels of 2 mm. Bracteoles large, red, 7 mm. long. Calyx 1 cm. long, tube red, strongly 5-ribbed, 6 mm. long, lobes yellow, 4 mm. long, deeply laciniate for nearly half their length into 5-6 teeth. Petals yellow, rotund, slightly shorter than the calyx lobes (3.5 mm. long). Stamens 2.5 mm. long, filaments flattened, anthers subglobose ; staminodia 1.5 mm. long, flattened and tipped with an abortive anther. Style 2 cm. long, bearded below the stigma.

Habitat.—Watsonville near Herberton, North Queensland. *Charles Porter*, communicated by Mr. W. J. Gallogly, who states :—

" This shrub appears to be confined to Watsonville so far as this Northern district is concerned. We can learn of no trace in surrounding districts.

" It grows upon apparently the bare rock at a considerable elevation, bare and unprotected. Its roots work into the crevices and it grows thickly in the form of a real hedge.

" When cut and placed in water it maintains its freshness for a considerable time. The plant was collected by Mr. Charles Porter."

Affinities.—The present species comes into Bentham's section Schuermannia (Flora Australiensis III. 7) and is most closely allied to *D. Thomasii* (F.v.M.) Benth, the only other Queensland member of the genus, the chief distinctions between the two species being as follows :—

Leaves obovate ; flowers single on pedicels of 6-7 mm., calyx lobes minutely denticulate	*D. Thomasii*
Leaves linear or very narrowly obovate, flowers in pairs on pedicels of 2 mm. ; calyx lobes deeply laciniate	*D. Porteri*

Melaleuca Cheelii sp. nov.

Arbor parva, 10 m. alta ; cortice lamellato ramulis junioribus pubescentibus. Folia opposita, glabra, elliptica vel ovata 0.8-1 cm. longa, plerumque $1\frac{1}{2}$-plo longioribus quam lata, perbreviter petiolata, textura crassa, 1-3-nervata sed nervis costa media excepta obscuris. Flores albi in spicas terminales dispositi, rhachide et bracteis et calycibus pubescentibus ; bracteis ovatis ; 3 mm. longis ; calycis tubo elliptico, 3 mm. longo, lobis brevis, triangularibus ; petalis breviter unguiculatis, cum ungue 2.5 mm. longis, ungue ipso 0.5 mm. longo ; staminibus in phalanges 5 petalis oppositis connatis ; cum parte connata 0.5 cm. longis ; parte connata ipsa 1.5 mm. longa ; stylo 0.6 cm. longo ; stigmate capitato. Capsula elliptica vel subglobosa, 0.5 cm. diam.

A small tree about 10 m. high, of rather spreading habit ; bark papery. Branchlets pubescent in the younger stage but soon becoming glabrous. Leaves opposite glabrous elliptic or when more rounded at the base ovate, 0.8-1 cm. long, mostly $1\frac{1}{2}$ times longer than broad, very shortly petiolate ; texture rather thick, 3-5-nerved but except for the midrib obscure. Flowers creamy white borne in short terminal spikes, the rhachis, bracts and calyces pubescent, rhachis 1 cm. long, 5-8-flowered ; bracts ovate 3 mm. long ; calyx tube ellipsoid, 3 mm. long ; lobes short, broadly triangular ; petals shortly clawed, with the claw 2.5 mm. long, the claw itself 0.5 mm. ; stamens united in five bundles of 9-12 opposite the petals, including the united portion 0.5 cm. long, the united portion itself 1.5 mm. long. Style 0.6 cm. long, stigma capitate. Capsule ellipsoid or subglobose, 0.5 cm. diam.

Habitat.—Traverston, mouth of the Burrum River, about 180 miles north of Brisbane, Queensland. Common in wet places in sandy " wallum " country. C. T. White, 6335 flowering and fruiting specimens. 6/10/1929.

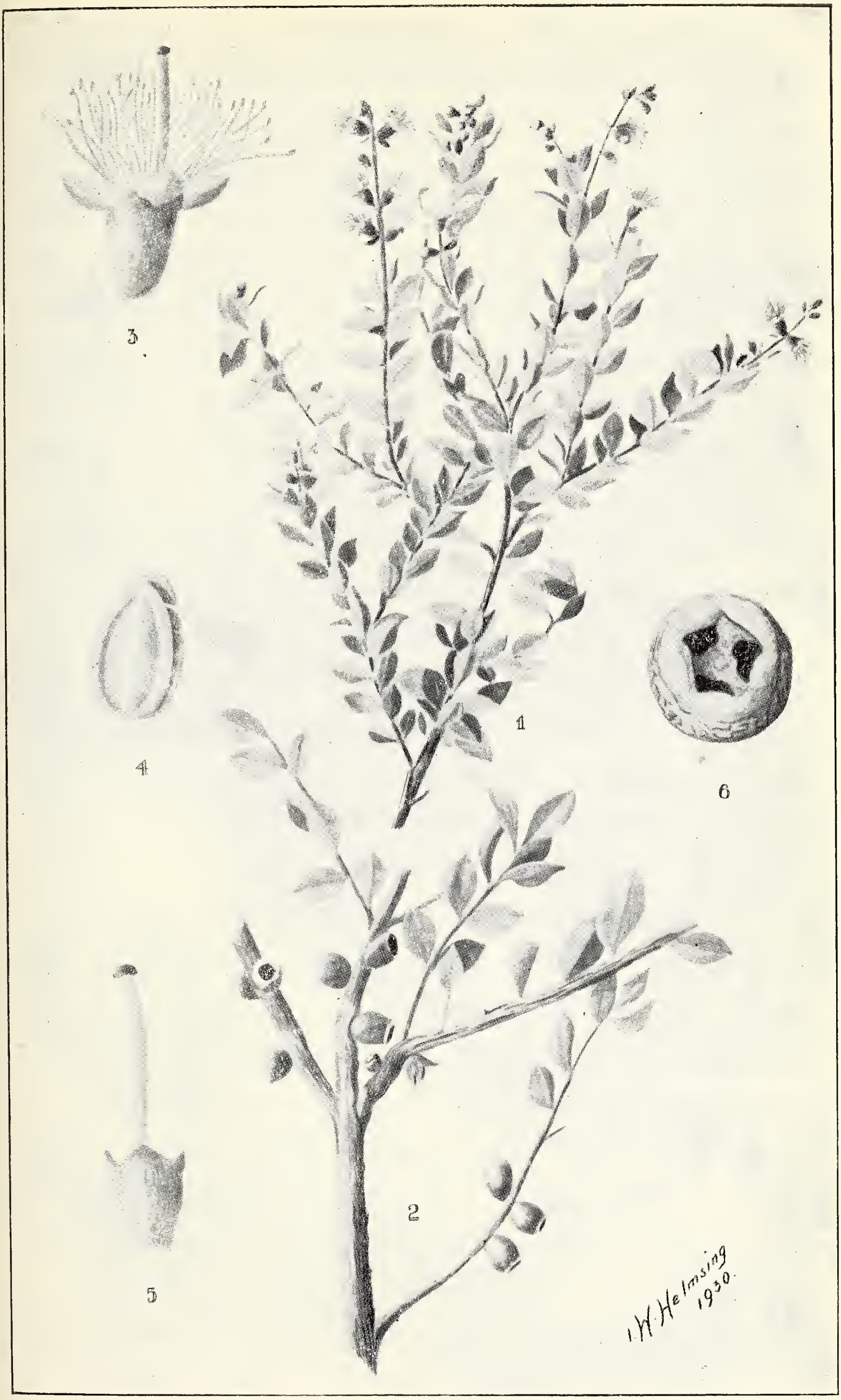
Named in honour of Mr. Edwin Cheel, Curator, National Herbarium, Sydney, who had done much to increase our knowledge of the Australian Myrtaceae.

Affinities.—The present species comes into Bentham's Series V. Spiciflorae (Flora Australiensis III. 125) and has its closest affinities with *M. squarrosa Sm.* but differs in several important details, the chief distinctions between the two species being as follows :—

Leaves 5-7-nerved, the lateral nerves clearly visible, spikes dense, 20-flowered or even more	*M. squarrosa*
Leaves 3-5-nerved, the lateral nerves obscure or not at all visible ; spikes interrupted, 5-8-flowered	*M. Cheelii*

Darwinia Porteri sp. nov.

Fig. 1. Flowering branchlet, nat. size.
Fig. 2. Two flowers × $2\frac{1}{4}$.
Fig. 3. Flower laid open × $4\frac{1}{2}$.
Fig. 4. (*a*) Staminode, (*b*) Stamen—front view, (*c*) Stamen—dorsal view × 15.



Melaleuca Cheelii sp. nov.

Fig. 1. Flowering branchlet, nat. size.
Fig. 2. Fruiting branchlet, nat. size.
Fig. 3. Single flower × 4.
Fig. 4. Anther × 43.
Fig. 5. Pistil × 4.
Fig. 6. Seed capsule, viewed from above, × 4.

The Movements of Neptunia gracilis, an Australian Sensitive Plant

By D. A. Herbert, D.Sc., Department of Biology, University of Queensland.

(*Read before the Royal Society of Queensland*, 27*th April*, 1931).

There are two endemic Australian species of the leguminous genus *Neptunia*. *N. monosperma*, F.v.M. is a tropical species extending south to Blackall ; *N. gracilis* in its typical form ranges from Shoalwater Bay and Broad Sound, North of Rockhampton, to western New South Wales between the Darling River and Cooper's Creek ; two varieties—*villulosa* and *major*—extend the distribution of the species northward from Rockhampton (1). Of the ten extra-Australian species, the sensitive *N. oleracea* is best known. This is a floating plant, and its leaves are very similar to those of *N. gracilis* ; it is figured by Arber (2).

In South Queensland the typical form grows on black soil and on alluvium. It is a straggling undershrub with procumbent or erect stems a foot or a little more in length, dying down in winter and shooting from its rootstock in spring. It roots deeply, and unless the plants are quite young they are difficult to transplant. The cotyledons are ovate-sagittate. The first leaves to make their appearance are pinnate with several pairs of leaflets. Several bipinnate leaves with one pair of pinnae are then produced before the normal adult type with two or three pairs of pinnae appears ; the number of pairs of leaflets in each pinna varies ; in the early stages, about four to six pairs are the rule, but though on old branches as many as twenty may be found, the usual number is about twelve. The pinnae and their leaflets in the unstimulated condition are horizontal. The terminal pinnae are at right angles to one another ; they each make an angle of 135 degrees with the axis. Those of the other pairs are in line at right angles to the rachis.

Sleep Movements.—The cotyledons of *Neptunia gracilis* fold together, and assume the vertical position at night or when covered during the day. Those of *Mimosa pudica* and of *M. Spegazzinii* behave similarly. In darkness the leaflets fold together. The pinnae approach one another with an oblique downward movement until they are parallel ; the final angle made with the stem depends on the position of the leaf on the stem, that is, on the position of the axis of the leaf. Usually the pinnae are reflexed to make an angle of 30-45 degrees with the axis, but they may be bent back so far that they are actually parallel with it. The petiole in darkness undergoes a slight depression of 5 to 15 degrees on the initial angle. A vertical petiole at the end of a branch shows a smaller amplitude of movement than one horizontally placed.

Mechanical stimulus.—The cotyledons, when stimulated by a light blow or by a stronger stimulus such as cutting or burning, fold together. Struck, the leaflets fold together upwards, and the pinnae approach one another slightly while bending backwards. The final position, even after a very violent blow, is not the same as that of a leaf in the night position. In a typical case the approach of the leaflets to one another was through an angle of about 3 degrees, and the pinnae were bent back through an angle of 30 degrees. The primary pulvinus moved the petiole through an angle of 5 degrees. Even when the stimulus was so violent that one pinna was broken from the axis (a piece of elastic being used for the blow) no greater movement took place. This latter fact also indicates that response to wounding does not produce as great a movement as darkness. This was borne out by subsequent experiments in which the terminal leaflets in some cases and the rachis of the pinna in others were cut or crushed ; the leaflets closed together, but the primary and secondary pulvini did not bend to the night angle. Recovery is usually complete in about fifteen minutes, the time varying with the age of the leaves and with external conditions.

Material Used.—The plants used in the experiments described in this paper were grown in a garden plot in Wooloowin from seed obtained from Beaudesert by Mr. E. C. Tommerup, B.Sc. The seed was planted in October, 1929, and the young seedlings transplanted to a deep clay loam garden bed beside similar seedlings of *Mimosa pudica* raised from local seed, and of *Mimosa Spegazzinii* raised from seed obtained from Heinrich Mette, of Germany. By the end of March, 1930, the *Neptunia* plants had produced branched procumbent stems of about six inches in length ; the *Mimosa pudica* plants were much branched and over a foot in diameter ; and those of *Mimosa Spegazzinii* were erect, branching at the base, and from nine inches to two feet high. All the plants were healthy and vigorous, and were growing under similar conditions of light and soil.

During the winter the plants of *Neptunia gracilis* died down, shooting again in spring and producing several straggling stems attaining a length of two to three feet.

The object of growing these three species together in the same bed was to compare their rates of response to stimulus under similar environmental conditions. As the rates in all three species vary under different environmental conditions, it was decided that the times mentioned in the experiments would have more significance if comparisons were made between the responses of adjacent plants of the three species.

Experimental Data.

A. *Mechanical stimulus.—Experiment* 1.—*Relative rates of recovery of leaves of adjacent plants of Neptunia gracilis, Mimosa pudica and Mimosa Spegazzinii growing under similar environmental conditions*—

Neptunia gracilis	10-15 minutes
Mimosa pudica	5- 8 minutes
Mimosa Spegazzinii	5- 8 minutes

These figures represent a great many experiments conducted on vigorous healthy leaves. The leaves of *Neptunia gracilis* fold together slowly even when violently stimulated. Whereas the leaflets of the two species of *Mimosa* close in a fraction of a second, those of *Neptunia* take from 5 to 7 seconds to complete the movement, though response commences on stimulation. The whole response is therefore more sluggish than in the two species of *Mimosa*.

The response to mechanical shock is shown only by those leaflets which are directly stimulated. If the end of a pinna is struck a sharp blow, the leaflets in that region commence to fold together, but the shaking has directly stimulated the primary and the secondary pulvini which therefore commence to move at the same time. If the leaf be clamped so that no shaking of the parts distal to the point of mechanical stimulation can take place, no response takes place beyond the clamp. This is consistent with what has been found in *Mimosa pudica*.

B. Wound Stimulus.—If the terminal leaflets be scorched or cut, care being taken to protect the rest of the leaf from the stimulus or from shaking during the operation, conduction of the excitation takes place. The leaflets of the injured pinna close one after the other until all are closed ; the pulvinus at its base then curves very slightly, swinging the pinna through a small angle. The secondary pulvinus of the pinna immediately below then curves similarly, and the leaflets commence to close from the base towards the tip. When the movement is half way along this pinna, the pinna opposite that stimulated in the first place may commence to close, but frequently only the bottom leaflets close and the rest are unaffected or it may show no response at all. The fourth pinna remains unaffected.

If, for convenience, we call the terminal pinnae *a* and *b* and the lower pair *c* and *d*, *c* being below *a*, the following may be given as a typical example of the rate of the action :

Experiment 2.—Rate of conduction of excitation in leaf of Neptunia gracilis following the cutting of the terminal leaflets of a terminal pinna (*a*).

Time of closing of all leaflets of *a* after cutting the terminal leaflets	20 seconds
Time of closing of all leaflets of *c* (from time of cutting) ..	30 seconds
Time of closing of all leaflets of *b*	32 seconds

When one of the lower pinnae, *c*, is snipped at the tip, its leaflets fold together in turn, and finally its pulvinus curves slightly. The pinna *a* immediately above then commences to respond about 2 seconds later. The following is a typical example :

Experiment 3.—Rate of conduction in leaf of Neptunia gracilis when lower pinna is injured :

Time of closing of all leaflets of lower pinna *c* after snipping of terminal leaflets	30 seconds
Time of commencement of response in pinna *a* immediately above (from time of injury)	32 seconds
Time of complete closing of the pinna *a*	28 seconds

Thus it appears that acropetal and basipetal conduction in the axis of the pinna, as indicated by the response of the leaflets, take place at approximately the same rate.

The movement gives no indication of a reflex arc through the main pulvinus.* The stimulus passes along the axis to the pinna immediately below or above (as the case may be) and just as the pulvinus of this pinna commences its curvature, or in some instances a second or two later, the pulvinus of the pinna opposite the one stimulated also responds. The transmission across the leaf axis—a distance of about one thirty-second of an inch—takes as long as, or longer than, the transmission along the axis—a distance of about one-third of an inch. Even when the response of the two pinnae is practically simultaneous, as it commonly is, the one opposite often responds with a few of the lower leaflets, and this indicates that the stimulus received across the axis is much weaker than that which passes longitudinally. Where the original stimulus is relatively weak, as when the terminal leaflets are only slightly injured by cutting, the opposite pinna may not respond at all.

That transmission from a pinna to the one opposite takes place across the axis and not through a reflex arc is shown by a simple experiment.

Experiment 4.—Transmission across the axis, not through a reflex arc.—The terminal pair of pinnae of a leaf was removed by cutting through the axis. The terminal leaflets of one of the remaining pair (now terminal) were stimulated by cutting with a sharp pair of scissors. In 20 seconds its leaflets had closed. Twelve seconds after the opposite pinna commenced to respond, and had completely closed in seventeen seconds. No response was shown by the primary pulvinus at the base of the leaf, and a reflex arc of course did not exist at the apical end.

The rates of conduction vary considerably, depending, no doubt, on variation in the severity of the stimulus, as well as on the individual leaves, but the following experiment will indicate the relative rates :

Experiment 5.—Comparison of apparent rates of conduction of excitation by wounding in Neptunia gracilis, Mimosa pudica, and M. Spegazzinii.

Neptunia gracilis	20-35 seconds per inch of pinna
Mimosa pudica	8-20 seconds per inch of pinna
M. Spegazzinii	8-20 seconds per inch of pinna

These figures, which were obtained by cutting the tips of pinnae and measuring the time taken for the secondary pulvini to commence to curve, must be regarded as only an indication of the rates of conduction. They represent the time taken for the pulvini to curve visibly in response to the conducted stimulus. That there is an appreciable reaction time for the leaflet pulvini is shown by the fact that when basipetal conduction is taking place the lower two or three leaflets may still be open when the secondary pulvinus reacts, and they close while the pinnae are swinging towards one another. In *Mimosa Spegazzinii*, for example, a pinna 3 inches long was snipped at the

*Reference is here made to the contention of Bose, which is supported by Molisch, that there is a reflex arc through the main pulvinus of the leaf of *Mimosa pudica*. Umrath has demonstrated that this reflex arc does not exist, and Ball also rightly considers that the transition takes places at the apex of the petiole.

tip ; the leaflets closed in pairs, and in 25 seconds the secondary pulvinus curved, though the lower three pairs of leaflets had not shown any visible response ; they showed a definite visible movement one second later. The same thing was noticed with both *Mimosa pudica* and *Neptunia gracilis*, but in by no means all cases.

Stem conduction, acropetal but not basipetal.

In no case was it possible to obtain evidence of conduction in the stem when the leaf only was stimulated. The stimuli which readily produce conduction in the stem of *Mimosa pudica* and of *M. Spegazzinii*, namely, burning or cutting of the pinnae, had no such effect on *Neptunia*. Slight wounding of the tips of the leaflets affected no more than five or six pairs of leaflets nearest to the wound, and did not produce any movement at all in the pulvinus at the base of the pinna.

Conduction takes place acropetally, however, when a razor cut is below a leaf. The stimulus passed up the petiole, and in the case of a large cut affects all leaflets. When the cut is small, it may affect one pinna only, or part of one—usually the right-hand lower pinna. In no case was basipetal conduction noted, even when the cut was made immediately above and very close to the pulvinus on the stem, though this type is found in the leaf.

The conduction of the stimulus suggests the possibility of a mechanism similar to that of *Mimosa Spegazzinii* and of *M. pudica* (3, 4, 5, 6). Normal conduction is, however, set up by a cut which does not reach to the wood.

Attempts to find a stem stimulant.

A number of living stems of *Neptunia* were crushed in a few drops of water. When the cut end of a stem of *Mimosa pudica* (or *M. Spegazzinii*) is put into an extract made from the shoots of its own species in this way the leaves respond in turn as the stimulating substance reaches them. When stems of *Neptunia*, which had been cut and placed in water and allowed to recover, were placed in the *Neptunia* extract no such response was produced. Other stems were placed in extracts of *Mimosa pudica* and of *M. Spegazzinii* which had been proved to be active by testing with recovered shoots of their own species. No response took place in this case. Both species of *Mimosa*, however, responded normally when treated with *Neptunia* extract.

Leaves of *Neptunia gracilis* were removed by cutting through the petiole half way along its length. They were allowed to recover fully in water and then transferred with their cut surfaces in *Neptunia* extract. No response took place, with the exception of two leaves which closed in half an hour and never reopened again, although transferred back to water. Such cases are met with when any sensitive plant is placed in water ; some leaves close permanently for no apparent reason. Apart from these exceptions the leaves which failed to respond in the extract were quite normal. They closed readily when struck a light blow. We may conclude that the so-called normal conduction of *Mimosa pudica* is not the type of conduction in *Neptunia gracilis*.

That stimulus is conducted is obvious. The presence of the stem stimulant in *Neptunia* capable of producing a response in the two species of *Mimosa* lost much of its significance when extracts of a number of other Leguminosae were tested on *Mimosa pudica* and produced a normal response such as is produced by the extract of the sensitive plant itself. Amongst the plants found to produce this result were *Leucaena glauca* (Mimoseae), *Mimosa Spegazzinii* (Mimoseae), *Bauhinia purpurea* (Caesalpineae), *Phaseolus lunatus* (Papilionaceae), *Wistaria sinensis* (Papilionaceae). No response was produced by extracts of a number of non-leguminous plants. I find that these extracts are stable on boiling. Snow reported that his extract of *Mimosa pudica* was not stable, but left the point in doubt owing to his lack of material and the fact that Ricca had reported that his stimulant of *M. Spegazzinii* was not destroyed by boiling. My results were always doubtful after mid-day, as the leaves either showed incomplete recovery or erratic response after recovery. In the morning positive results could practically always be obtained with boiled *Mimosa pudica* extract, and usually in the afternoons as well.

These results will be published in detail later ; for the present it is necessary to refer to them as they indicate that the presence of substances stimulating *Mimosa pudica* and *M. Spegazzinii* is a characteristic of widely separated species of Leguminosae, and such a substance may be expected and does occur in *Neptunia,* which also belongs to the *Mimoseae,* though it may have no function in the transmission of stimulus in that plant.

Summary.

Neptunia gracilis is an endemic sensitive plant with pinnate leaves sensitive to mechanical and wound stimulus, but whose movement is much slower than that of *Mimosa pudica* or of *M. Spegazzinii.* Recovery takes place in 10-15 minutes as against 5-8 minutes in the two species of *Mimosa.* Sleep movements of the leaves are much more pronounced than shock movements. Response to mechanical stimulus is shown only by those leaves which are directly stimulated. Wounding of the terminal leaflets of the pinna results in a transmission of excitation to the pinna immediately above or below, and when sufficiently severe, to the one opposite to the one stimulated, but the primary pulvinus and the pinna most remote from the point of injury are not affected. Acropetal and basipetal conduction in the rachis of the pinna take place at practically the same rate. The rate of conduction in the pinna is 20-35 seconds per inch, as contrasted with 8-20 seconds per inch in the cases of the two species of *Mimosa.* Conduction across the axis to an opposite pinna is direct, and not through a reflex arc.

Stem conduction is acropetal, but not basipetal, and takes place when a razor cut is made even when this does not reach the wood. A concentrated aqueous extract of *Neptunia* shoots produced no reaction when the cut ends of recovered *Neptunia* shoots were placed in it. The extract produced a reaction in similar shoots of *Mimosa Spegazzinii* and of *M. pudica.* Extracts of these species were also without effect on *Neptunia* shoots. It was found incidentally that extracts of various leguminous plants belonging to the three sub-families gave positive results with shoots of these species of *Mimosa.*

REFERENCES.

(1) Bailey, F. M.—Queensland Flora, Part II., p. 472, 1900.

(2) Arber, Agnes—Water Plants, p. 191, Cambridge, 1920.

(3) Ricca, U.—Soluzione d'un problema di fisiologia. Nuovo Giornale Botanico Italiano, 23, 1916.

(4) Snow, R.—Conduction of Excitation in Stems of Mimosa pudica. Proc. Roy. Soc., B96 : 349, 1924.

(5) Snow, R.—Conduction of Excitation in leaf of M. Spegazzinii. Proc. Roy. Soc. B98 : 188-201, 1925.

(6) Herbert, D. A.—Movement of Mimosa pudica as affected by anaesthetics and other substances. Proc. Roy. Soc. XXXVII, 121-147, 1925.

Essential Oils from the Queensland Flora.

PART III.—*AGONIS LUEHMANNI.*

By T. G. H. JONES, D.Sc., and M. WHITE, M.Sc.

(*Read before the Royal Society of Queensland, 25th May,* 1931).

Agonis Luehmanni was originally described as a species of Leptospermum by Bailey,[1] but was later transferred to the genus *Agonis* by White and Francis. The species is known only to occur on the tops of some of the Glasshouse Mountains. Leaves and terminal branches were collected from the rocky slopes of Ngun Ngun Mountain, the difficulties of transport preventing large supplies being obtained, although the tree grows in abundance on the Mountain. The yield of oil from samples collected at different periods of the year showed little variation, ranging from ·2 to ·25%.

Examination of the oil reveals a striking difference from that obtained from *Agonis abnormis*,[2] the only other Queensland *Agonis* at present investigated, which contains a preponderance of sesquiterpenes. The dominating constituent of the oil of *Agonis Luehmanni* is d α-pinene (greater than 60%), but the presence of the olefinic terpene ocimene associated with it is noteworthy. This terpene, noted for its rapid absorption of oxygen on exposure imparts its characteristic odour to the oil, and its presence can be readily detected by crushing the leaf.

Minor constituents of the oil totalling not more than 15% were found to be an unidentified alcohol, probably $C_{10}H_{18}O$, a trace of cineol, aromadendrene, a sesquiterpene alcohol and a crystalline yellow solid, melting point 104°C., apparently identical with that obtained by Penfold[3] from the oils of *Baeckea crenulata* and *Darwinia grandiflora.*

EXPERIMENTAL.

250 lbs. collected on 20th September, 1929, gave 265 ccs. of oil, 400 lbs. collected on 26th April, 1930, gave 430 ccs. of oil, the wet season intervening between these two collections, making little difference in either the yield or the constants of the oils, which were determined as—

$d_{15.5}$	·8675
n^{D}_{20}	1·4738
$[\alpha]_D$	+34
ester value	3
acetyl value	36

Extraction of the oil with dilute sodium hydroxide solution ..d traces of phenols only, and no absorption was shown by the oth.. usual reagents. 300 ccs. of oil were submitted to fractional distillation at 26 mms. pressure, and the following fractions collected :—

Fraction.	Temp.	ccs.	$d_{15.5}$	n_{20}^{D}	$[\alpha]_D$
1	0— 60°C.	175	·8653	1·4636	+43
2	60— 95°C.	50	·8464	1·479	+20
3	95—110°C.	25	·905	1·480	+15
4	110—140°C.	20	·941	1·496	+9
5	viscous residue	30 ccs.	crystals	slowly sepa	rated

Refractionation of fractions (1) and (2) gave a series of fractions, showing diminishing density and optical rotation and rising refractive index. Details of these fractions are omitted for economy of space, but the presence of pinene, associated with smaller quantities of ocimene was indicated on examination. The presence of pinene was demonstrated by examination of the first main fraction obtained, viz. :—

165 ccs. b.p. 58–62°C. 26 mms. 155° 760 mms.
$d_{15.5}$ ·8653
n_{20}^{D} 1·4636
$[\alpha]_D$ +42

Pinonic acid was obtained on oxidation of a smaller portion in the prescribed manner, the absence of β-pinene being similarly shown.

The presence of ocimene in the various fractions was demonstrated by examination of the following fraction, viz. :—

24 ccs. b.p. 72–80°C. 26 mms.
$d_{15.5}$ ·828
$[\alpha]_D$ +11
n_{20}^{D} 1·478

This fraction consisted of d α-pinene to which the rotation was mainly due, admixed with ocimene and represented the nearest approach to a pure sample of ocimene obtained. Treatment in alcoholic solution with metallic sodium gave a liquid with the following constants :—

b.p. 165–169°C.
$d_{15.5}$ ·8050
$[\alpha]_D$ +12
n_{20}^{D} 1·4530

The odour of dihydro ocimene was most pronounced, and confirmation of its presence was obtained by the preparation of the tetra bromide M.P. 88°C.

Extraction of the several pinene ocimene fractions with resorcin solution revealed the presence of a trace only of cineol.

Fractions (3) and (4) (together with higher boiling residues from the pinene ocimene fractionations) were further fractionated at 4 mms. pressure, and the following fractions obtained :—

(*a*) 4 ccs. b.p. 50–60°C. (4 mms.)
$d_{15.5}$ ·9042
n^{D}_{20} 1·4680

This fraction appeared to consist of ocimene, together with an alcoholic body, probably $C_{10}H_{18}O$. The alcohol combined with phthalic anhydride, and on isolation in this way possessed a pleasant odour. The amount available was, however, too small for characterisation.

(*b*) 10 ccs. b.p. 70–80° (4 mms.)

This fraction gave the usual colour reaction with bromine vapour and acetic acid characteristic of Myrtaceous sesquiterpenes, and after repeated distillation over sodium, possessed the following constants :—

$d_{15.5}$ ·9150
n^{D}_{20} 1·4860
$[\alpha]_D$ +12

These constants are in moderate agreement with those of aromadendrene.

(*c*) 4 ccs. b.p. 85–95 (4 mms.)
$d_{15.5}$ ·947
n^{D}_{20} 1·4912

The colour reaction for sesquiterpene was also shown by this fraction : the higher density and analysis indicated the presence of an oxygenated body, presumably an alcohol.

As noted in the original table of fractionation, a residue was obtained which slowly deposited crystals. The whole was spread on porous tile to remove liquid impurities and the separated crystals purified by repeated crystallisation from alcohol. Yellow crystalline prisms were obtained M.P. 104°C.

Combustion Results.—

Found H = 6·5%
C = 70·5%
Methoxyl determination—OCH_3 = 22·8%

We were unable to carry out more than two combustions of the substance owing to lack of material, little more than $\frac{1}{4}$ gramme being available in the pure state. These figures do not agree with those quoted by Penfold[3] (H = 7·7 : C = 65·5), and it is possible that the substances are not identical, although we would not unduly stress the accuracy of our results given above, no definite formula being calculable from them.

Our thanks are due to Mr. C. T. White for his usua courteous botanical assistance, and to the Commonwealth Department of Science and Industry for a grant to one of us (T.G.H.J.), which defrayed the cost of collection of leaves.

REFERENCES.

1 Bailey, The Queensland Flora, p. 592.

2. Jones and White, Royal Society of Queensland, 1930, p. 68-70.

3. Penfold, Royal Society of N.S.W., 1922, p. 87-89.

The Fixed Oil from the Seeds of the Noogoorra Burr (*Xanthium pungens*).

By L. F. HITCHCOCK, M.Sc., and T. G. H. JONES, D.Sc., A.A.C.I.

(*Read before the Royal Society of Queensland, 29th June,* 1931).

The investigation of the above oil was undertaken at the request of Dr. Jean White-Haney, at that time an officer of the Division of Plant Industry of the Commonwealth Council for Scientific and Industrial Research, in order to determine whether any economic value was attached to the oil. The seed used was collected in the neighbourhood of Brisbane and the oil obtained by extraction of the fully ground seeds with low boiling point benzoline. 3·2 lbs. of oil were obtained from 40 lbs. of seed, a yield of 8%.

The oil on examination proved to be a semi-drying oil consisting principally of the glycerides of oleic, linolic and smaller amounts of saturated acids. Although such oils are of economic value, in our opinion the difficulty attached to the collection and isolation of the oil in the case of the Noogoorra burr would render the process unprofitable.

The tough nature of the burr seeds present a formidable obstacle and the only method, found available on the large scale, was to grind the whole in a mill to a powder. On the small scale, burrs may be opened by hand and the interior extracted, the yield of oil in this case being considerably higher, 20–25%, owing to the rejection of the shell which contains no oil.

In the investigation we have also considered the question of the structure of linolic acid and have confirmed that proposed recently by Howarth,[1] viz.,

$$CH_3-(CH_2)_4-CH=CH-CH_2-CH=CH\ \ (CH_2)_7-COOH$$

The amount of crystalline unsaponifiable material obtained in the investigation was too small for investigation.

EXPERIMENTAL.

40 lbs. of finely ground burr were extracted three times with boiling benzoline, the solvent being removed by distillation finally in vacuo.

The oil, which was dark in colour, and of characteristic odour possessed the following constants—

$d_{15.5}$	·9616
n^{D}_{20}	1·4745
Saponification value	192
Iodine value	145

Isolation of Acids.

The acids obtained in the usual manner by hydrolysis of the glycerides comprised 91% by weight of the oil, and possessed the following constants—

$d_{15.5}$	·9104
n_{20}^{D}	1·4649
Acid number	198
Iodine value	140

Investigation of these acids by the standard lead salt method showed them to consist of 90% unsaturated, and 10% saturated acid.

The saturated acids consisted of a mixture of palmitic and stearic acids.

The unsaturated acids, subsequently shown to consist of oleic and linolic acids, possessed iodine value of 145 indicating 60% linolic and 40% oleic acids.

Methyl esters of the acids.

Methyl esters were obtained from the mixed acids by refluxing for several hours with methyl alcohol and a little concentrated sulphuric acid. Distillation of the isolated esters (B.P. 205–210°C. 10 mms.) gave a colourless liquid with iodine value 147.

Oxidation of the mixed esters.

100 grammes distilled esters, dissolved in 1500 ccs. acetone, containing a suspension of 20 grammes sodium bicarbonate, were oxidised at room temperature by the gradual addition of finely divided potassium permanganate (500 grs.). The acetone solution, removed by filtration, at the end of the oxidation from the manganese dioxide sludge, yielded, on evaporation of the solvent, 10 grammes of esters (iodine value nil) of saturated (unoxidised) acids consisting primarily of methyl palmitate and stearate.

The acid oxidation products, obtained in solution as potassium salts, by thorough leaching of the manganese dioxide sludge with boiling water were liberated by acidification of the solution. Volatile acids were separated by distillation in steam and subsequently converted to ethyl esters. Involatile acid was isolated by extraction of the solution, remaining after steam distillation, with ether. It was shown to consist of azelaic acid (M.P. 106°C). Oxalic acid was also shown to be present by the solution of potassium salts by isolation of calcium oxalate.

The ethyl esters of volatile acids (obtained above) were fractionally distilled, being thereby separated into two main fractions—

(*a*) Ethyl hexoate B.P. 166°C.

Hexoic acid, obtained on hydrolysis, was identified by silver salt determined (48·8% Ag.).

(*b*) Ethyl nonoate B.P. 222°C.

Monoic acid was likewise identified by the silver salt method (40·5% Ag.).

The results, obtained on oxidation of the mixed esters indicated about 10% saturated acid and 90% unsaturated acid, confirming the result obtained by the lead salt method.

Isolation of hexoic, nonoic, axelaic and oxalic acids demonstrated the presence of oleic and linolic acids, confirming also the formula for this latter acid.

Examination of sativic acid prepared from linolic acid.

As four isomeric linolic acids (geometric isomers) are theoretically possible, 30 grammes of mixed acids were oxidising in the prescribed manner for preparation of dihydroxy stearic and sativic acids. As melting points of 153°C and 171°C have been recorded for isomeric sativic acids and conclusions thereby drawn as to the nature of the original linolic acid, it was thought advisable to examine the sativic acid isolated in this oxidation.

Prolonged practical crystallisation from water (containing 2 ccs. concentrated HCl per litre) gave numerous fractions with melting point 153°C, only a small quantity being finally obtained of M.P. 171°C. indicating that the sativic acid consisted principally of the acid M.P. 153°C.

Sativic acid was also obtained from the original mixed acids[2] by preparation of linolic acid tetrabromide, decomposition of the tetrabromide yielding linolic acid and final oxidation to sativic acid. This sativic acid was also submitted to repeated fractional crystallisation and readily yielded the two form M.P.'s. 153°C and 171°C, the latter in much larger amount than obtained in the experiment above.

Our examination of the isomeric sativic acids would therefore suggest that little information can be drawn from them regarding isomeric linolic acids,[3] as it is clear that the much greater yield of the sativic acid of higher melting point (171°C) obtained by the tetrabromide method of isolation as compared with that obtained by direct oxidation, must have been occasioned by isomeric change during the operations. The preponderance of the sativic acid of lower melting point (153°C) in the products from direct oxidation, suggest that the original linolic acid consists largely of one of the possible isomers, it being probable that isomeric change does not occur in this process of direct addition of four hydroxyl groups to linolic acid.

Our thanks are due to the Commonwealth Council for Scientific and Industrial Recearch for a grant which has defrayed part of the cost of this investigation.

REFERENCES.

(1) R. D. Haworth, J.C.S., 1929, 1456–1461.

(2) Nicolet and Cox, J.A.C.S., 1922, 144–152.

(3) Compare W. S. Smith, Amer. Chem. Abst. 1930, 4261.

Aphididae in Australia.

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(*Read before the Royal Society of Queensland*, 27th *July*, 1931).

No account has yet been given of the aphides occurring in Australia. A few species regarded as being of importance are mentioned by Tillyard in the "Australian Encyclopedia" and in his "Insects of Australia and New Zealand." Also various authors have treated with some of them in economic literature, but the bulk of the species remains neglected. It seems advisable, whilst introducing this subject in its wider aspect, to summarise all the forms that are known to me, the majority of the species recorded being new to the Australian list.

Nearly all the known species are regarded as being introduced, but there is a form that I have not seen, *Anomalaphis comperei* Baker, on *Acacia* and *Eucalyptus* in South Western Australia ; this is an outstanding exception, for there can be little doubt but that it is indigenous, and perhaps the grass-root feeding species of *Anoecia*, found by Mr. R. W. Mungomery in the sugar-cane districts of Queensland together with a species of *Oregma* found by Mr. H. Tryon in Brisbane, may also be indigenous. Again it may prove difficult to show that *Neophyllaphis* on *Podocarpus* and *Greenidea* on *Ficus*, are not of the same category. The bulk of aphides occurring on indigenous plants are, however, introduced, of this there can be little doubt.

Of the subfamily *Aphidinae*, four of the six tribes are found in the Commonwealth. The tribe Lachnini is represented by two species on *Thuja orientalis*, found originally by Mr. F. A. Perkins. One, *Lachnus thujafoliae* Theobald, was described as indigenous under the name *Dilachnus callitris* by Froggatt, whilst the other is a small green form that takes on the generic characters of both *Lachnus* and *Dilachnus* quite indiscriminately, thus making it inadvisable to accept the generic status of *Dilachnus*, unless it be founded on a better basis than that given by Baker in 1920. A grass-root feeding species of *Anoecia* belongs to the subtribe Tramina.

The tribe Callipterini is represented by *Neophyllaphis podocarpi* Takahashi, on *Podocarpus elata*, by *Myzocallis sp.* on *Arundinaria* (Bamboo) in the Sydney Botanical Gardens, and by *Myzocallis annulata* Hartig, on various species of *Quercus*.

The tribe Greenideini has the very interesting *Greenidea ficicola* Takahashi, that has been found on every indigenous species of fig tree yet searched, but on no commercial varieties as far as yet known ; on one occasion a small colony was found on Oak (*Quercus*).

The tribe Aphidini is one containing numerous species and most pests come under it. It is composed of four subtribes, all in Australia where at least twenty-five per cent. of the genera are represented. In subtribe Aphidina, genera *Anuraphis*, *Aphis*, *Brevicoryne*, *Hyalopterus*, *Rhopalosiphum*, and perhaps others have been found. Under subtribe Cervaphidina, comes the indigenous *Anomalaphis*, the only other known genus being confined to Java. Of subtribe Macrosiphina, *Macrosiphum*, *Macrosiphoniella Myzus*, *Rhopalosiphoninus* and perhaps others occur. Finally in the Pentalonina, there are *Pentalonia*, *Idiopterus* and *Fullawayella*, three of the four known genera.

The subfamily Eriosomatinae is represented by the notorious woolly aphis (*Eriosoma*) of apple and another is recorded from pear.

The subfamily Hormaphidinae contains a species of *Oregma* and the world-wide *Cerataphis lataniae* which occurs on orchids and palms, being quite common in glass-house and bush-houses, and in Brisbane it regularly produces the winged form about April.

Subtribe Pentalonina

Key to the genera of Pentalonina

1. Radial and median veins typically fused at a point beyond the first branching of the median; rarely separated .. .. *Pentalonia*

   Radial and median veins typically separated, but if fused the fusion starts before the branching of the median vein. 2

2. Cornicles cylindrical, but usually constricted in the middle, that is invariably the latter half is no thicker than the basal half *Idiopterus*

   Cornicles swollen at the apical half, that is, they swell out in this region so as to be a little wider than at the basal portion *Fullawayella*

I have been forced to modify the characters given by Baker in each of the three genera given above, whilst the fourth genus given by him does not seem to be very distinctive. It appears to me that the whole subtribe is worthy of only generic status and would then be placed under subtribe Macrosiphina. Baker suggested that some of the specific names standing may prove to be synonyms, and this is now found to be the case with one of the two listed under genus *Pentalonia*. Theobald places *Fullawayella* as a synonym of *Idiopterus* but gives no reasons for doing so, nevertheless there is much to commend the action.

Pentalonia nigronervosa Coq.

Pentalonia nigronervosa Coquerel, Ann. Soc. Ent. France, 1859, 259; Wilson, Journ. Econ. Entom. ii., 1909, 346; Fullaway, Ann. Rep. Hawaii Agr. Exp. Stat. 1910, 346; Baker, Bull. Ent. Res. London, x. 1919, 45; Swain, Univ. Cal. Tech. Bull. iii., 1919, 78; Takahashi, Aphid. Formosa i. 1921, 30; and ii. 1923, 89; and v. 1927, 16; Froggatt, Agric. Gaz., N. S. Wales, xxxiv. 1923, 296; Moriera, Inst. Biol. defessa Agrig. Bull. ii. 1925, 28; Theobald, Aphid. Gt. Britain, i. 1926, 361; Magee, Council Scient. Ind. Res. Bull. No. 30, 1927, 64 pp.; Froggatt, Queensl. Agric. Journ. xxx, 1928, 11; Veitch and Simmonds, Pests and Diseases of Queensl. fruits and veg., 1929, 117; reprinted in Queensl. Agric. Journ. xxxii, 1929, 274; Zeck and Eastwood, Agric. Gaz. N. S. Wales, xl, 1929, 675.

Pentalonia caladii v.d. Goot, Contr, faune Indes Neerdrl., 1917, 57; Baker, Bull. Ent. Res. Lond. x 1919, 45.

Synonymy.—The recognisable difference between *P. nigronervosa* and *P. caladii* exists in the density of the infuscation along the veins of the wing, this being much lighter on the latter form. When *Pentalonia* from *Musa* were placed on *Caladium*, and *vice versa*, those found on *Caladium* were placed on banana stools, those aphides that would normally have produced the dark winged forms on *Musa*, yielded light forms when transferred to *Caladium* and those transferred from *Caladium* to *Musa* produced dark forms. In addition there is a strong tendency for those bred on *Caladium* to be more slender and to differ in the number of sensoria on the antennae, but the same variations in build were found when comparing the aphides from *Musa* in the north of Queensland with those from Brisbane, showing that these differences, as well as that of the wing, may be due to environment.

Host-plants.—P. nigronervosa is found throughout the world wherever bananas are grown and all species of *Musa* are liable to be attacked by them.

Strelitzia and *Ravenala*, in Brisbane, are sometimes found to support small colonies, but winged forms have not been found amongst these.

Caladium, as reported under remarks on synonymy, again are found to support colonies, and quantities of winged forms are found there in the autumn, but the plant dies down before the winged ones have reached their peak numbers, so in consequence these colonies do not last their normal life.

Alocasia macrorrhiza, the Cunjevoi, has long been reported as harbouring the species, and Professor E. J. Goddard searched for and discovered some near a plantation visited by him. Later, some plants grown in the University grounds were attacked, and at about the same time those in the Botanical Gardens were found harbouring them. The transferrence of colonies from *Musa* to *Alocasia* is readily achieved ; the colonies take to their new host plant and breed freely. An African species of *Alocasia* in the Botanical Gardens was found harbouring the aphis in large quantities in two consecutive years, both times in the autumn.

Opuntia inermis, growing alongside bananas infested with the aphis, were alighted upon and colonies started on the buds and continued to thrive as long as the flowers flourished. As soon as the sap-flow ceased, though the petals had scarcely time to wither and fall, the colonies died. Apparently they can thrive on the pear only on the flower heads.

Hedychium coronarium was found harbouring the aphis during the autumn of 1929 ; one plant in the Botanical Gardens supported a large colony in which the winged forms had started to develop.

Alpinia vittata variegata in the glass-house of the Sydney Botanical Gardens supported many colonies during April, 1928 ; they have been reported from two other species of this genus, *Alpinia rafflesiana* at Kew Gardens, England, and *Alpinia speciosa* in Formosa.

Heliconia, also in a glass-house of the Sydney Botanical Gardens, was found to aupport colonies in small numbers in December, 1930, at which time none were found on *Alpinia.*

Dieffenbachia magnifica is a plant upon which *Pentalonia* breeds prolifically in Brisbane, and in April, 1928, some wingless specimens of presumably the same species were detected in the Botanical Gardens of Sydney.

The species is also recorded as breeding on *Arum* in Brazil, but none have been found in Australia on this plant which is estensively grown in Brisbane. From California comes one record of a specimen on *Pelargonium*, but it was not recorded as breeding on this plant.

A review of this list of plants upon which *Penι alonia* has been found shows a monocotyledon type of plant dominates. The others recorded consist of the flower heads on *Opuntia* under unnatural conditions and *Pelargonium* based on a not very satisfactory record. Doubtless there are other monocotyledons yet to be found supporting this aphis. I have tried transferring specimens to *Platycerium* the host-plant of *Idiopterus*, and to *Viola*, the host-plant of *Fullawayella*, but in neither case with success.

Natural controls.—Other than those afforded by climatic conditions, there are no adequate controls of *Pentalonia* in Brisbane. Only on one occasion was a larva of a Syrphid fly discovered amongst a colony. I regard this immunity as being due to the habits of the aphis, for they live usually in protected positions, like the unrolled leaf of the banana, on the pseudostem beneath the hard outer covering down to the ground level and even below it. Such positions are usually excessively moist, a condition that may not be congenial to predatory and parasitic insects.

Idiopterus nephrolepidis Davis.

In 1926 and 1927, this species was very abundant on *Platycerium grande* and *P. alcicorne*, and occasionally on *Asplenum nidus*, but it was heavily preyed upon by predaceous insects. During 1928 and subsequent years it was difficult to find, and those colonies noted were soon exterminated by predaceans. Only once was it found harbouring an internal parasite ; the ferns supporting the colonies were grown under cover of a lobby leading to a small central yard of a hotel, where predaceous insects are not likely to penetrate.

Fullawayella violae Pergande.

This species was found on violets in 1926 and during all subsequent years except 1929. It is confined to the winter months of June and July and disappears during August ; the winged form becomes very plentiful for a short period. Neither predaceous nor parasitic insects have been found preying upon it.

List of identified aphides and their host-plants.

Anoecia sp.	*Echinochloa colona* and *Digitaria marginata*—on roots.
Lachnus thujafoliae, Theob. ..	*Thuja orientalis.*
Lachnus sp.	*Thuja orientalis.*
Neophyllaphis podocarpi, Tak. ..	*Podocarpus elata.*
Myzocallis annulata, Hartig. ..	*Quercus spp.*
Myzocallis sp.	*Arundinaria falcata* (in Sydney).

List of identified aphides and their host-plants.—Continued.

Greenidea ficicola, Tak.	*Ficus glomerata, F. hilli*, and *F. macrophylla* in Brisbane; *F. parcelli, F. rubiginosus* and *F. stephanocarpa* in Sydney. *Quercus sp.* (on one occasion only).
Anuraphis sp.	*Hordeum.*
Aphis tulipae Boyer	*Daucus carota.*
Aphis sacchari Zehnt.	*Saccharum officinarum.*
Brevicoryne brassicae L.	*Brassica sp.*
Hyalopterus arundinis Fab. ..	*Phragmites communis.*
Rhopalosiphum nymphaeae L. ..	*Vallisneria.*
Macrosiphoniella sanborni Gill. ..	*Chrysanthemum leucanthemum.*
Macrosiphum rosae L.	*Rosa spp.*
Macrosiphum gei Koch.	*Gladiolus* and *Musa* (rare).
Myzus persicae Sulz.	*Ageratum, Bougainvillea, Brassica, Cineraria* and *Papaver.*
Fullawayella violae Perg.	*Viola.*
Idiopterus nephrelepidis Davis ..	*Platycerium spp., Asplenium nidus.*
Pentalonia nigronervosa Coq. ..	*Musa spp., Caladium, Alocasia macrorrhiza, Alocasia sp.* (African). *Dieffenbachia magnifica, Hedychium, Ravenala. Strelitzia. Alpinia vittatavariegata, Opuntia* (flowers).
Geoica lucifuga Zehnt.	*Saccharium officinale* (roots).
Oregma sp.	*Dactyloctenium* and rarely *Setaria macrostachya.*
Ceratachis lataniae Bois.	*Epidendrum* and other Orchidaceae.

The above are only some of the aphides gathered from over eighty genera of plants, but the majority of the aphides are identified only as far as the genera. One unidentified species of genus *Aphis* can be recognised as common on *Eucalyptus paniculata, Tristania conferta* and *Banksia intregrifolia.* In Sydney it infests at times the avenues of *Tristania*, and it is not uncommon around Brisbane on saplings, and cows invariably eat the leaves containing the aphides when they find them.

There are two species of Prickly Pear (Opuntia), a green one on the roots and a black one on the pads. Also *Polygonum hydropiper* has two, an *Aphis* and a *Macrosiphum*, one clustering on the stems, the other on the underside of the leaves.

There are twenty-nine genera of indigenous plants supporting aphides in Queensland, but there is no evidence to indicate that any of these aphides are indigenous too.

For the naming of practically all plants in this paper, I wish to acknowledge my indebtedness to Mr. C. T. White, Government Botanist, and to Mr. E. W. Bick, Director of the Brisbane Botanical Gardens.

LIST OF INDIGENOUS PLANTS HARBOURING APHIDES.

Dicotyledons—

Bixineae	Scolopia Brownii	Aphis.
Portulaceae	Portulaca oleracea	Aphis.
Malvaceae	Malvastrum tricuspidatum	Myzus.
Sterculiacea	Sterculia discolor	Aphis.
Zygophylleae	Tribulus	Aphis.
Meliaceae	Flindersia	Aphis.
Sapindaceae	Harpullia pendula	Myzus.

LIST OF INDIGENOUS PLANTS HARBOURING APHIDES.

DICOTYLEDONS.—*Continued.*		
Myrtaceae	Eucalyptus paniculata	Aphis.
	Tristania conferta	Aphis.
Araliaceae	Astrotricha floccosa	Anuraphis.
Rubiaceae	Sarcocephalus Bartlingii	Macrosiphoniella.
Polygonaceae	Polygonum hydropiper	Aphis, Macrosiphum.
	Rumex Brownii	Aphis, Myzus.
Proteaceae	Banksia integrifolia	Aphis.
Loranthaceae	Loranthus longiflorus	Aphis.
Urticaceae	Ficus spp.	Greenidea.
	Ficus cunninghamii	Aphis.
GYMNOSPERMEAE—		
Taxaceae	Podocarpus elata	Neophyllaphis.
MONOCOTYLEDONS—		
Orchideae	Dendrobium	Cerataphis.
Lilliaceae	Cordyline	Pentalonia, Aphis.
Aroideae	Alocasia macrorrhiza	Pentalonia.
Cyperaceae	Cyperus rotundus	Aphis, Myzus.
Gramineae	Digitaria marginata	Anoecia, Aphis.
	Echinochloa colona	Anoecia, Aphis.
	Dactyloctenium	Oregma.
	Setaria macrostachya	Oregma.
	Imperata arundinacea	Aphis.
	Phragmites communis	Hyalopterus.
CRYPTOGAMS—		
Filices	Asplenium nidus	Idiopterus.
	Platycerium spp.	Idiopterus.

Since the above was written, Tribe Setaphidini (subfamily Aphidinae) has been found at Southport, in the scrub along the main beach, on *Breynia oblongifolia*. This species of *Setaphis* appears to be undescribed and may possibly be indigenous.

Investigations of Queensland Soils.

1.—Properties as Shown by Single Value Characteristics.

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(Three Text Figures)

(*Tabled before the Royal Society of Queensland, 31st August,* 1931).

Although a considerable body of information exists as to the chemical features of Queensland soils,[1] little has been done of recent years to indicate more permanent properties of our soil types, which would serve as a basis for classification. This is no doubt in part due to the labour involved in mechanical analyses and the difficulty of their interpretation. Although methods of mechanical analysis have been considerably improved, the analysis is not free from criticism, both on theoretical and manipulative grounds. Furthermore for rapid routine work, mechanical analysis is tedious and expensive.

During the last decade, it has become apparent, that apart from the effects of the coarser structural units, the physical properties of the soil mass, and more particularly the soil-water relationships, are dominated by the amount and nature of the collodial material present. Numerous attempts have been made to devise simple methods capable of giving an estimate of the nature of these properties and British Empire workers in particular have achieved considerable success in this respect. Following a comprehensive study of Natal soils, in which the results of mechanical analyses were compared and correlated with a number of soil-water relationships, Coutts has shown that it is highly probable that these latter give a more accurate estimate of colloid properties than does the more elaborate procedure.[2]

During the past two years a number of samples representative of typical Queensland profiles had been collected, partly from around Brisbane and partly from other parts of the State when accompanying Professor J. A. Prescott on a preliminary survey of the State. This paper records the results of a number of " single-value " determinations designed to give rapidly and conveniently information on a number of physical properties of these samples.

Methods.

All samples had been ground to pass a 2 mm. sieve and stored for some months before used. The determinations made were those suggested by Coutts, viz., water absorbed per 100 gms. of soil, pore space and volume swelling as determined by the procedure of Keen and Racskowski, moisture at the point of maximum plasticity (sticky point), air-dry moisture and ignition loss.

In the Keen-Racskowski procedure soil passing a 1 mm. sieve was used and was sifted through a 70 mesh sieve and the portions remixed. Owing to an error in Coutts' paper the boxes were made 1 inch in diameter. These small boxes worked well and gave reproducible results. The standard boxes[3] are now being used. Moisture at the point of maximum plasticity was determined by the method advocated by Keen and Coutts.[4] Samples were dried at 105° in a Hearson electric oven and all values here reported are calculated on the basis of oven-dry soil.

The following soils were used.

Group A.

Grey sandy soils, with brown or yellow subsoils, carrying open forest vegetation.

No.	Locality.	Horizon	Depth	Description.
1	Brisbane, Gregory Terrace	A_1	0–3″	Grey Brown. Humus sandy loam. Skeletal.
2	Brisbane, Gregory Terrace.	A–C	3–14″	Grey yellow sandy loam with rock fragments. Brisbane Schist.
3	Enoggera Gap ..	A	0–14″	Grey brown sandy loam.
4	Enoggera Gap ..	B–C	14–34″	Yellow brown loam with fragments of decomposing granite.
5	Happy Valley, Brisbane.	A	0–11″	Grey brown sandy loam.
6	Happy Valley, Brisbane	B_1	11–14″	Brown sandy clay with accumulation of stones at 11-12″.
7	Happy Valley, Brisbane	B_2 C	14–20″	Yellow coarse sand and clay on Brisbane Tuff.
8	Wild River, Herberton.	A_1	0–5″	Dark grey sandy humus.
9	Wild River, Herberton	A_2	5–12″	Ash grey coarse sand.
10	Wild River, Herberton	B_1	12–22″	Brown sandy clay and gravel.
11	Wild River, Herberton	B_2	22–39″	Pink sandy clay on granite.
12	Selheim	A_1	0–3″	Humus fine sand.
13	Selheim	A_2	3–12″	Grey brown sandy loam.
14	Selheim	B_1	12–36″	Grey brown sandy clay with ferruginous concretions.
15	Selheim	B_2C	36–48″	Brown sandy clay on Desert Sandstone.
16	Callide Expt. Station	A	0–5″	Grey black sandy loam (cultivated).
17	Callide Expt. Station	B	5–40″	Grey black loam.
18	Callide Expt. Station	C	40 and below	Yellow sandy loam (alluvium).

Group B.

Brown sandy loams or loams with red or red-brown loam or clay loam subsoils.

No.	Locality.	Horizon.	Depth.	Description.
19	Selheim	A	0–9″	Reddish-brown
20	Selheim	B	9–27″	Bright red sandy clay on Desert Sandstone.
21	Charters Towers ..	A_1	0–5″	Reddish brown coarse sandy loam with humus.
22	Charters Towers ..	A_2	5–14″	Reddish brown coarse sandy loam.
23	Charters Towers ..	B_1	14–24″	Red brown clay loam.
24	Charters Towers ..	B_2C	24–36″	Red bown clay loam, with granite fragments.
25	Rockhampton ..	A	0–12″	Dark grey brown sandy loam (cultivated for pineapples).
26	Rockhampton ..	B	12–27″	Red clay loam, with layer of stone 12″.
27	Rockhampton ..	C	27″ and down	Yellow. partly decomposed granite.

Group C.

Brown sandy loams with deep red or red-brown subsoils.

No.	Locality.	Horizon.	Depth.	Description.
28	Raff's Hill ..	A_1	0–2″	Humus sandy loam.
29	Raff's Hill ..	A_2	2–14″	Brown sandy loam.
30	Raff's Hill ..	B_1	14–18″	Red clay, with many ferruginous concretions.
31	Raff's Hill ..	B_2	18–54″	Red clay loam, with few concretions.
32	Raff's Hill ..	C	54–78″	White clay mottled red and purple. Decomposed. Petrie Series.
33	Scarborough Cliff	A	0–30″	Brown loam humus stained.
34	Scarborough Cliff	B_1	30–78″	Brick red clay loam. Marble size concretions.
35	Scarborough Cliff	B_2	78–108″	Red clay loam, thickly studded with buckshot ferruginous concretions.
36	Scarborough Cliff	B–C	108″ down	Red and white mottled clay, with purple streaks

Group D.

Red loams of indeterminate depth on basalt carrying rain forest.

No.	Locality.	Horizon.	Depth.	Description.
37	Tolga Scrub ..	A	0–9″	Reddish-chocolate coloured loam.
38	Tolga Scrub ..	A	9–18″	Reddish-chocolate coloured loam.
39	Tolga Scrub ..	A	18–27″	Reddish-chocolate coloured loam
40	Tolga Scrub ..	A	27–35″	Reddish-chocolate coloured loam
41	Childers Mill ..	A	0–9″	Red loam.
42	Childers Mill ..	A	9–18″	Red loam.
43	Childers Mill ..	A	18–27″	Red loam.
44	Kingaroy	A	0–9″	Red loam.

Group E.

Dark coloured soils with calcareous subsoils.

No.	Locality.	Horizon.	Depth.	Description.
45	Bald Hills	A	0–12″	Dark brown clay loam (grassy knoll).
46	Bald Hills	C	12–36″	Yellow brown clay loam, with partially decomposed tertiary basalt. Faintly calcareous. Veins of magnesite in fissures of parent material.
47	Monto	A_1	0–22″	Brown loam. (Softwood monsoon forest).
48	Monto	A_2	22–33″	Yellow brown loam.
49	Monto	B–C	33–42″	Brown calcareous loam.
50	Emerald Downs ..	A	0–12″	Dark brown clay loam. (Brigalow forest).
51	Emerald Downs ..	A	12–27″	Brown-black clay loam, with carbonate grains.
52	Emerald Downs ..	C	27–36″	Brown clay loam, with carbonate concretions and gypsum.
53	Orion Downs ..	A	0–5″	Brown-black clay loam crumb structure (grass land).
54	Orion Downs ..	A	5–27″	Brown-black compact clay, carbonate grains.
55	Orion Downs ..	C	27″ down	Yellow clay, with carbonate nodules.
56	Blairmoor, Winton	A	0–9″	Brown loam, loose crumb structure.
57	Blairmoor, Winton	A_2	9–15″	Brown loam, nut structure. Carbonate grains.
58	Blairmoor, Winton	B–C	15–27″	Yellow brown clay, with carbonate nodules.
59	Blairmoor, Winton	B–C	27–40″	Yellow brown clay, with carbonate nodules and gypsum.
60	Blairmoor, Winton	C	40″ & down	Yellow brown loam, gypsum flakes on mudstone.

Group F.

Chestnut soil.

No.	Locality.	Horizon.	Depth.	Description.
61	Fifteen miles West of Hughenden ..	A	0–10″	Brown crumbly clay loam.
62	Fifteen miles West of Hughenden ..	C	10–18″	Brown compact clay loam, flecks of carbonate and gypsum.
63	Fifteen miles West of Hughenden ..	C	18″ & down	Brown compact clay loam, increasing gypsum in larger crystals.

The following values were obtained :—

	Keen Racskowski Box			Moisture at sticky point.	Air-dry moisture.	Ignition loss.
Soil No.	W	P	V	S	A	I
1	44.8	51.1	0.18	37.5	1.94	6.93
2	42.4	50.9	nil	33.5	1.73	5.80
3	32.3	41.4	1.47	27.2	1.11	3.45
4	30.1	39.3	2.79	32.0	1.52	3.46
5	42.0	49.7	1.10	32.2	1.42	5.18
6	40.7	47.6	5.65	38.3	4.17	6.66
7	42.9	49.0	8.75	38.7	5.04	7.14

	Keen Racskowski Box			Moisture at sticky point.	Air-dry moisture.	Ignition loss.
Soil No.	W	P	V	S	A	I
8	20.8	33.1	nil	16.9	0.20	1.9
9	18.3	30.4	nil	15.9	0.30	1.4
10	38.2	47.1	4.96	31.4	1.85	6.71
11	53.1	53.9	6.82	50.8	3.1	10.9
12	16.4	27.4	0.64	15.4	0.40	1.4
13	13.8	24.8	1.1	14.0	0.20	0.5
14	23.9	30.8	6.78	21.1	3.52	3.31
15	39.1	46.6	8.83	26.4	4.29	4.39
16	48.3	55.0	2.87	35.3	4.29	8.11
17	49.2	53.8	10.15	40.3	5.60	6.87
18	45.8	50.4	10.7	34.3	4.82	4.30
19	20.5	32.8	0.58	15.6	0.5	2.95
20	34.1	43.5	0.89	23.6	1.31	5.07
21	32.4	40.0	3.49	24.8	2.46	6.02
22	34.9	45.6	4.42	36.7	2.25	4.40
23	44.3	49.9	8.21	35.3	5.93	8.16
24	28.9	41.4	3.49	22.3	2.20	2.61
25	28.6	40.4	3.64	20.0	2.29	5.51
26	42.1	47.3	7.36	33.8	4.93	8.50
27	32.4	40.0	6.90	31.1	5.26	5.88
28	44.9	49.7	0.54	28.5	2.20	8.42
29	33.9	43.0	0.93	25.8	2.07	7.10
30	30.1	40.4	1.94	25.2	1.63	5.47
31	42.2	48.5	2.48	35.0	2.58	7.12
32	46.5	51.8	2.17	41.6	2.21	8.89
33	38.1	47.2	2.51	29.7	3.22	11.7
34	49.6	54.4	2.48	38.4	3.31	14.1
35	45.0	50.9	1.97	39.9	3.31	13.4
36	55.2	57.0	0.15	44.1	2.85	12.9
37	63.7	56.3	12.6	51.0	5.72	20.8
38	52.8	55.3	4.84	43.9	4.17	15.2
39	46.0	53.6	2.02	41.8	2.89	13.5
40	48.5	54.2	1.16	43.1	3.11	12.4
41	53.8	56.5	5.81	41.2	4.51	14.5
42	44.3	49.7	3.49	44.1	3.22	11.0
43	44.9	52.4	2.79	36.0	2.99	10.7
44	49.5	52.7	9.84	44.8	6.16	13.8
45	51.2	53.9	11.0	46.7	7.41	10.5
46	54.2	54.3	6.95	45.9	7.64	8.94
47	45.4	48.7	10.15	38.7	5.25	10.4
48	51.7	53.8	14.1	38.4	6.50	6.19
49	44.5	49.2	9.64	35.3	6.16	6.57
50	49.8	59.3	19.5	32.2	7.07	6.21
51	50.2	53.7	16.8	32.5	6.50	5.86
52	45.6	50.7	13.5	32.7	5.04	4.73
53	80.2	63.1	29.6	63.7	15.1	10.9
54	83.0	57.2	24.7	47.8	9.45	9.22
55	59.3	57.1	17.3	48.4	10.7	8.86
56	49.9	54.8	16.0	38.9	6.04	4.98
57	49.1	54.0	17.0	40.3	6.83	3.53
58	48.1	55.9	10.0	43.2	7.41	5.37
59	47.5	57.9	12.6	42.3	7.41	3.87
60	59.3	56.7	20.9	38.3	7.63	4.74
61	59.4	60.9	20.5	42.2	9.17	6.77
62	61.9	56.7	27.5	51.2	9.65	6.47
63	64.4	56.3	20.5	48.9	12.0	9.29

Discussion.

The soils used include a wide range of types with a preponderance of sandy soils. Certain general relationships confirmatory of observations made elsewhere are apparent. These have been expressed graphically by ranging the soils in order of their S values, grouping to nine groups of seven and plotting the mean values obtained.

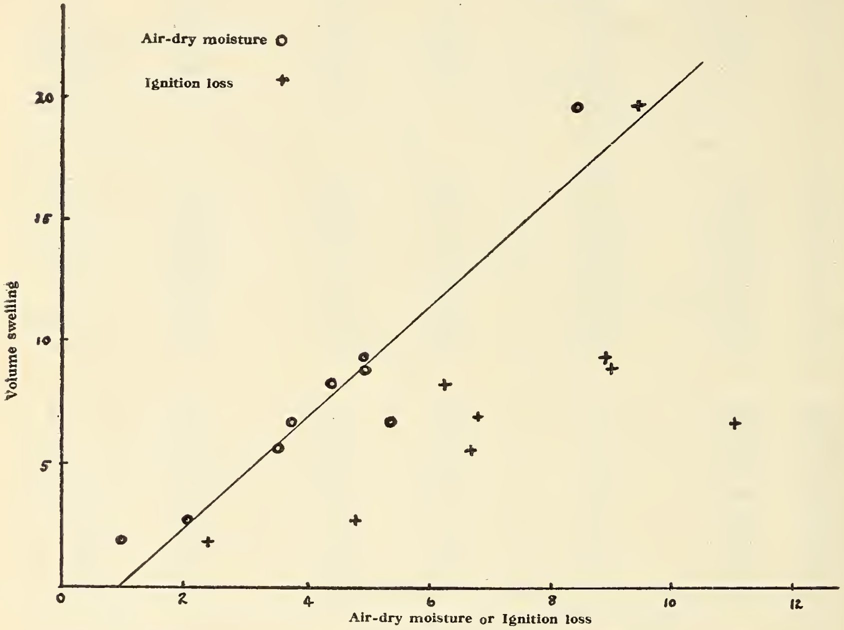


FIGURE 1.—RELATIONSHIPS OF VOLUME SWELLING TO AIR-DRY MOISTURE AND IGNITION LOSS.

The collodial properties of the soil as a whole, as reflected in their water relationships, will be compounded of two main factors:—(*a*) what may be termed the degree of comminution, *i.e.*, the proportion of particles small enough to exhibit collodial behaviour, (*b*) the influence of the chemical composition of these particles on their water relationships. Of the values determined the ignition loss is most likely to be affected by the latter factor, including as it does both "combined" water, carbon dioxide from carbonates and organic matter. "Combined" water has been shown by several investigators to vary with chemical composition of the colloidal material, being high in the case of material of low silica—sesquioxide ratio.[5]

Pore space, water absorbed and moisture at the sticky point are values of the same order and are less likely to be disturbed by chemical influences, although the nature of the exchangeable bases and the presence of salts may lead to variations. It will be seen that the relationship between S and W is probably linear, and between S (on a weight basis) and P (on a volume basis) is curvilinear (Fig. 2). The values obtained show a minimum pore space of approximately 26% and a minimum water capacity of 14–16 as indicated on theoretical grounds by Keen.[6] The pore space as determined by this method appears to approach an upper limit of about 60%. A close relationship exists between S and A (Fig. 3) and if an equation were justified it would be of the type S=14+5A, confirmatory of the suggestion that in a closely packed soil the "free" water is about 14%.[4]

The volume swelling appears to be associated with the air dry moisture rather than with ignition loss (Fig. 1), and in general it may be said that but for the erratic values of the ignition loss these results tend to confirm those previously obtained elsewhere and need not be discussed further in a general way.

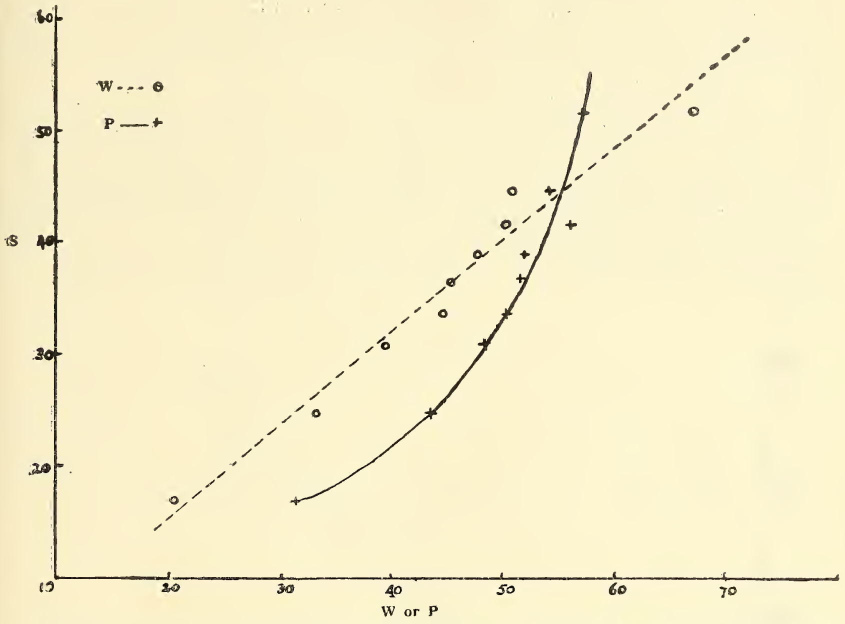


FIGURE 2.—MOISTURE AT STICKY POINT PLOTTED AGAINST WATER ABSORBED OR PORE SPACE.

The soils examined have been grouped in accordance with profile resemblances, and the laboratory measurements reveal interesting resemblances and differences. All samples were taken from uncultivated soils except where indicated.

In group A there is a general sharp contrast between A and B horizons with well marked zones of accumulation. The shallow soil on the Brisbane schist (Bunya phyllites) resembles in some characteristics those of Group D. Following the colour change from grey through brown to red in groups B, C and D, a gradual transition in colloidal properties is noticed. The soils become finer in texture and exhibit less tendency to accumulate colloidal material in the lower horizons. Indeed in the case of the deep red loams, the values decrease in magnitude with increasing depth. These latter constitute the most interesting group of the non-calcareous soils. Although finely comminuted they exhibit low value swelling and air dry moisture and high ignition loss. These characteristics serve to identify them with the lateritic soils (cf Marchand,[7] Hardy[8]). They develop under rain-forest cover upon basic rocks. Characteristic of them is the low silica—alumina ratio of the clay fraction. Agriculturally they are highly valued not only for their often high fertility but also for their ease of working and free drainage. This latter characteristic is in accord with their low volume swelling as shown by Green and Ampt[9] and by Hardy.[10]

In marked contrast to the behaviour of these non-calcareous soils are the soils of groups E and F. Except for numbers 47–52 these support a grassland flora. As has been observed in other countries, these are typical clay soils, which, under cultivation, are highly fertile but difficult to work except under favourable moisture conditions. The results quoted show characteristically high values for volume swelling and air-dry moisture and relatively low values for ignition loss. These appear to be characteristic for clays relatively rich in silica as shown for example in the analyses of Holmes and Edgington[11] and also for bentonites and minerals of the montmorillonite group.[12] The values of air dry moisture and ignition loss for groups C and D show marked resemblances to those quoted in analyses of halloysite and kaolinite. The soils of groups E and F resemble, however, those of group D in that some are derived from basalt; they are fine in texture and there is a tendency for colloidal properties to diminish with depth.

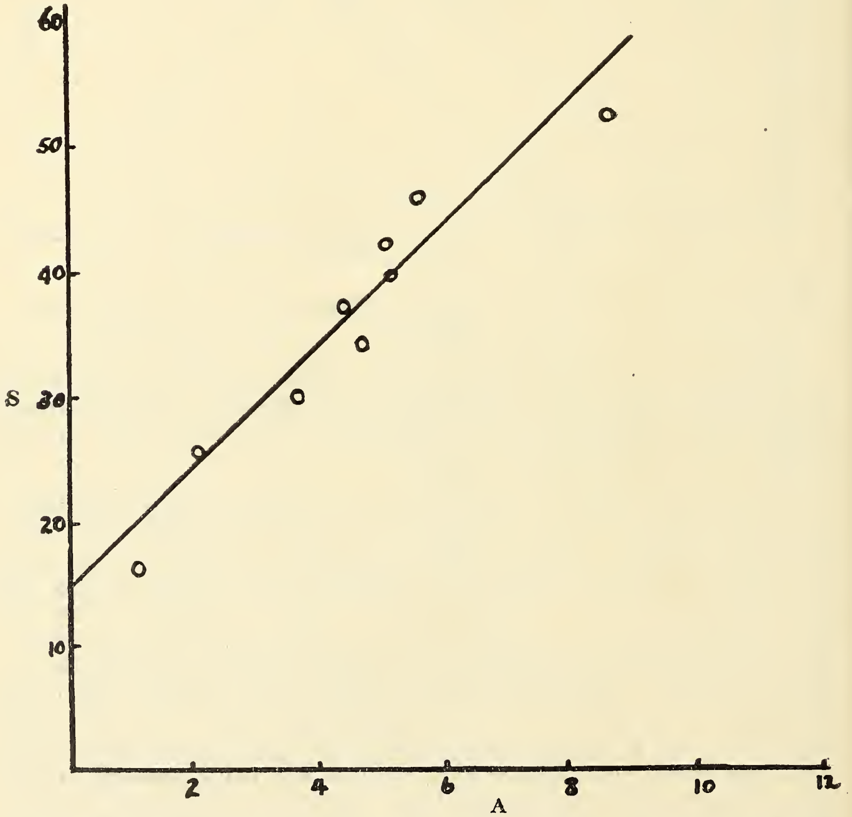


FIGURE 3.—RELATIONSHIP OF MOISTURE AT STICKY POINT TO AIR-DRY MOISTURE.

SUMMARY.

A number of soils, typical of Queensland profiles have been examined, using simply determined "single value" measurements on the lines suggested by Coutts. The general findings of earlier workers have been confirmed and comparisons made of the characteristics of Queensland types with those of soils of other countries. The usefulness of such determinations as an aid to classification and prediction of field behaviour has been demonstrated.

I am indebted to the Commonwealth Council for Scientific and Industrial Research for a grant in aid of expenses.

REFERENCES.

(1) Annual Reports, Agricultural Chemist, Brisbane.

(2) COUTTS, J. R. H., J. Agric. Sci., 1929, 19, 325.

(3) COUTTS, J. R. H., J. Agric. Sci., 1930, 20, 407; see also KEEN, B.A., ibid, 414.

(4) KEEN, B. A., and COUTTS, J. R. H., J. Agric., Sci., 1928, 18, 740.

(5) See *e.g.* HOLMES, R. S., and EDDINGTON, G., U.S. Dept. Agric. Technical Bulletin, No. 229, 1930.

(6) KEEN, B. A., J. Agric. Sci., 1924, 14, 170.

(7) MARCHAND, B. DE C., J. Agric. Sci., 1924, 14, 151.

(8) HARDY, F., J. Agric. Sci., 1925, 15, 434.

(9) GREEN, W. H., and AMPT, G. A., J. Agric. Sci., 1911, 4, 1.

(10) Loc. cit.

(11) Loc. cit.

(12) ROSS, C. S., and SHANNON, E. V., J. Amer. Ceram. Soc., 1926, 9, 77.

Two Previously Undescribed Rutaceae from South Eastern Queensland.

By C. T. WHITE (Government Botanist), Brisbane.

(*Read before the Royal Society of Queensland, 30th November, 1931*).

Zieria collina sp. nov.

Frutex 2-3 m., ramulis junioribus dense pilosis adultis glabris lenticellatis ; foliis oppositis trifoliolatis, pedicellis pilosis 5-8 mm. ; foliolis sessilibus lanceolatis supra viridis glabrescentibus subtus albidis tomentosis 1-2 cm. longis ca. 3 mm. latis ; floribus in cymis 2-3-chotomis axillaribus dispositis pedunculis gracilis 0.5—1.5 c.m. pedunculis et ramulis pilosis, bracteis linearibus, pedicellis 1-2 mm., bracteolis parvis ; calycis lobis late ovatis ca. 0.5 mm., petalis ovatis utrinque dense tomentosis, staminibus glabris, gynoecio glabro ; carpellis 2 mm. longis, seminibus opaquis nigris 1.5 mm. longis.

Large spreading shrub 2-3 m. forming thickets on hillsides in brush or in clearings in light rain-forest, younger branches densely pilose, older ones glabrous lenticellate ; leaves opposite, 3-foliolate, pedicels pilose 5-8 mm. long, leaflets sessile lanceolate, dull green and glabrescent above, densely whitish tomentose beneath, 1-2 cm. long, mostly about 3 mm. broad. Flowers in axillary 2-3-chotomous cymes, peduncles slender 0.5—1.5 c.m. long, peduncle and branches pilose, bracts linear, pedicels 1-2 mm., bracteoles small ; calyx lobes broadly ovate about 0.5 mm., petals ovate densely tomentose on both faces, 2 mm. long, stamens glabrous, filaments white, 1 nm. long ; anthers orange red (in dried state, cream), 0.5 cm. diam ; gynoecium glabrous ; cocci 2 mm. long ; endocarp white cartilaginous, seed dull black 1.5 mm. long.

Tamborine Mt., S.E. Queensland, C. T. White, 6155, flowering specimens (11-8-1929)—type ; large spreading shrub on hillsides, forming thickets in brush or in clearings in light rain-forest ; leaves dull green above, paler beneath ; petals white, filaments white, anthers orange red. Goambo Creek, Tamborine Mountain, F. M. Bailey ; Tamborine Mt., C. T. White, 3337, fruiting specimens 27-12-1926.

This is evidently the plant referred to by Domin Bibl. Botanica 89, 837 to *Zieria Smithii* Andr. var. *parvifolia* Benth. and as such it was labelled on the sheets in the Queensland Herbarium. I was very doubtful on this point, however, and after collecting fruiting specimens in December, 1926, forwarded specimens to the Director, Royal Botanic Gardens, Kew, where they were reported on by Mr. V. S. Summerhayes as follows :—

> " *White* 3337. The specimen does not agree with anything we have in the herbarium. Of the two specimens cited by Bentham under *Zieria Smithii* var. *parvifolia*, that collected by Robert Brown does not fit the description, most of the leaflets being 1¼-1½ inches long. In any case it does not seem to be the same as White 3337 since it has the black glands on the under surface of the leaves so characteristic of Z. *Smithii* Andr. Type. We have no specimen labelled ' New England,' but there is one collected by C. Stuart near Tenterden which may be the specimen cited. This, however, has *hairy*, not stellately pubescent branches and very short petioles. It seems to be more closely related to Z. *pilosa*. I should very much like to see more Queensland material of Z. *Smithii*, as the various forms are not at all clear, but I do not believe that var. *parvifolia*, as far as R. Brown's specimens are concerned, is distinct from the type variety."

Now that good flowering material has been collected I name the species as above.

Acronychia suberosa sp. nov.

Arbor alta cortice suberoso ; ramulis puberulis, mox glabris ; foliis oppositis, tirfoliolatis, petiolis supra sulcatis ad 3 cm. longis ; foliolis sessilibus, lanceolatis ad 7 cm. longis et 2 cm. latis sed plerumque minoribus ; floribus citrinis suaveolentibus in cymis simplicibus axillaribus dispositis ; pedunculis ad 2 cm. longis puberulis vel glabrescentibus ; pedicellis puberulis, 1-2 mm. longis ; calycis lobis rotundis 2.5 mm. latis, extus puberulis, intus glabris ; filamentis applanatis marginibus in parte inferiore pilis albis longis dense obsitis ; antheris ca. 1 mm. ; ovario glabro conico prominente 4-loculari ; stylo 4 mm. longo in parte inferiore pilis longis albis obsitis ; stigma parva, capitata ; fructu carnoso ca. 2.5 cm. longo infra medium ca. 2 cm. diam. ; loculis distinctis et facile separatis ; semnibus castaneis vel nigris, 3 mm. longis.

Large tree with a corky bark, branchlets puberulous, soon glabrous. Leaves opposite, trifoliolate, petiole channeled above, thickened at the apex, up to 3 cm. long, leaflets sessile, lanceolate, up to 7 cm. long and 2 cm. broad, but mostly somewhat smaller. Flowers yellowish cream, sweetly scented borne in simple axillary cymes ; peduncles up to 2 cm. long, puberulous or glabrescent, pedicels puberulous 1-2 mm. long ; calyx lobes rounded 2.5 mm. across, outside puberulous, inside glabrous ; petals linear, 6 mm. long, puberulent with scattered hairs outside, glabrous inside ; filaments flattened densely clothed on the edges in the lower half with long white hairs, anthers about 1 mm. long, ovary glabrous conical, prominently divided into 4 cells, style 4 mm. long, densely clothed in the lower part with long white hairs, stigma small capitate. Fruit succulent about 2.5 cm. long and 2 cm. or slightly more in diameter below the middle tapering towards the top to a blunt apex, the individual cells very distinct and easily separable, endocarp of thin parchment-like consistency; seeds brown or blackish 3 mm. long.

Roberts Plateau, Lamington National Park, S.E. Queensland, H. Tryon and C. T. White. Flowering and fruiting specimens, March, 1921. Large trees with a corky bark, flowers sweetly scented. Springbrook, S. E. Queensland, altitude 3,000 ft. C. T. White, 6270, 20-9-1929 (leaves only).

Closely allied to the common North Queensland *A. melicopoides* F.v.M., which differs in being larger in all its parts, in the petals being quite glabrous except for a few hairs on the margin near the base, in having a densely hairy ovary and in the less succulent fruit not readily separable into distinct carpels.

A Previously Undescribed Papuan Dipterocarp.

By C. T. White (Government Botanist, Brisbane).

(*Read before the Royal Society of Queensland, 30th November,* 1931).

Hopea glabrifolia sp. nov.

Arbor partibus junioribus et inflorescentiis pubescentibus ; foliis petiolatis, petiolis 5-7 mm. longis, laminis ad 14 cm. longis plerumque 3-plo longioribus quam latae ellipticis supra nitidis subtus pallidioribus basi rotundatis et inaequalibus apice obtuse acuminatis acumine ipso ad 1 cm. longo, nervis praecipuis utrinque 9-11 subtus prominentioribus ; paniculis lateralibus et axillaribus foliis brevioribus, ramulis pubescentibus ; floribus sessilibus vel brevissime pedicellatis 2-bracteatis, bracteis pubescentibus late ovatis ca. 1 mm. longis, calycis segmentis imbricatis, 2 exterioribus 3 mm. longis obtuse acuminatis, extus in dorso pubescentibus margine in parte superiore ciliolatis ; petalis linearibus, acutis 3 mm. longis 1 mm. latis extus pubescentibus ; staminibus, 10 cum seta 2 mm. longis, seta ipsa 1 mm. longa ; ovario glabro ; fructu ignoto.

Papua : Misima Island. Received from Hon. Staniforth Smith, Director of Agriculture, Port Moresby, with the following note :—

" A very useful mining timber found on Misima Island : the native name is ' Rul.' "

The present record extends the known range of the family considerably eastwards.

Australian Flies of Genus Actina (*Stratiomyiidae*)

By G. H. HARDY

(Walter and Eliza Hall Fellow in Economic Biology, University of Queensland, Brisbane).

(*Tabled before the Royal Society of Queensland, 30th November, 1931*).

In Australia there are four defined genera of Stratiomyiidae that come within the tribe Beridini, and three of these are represented by one described species each. It is not possible to associate the Australian species seen by me with a number of other genera that are allied and described from other parts of the world, as the species before me do not fall into line with the characters cited ; nevertheless there are several that grade towards those genera and are here retained under genus *Actina*, which is used in a wider sense than usual. The following key will enable the new species to be relegated to this genus :—

1. Abdomen short, more or less parallel sided and all the segments wider than long ; eyes pubescent or bare ; median vein three or four branched ; antennae quite normal in shape and very similar to that of *Neoexaireta* ; the tenth segment is usually about the length of the two preceding ones never less ; scutellum with six or eight spines .. .. .. *Actina* Meigen

   Abdomen long, widening towards the apex and at least some segments are as long as wide ; eyes invariably bare ; antennal segments normal or irregular in size 2

2. Antennae with the three last segments very minute, being reduced in both length and width ; scutellum with four spines ; median vein three branched .. .. *Xanthoberis* White

   Antennae not so formed 3

3. Fourth to ninth antennal segments about equal in size, the tenth about as long as four of these. Scutellum with four spines. Median vein four branched .. *Neoexaireta* Ost.-Sacken

   Third to seventh antennal segments subequal, the eighth and ninth are much longer and the tenth as long as the four preceding ones. Scutellum with six spines. Median vein two branched .. .. *Eumecacis* Enderlein

Only *Actina* and *Neoexaireta* are commonly found, both being very plentiful in collections and therefore are best understood. They may be distinguished by many characters, of which the more important ones seem to be in the hairs of the pleura. *Neoexaireta* has a bare area extending from the pteropleura, immediately below the insertion of the wing, to the hypopleura, between the intermediate and posterior coxae. When the posterior leg is drawn up against the body, it lies along this bare area which perhaps accounts for its nature. The whole of the pteropleura is hairy on *Actina*, and the hypopleura is bare; variations in the density of the hairs occur in this genus, so that sometimes the hairs on the pteropleura are scantily represented. Hairs are present on the metanotum of *Neoexaireta*, and absent there on *Actina*. The hind femora may be equally thickened in both genera, but on *Neoexaireta* a small ventral tubercle occurs well before the apex and seems to be distinctive. Hitherto none of these characters have been regarded as of generic importance.

Genus Actina Meigen.

Actina Meigen, Klassif. i. 1804, p. 116. White, Proc. Roy. Soc. Tasmania, 1914, p. 49; and Proc. Lin. Soc. N.S. Wales, xli, 1916, p. 77. Hardy, Proc. Roy. Soc. Tasmania, 1920, p. 40. Malloch, Proc. Lin. Soc. N.S. Wales, liii, 1924, p. 40.

The hairy nature of the eyes and the spines of the scutellum are two characters usually regarded of generic importance for this genus, but neither are maintained on the species before me. A male caught in a fruit-fly lure and given to me by Mr. A. F. Perkins, comes from somewhere in the Toowoomba district, Queensland, and is now mounted whole on a micro-slide. The pubescence of the eyes, though on a male, is of the same nature as that on the typical female, and moreover the hind metatarsus is considerably dilated, a character not seen by me on any other species. Again from the dense rain-forest regions of Queensland and Western Tasmania, come two further forms on which the eyes are bare, and are described below. The scutellum contains normally six spines, but one species and one sex only of another has eight. According to modern innovations, all or nearly all of these species would be placed in different genera, but they are very much alike in all general features and are too closely related to be treated other than as one generic conception.

Key to Species of Actina.

1. Eyes thickly pubescent, long on the male and short on the female. Pleural hairs plentiful	2
Eyes entirely bare, pleural hairs scanty	5
2. Wings with a large dark costal blotch around the stigma and reaching towards the apex. Abdomen entirely blue-black, thorax with abundant bright yellow pubescenece. Scutellum with eight spines ..	*ocinis* n. sp.
Wings hyaline, or uniformly smoky. Scutellum normally with six spines, rarely eight	3
3. Spines of scutellum entirely metallic green; abdomen entirely black	*costata* White
Spines of scutellum invariably yellow at least on the apical half. Abdomen rarely entirely black, usually some traces of yellow to be found on the underside	4
4. First antennal segment about or less than one and a half times the length of the second. Australian mainland	*incisuralis* Macquart.
First antennal segment at least twice the length of the second. Tasmanian species	*nigricornis* Enderlein

Key to Species of Actina.—Continued.

5. First antennal segment about or less than one and a half times the length of the second; the apical segment about the length of the eighth to ninth .. *imperfecta n. sp.*

First antennal segment at least twice the length of the second; the apical segment about the length of the sixth to ninth .. .. *silvicola n. sp.*

Actina ocinis n sp.

Male: the head is similar to that on *A. incisuralis*, but the hair of the eyes is shorter. The antennae are yellow. The copper-coloured dorsal area of the thorax is overlaid by abundant long yellow hairs, the scutellum is similarly coloured and has eight spines, but the pleura is blue black, as is also the abdomen both above and below. The legs are black with the intermediate and anterior tibiae and tarsi sometimes dirty yellowish. The wings are somewhat smoky with a large fuscous area around the stigma, and extending towards the apex of the wing.

Female: the head is similar to that of *A. incisuralis*, but the frons has hair scattered all over it and is sunken; the eyes have very short pubescence. The thorax is vivid green above and has abundant yellow pubescence. In other characters it resembles the male. The metallic colours are liable to vary, as is usual in the genus. Length, 7½ to 8 mm.

Hab.—Queensland; Brisbane, April and May, 1928 to 1931. 25 males, 9 females. It was also seen in September and December, 1931.

The species is rather common during the autumn, and is to be found resting on the underside of leaves and is readily seen in such positions on fig-trees, sometimes in company with *A. incisuralis*. When alive the eyes are green with a large blue blotch above, this area, having a reddish-purple edge, touches only the frontal margin.

Actina costata White.

Actina costata White, Proc. Roy. Soc. Tasmania, 1914, p. 51; and Proc. Lin. Soc. N.S. Wales, xli. 1916, p. 77. Hardy, Proc. Roy. Soc. Tasmania, 1920, p. 41; and Proc. Roy. Soc. Queensland, xxxvi. 1924, p. 40.

This form is metallic blue-green on the thorax of both sexes, but the leg colouration varies. The female has the hair distributed all over the frons, whereas on *A. incisuralis* there is a bare strip on the central third of the frons.

Hab.—Tasmania: not uncommon at high altitudes. Victoria: there are five specimens labelled "Begong Plains, 5600-6000 ft., Jan., 1928, F. E. Wilson." These differ only in having the eyes slightly wider apart.

ACTINA INCISURALIS MACQUART.

Beris incisuralis Macquart, 1847-9; Walker 1854.
Actina incisuralis White 1916 (part); Hardy 1920 and 1924.
Beris filipalpis Macquart 1849.
Actina filipalpis Enderlein 1921
Beris fusciventris Macquart 1849.
Beris nitidithorax Macquart 1849.
Actina victoriae Hill 1919; Hardy 1920; Malloch, Proc. Lin. Soc. N.S. Wales, liii, 1928, p. 364.

(For references not cited in full above, see these proceedings, Vol. xxxvi., 1924, p. 40).

Synonymy.—When cataloguing the Stratiomyiidae for my paper published in 1920, I went rather fully into White's Tasmanian specimens of *Actina incisuralis* and the descriptions of *A. victoriae*, discovering the difference in the basal segments of the antennae. In 1924, I again revised the position using this clue in antennal structures on the material from various States, and I incorporated my conclusions concerning Enderlein's species described in the interval. Since then the question has arisen with regard to the type locality "Tasmania" given in the fourth supplement of "Dipteres Exotiques," by Macquart, and it seems necessary to amend this to "Sydney" (see Hardy, Proc. Lin. Soc. N.S. Wales, liv., 1929, p. 61). The status of the Australian and the Tasmanian forms may be regarded as of subgeneric value, and if so, then it scarcely matters about separating them under more than one specific conception. So far as I have been able to discover, there is only the antennal character to maintain their present position and gradations may yet be found in this structure.

In Brisbane there occurs a dark form which, at the lightest, has the lateral margins of the abdomen broadly black, thus restricting the orange colour to larger or smaller spots on the central area. The tendency for the abdomen to become completely black is especially marked on the male, but the underside usually retains its lighter tones in such cases.

From Stanthorpe, only females are before me, and on them the abdomen has the typical colouration.

In Sydney, the typical female occurs, these having practically no lateral dark stripe, or an incomplete one, but the males before me are of the dark form.

From Melbourne, the dark males are before me, and also from Millgrove there is a male on which three segments are uniformly dirty brown. The females from Victoria, judging from Hill's species, of which I have seen one, are similar to those from Sydney.

From Tasmania, typical coloured females are before me, but one male from Sheffield and one male from Hobart both have the narrow darkened lateral border of the female, whilst other males, one being the largest I have yet seen (7½ mm.), are black or practically so.

With regard to the male, it would seem that gradations are found from the typical female colouration on Tasmanian specimens to the practically black colouration that is to be found throughout the eastern coast of Australia, as well as in Tasmania. Dark females are not common in the southern States, but quite plentiful in Queensland.

Actina nigricornis Enderlein.

Actina incisuralis White 1914 and part of 1916; Hardy 1920 (nec. Macquart).
Actina nigricornis Enderlein, Mitt. Zool. Mus. Berlin, x, 1921, p. 191.
Actina filipalpis Hardy, Proc. Roy. Soc. Queensland, xxxvi, 1924, p. 40 (nec. Macquart).

It would seem that Enderlein described this species from a very dark form of the female on which the orange colour had disappeared. The name given by Enderlein seems to be the only legitimate one that is applicable to Tasmanian specimens.

Hab.—Tasmania: throughout the whole eastern half of the island, at low elevations.

Actina imperfecta n. sp.

Eyes bare and widely separated on both sexes. The frons is entirely bluish green with two square spots of white pubescence occupying almost the whole width just above the antennae. This pubescence extends down the face which is otherwise also bluish green and, as on other species, much narrower on the male than on the female. Proboscis and palpi, like the antennae, are yellowish, but are without the black stains that occur on the fourth to tenth segments. In profile the antennae are seen to be inserted above the centre of the head; this and other general features being like that of other species.

The thorax is metallic green above, with humeral and postalar tubercles yellow on the female, and the underside is also yellow; on the male the thorax is bronze green above and below, with yellow humeral and postalar callus. The scutellum in both sexes is metallic with light yellow spines, six on the female and eight on the male.

The abdomen is dirty yellowish with violet tinges, these markings becoming more defined on the male. The light colour is comparable to that on *A. incisuralis*, and the variations in the colour marks are very similar to those of that species, the lateral dark border being well defined on some specimens, thus there is a range of forms from light to dark ones, but specimens completely black above have not been seen. The abdomen is yellow below on both sexes.

The wings have the typical venation except the third median vein is very stunted on the male and missing on the female; they are distinctly smoky along the anterior border, but show a clear spot just beyond the stigma, but these markings may be obscure. Except for the hind tibiae being stained apically on the female, and almost entirely black on the male, and the first segment of the posterior tarsi being apically black, and the following ones on the male only being black, the legs are yellow.

Hab.—Queensland : National Park, March, 1921, 1 male holotype and 1 female allotype. Paratypes are 1 female, March, 1929 (A. J. Turner) ; 1 female with clear wings, November, 1925 (A. J. Turner) ; 1 male, December, 1921 (H. Hacker) ; 1 female with a long third median vein, October, 1923 (H. Hacker) ; Tamborine Mt., 1 male, October, 1925 (H. Hacker) ; Mapleton, 1 male, March, 1924 (H. Hacker).

Actina silvicola n. sp.

The eyes are bare and widely separated on both sexes. The frons is metallic blue on the male and metallic green on the female. The pubescence on the frons and face, and the colour of the antennae, proboscis and palpi are as on *A. imperfecta*, but the tenth antennal segment is unusually long, being about half the length of the third to ninth segments united, whereas on other species it is as long as or slightly longer than the two preceding segments.

The thorax is metallic green on the female and blue on the male, both above and below, but the humeral and postalar callus are yellow. The scutellum is similarly coloured on each sex and with six yellow spines ; a seventh is indicated on the male.

The abdomen above is dirty yellow in the centre, bordered by somewhat brownish sides and bands along the incisions of the sclerites, thus cutting the yellow into spots. The darker colouration is more intense and widely spread on the male where three yellow spots occur, than on the female which has four such spots. Below, the abdomen is yellowish on both sexes.

The legs are yellow except on the male the posterior femora have the apical half black and the tibiae are mostly black. The wings have the typical venation, the third median vein being present ; the smoky area along the anterior border of the wing is as in *A. imperfecta*, and interrupted by a clear spot just beyond the stigma.

Hab.—Tasmania : Strahan, People's Park, February, 1924. 1 male and one female, both taken by sweeping the lower branches of tall trees.

Note.—On the male, the hook-like claspers of the genitalia are exserted and clearly defined, having a shape such as I have not seen on any other species. No attempt has yet been made to study the genitalia of these obscure forms, but I have examined some in situ without discovering characters that would aid in distinguishing between species, other than in the present case. In general appearance this species looks very like *A. imperfecta*, and presumably it is subject to similar variations in colour markings.

Correlations of the Queensland Permo-Carboniferous Basin.

THE DILLY STAGE OF THE LOWER BOWEN.

By J. H. Reid.

(*Read before the Royal Society of Queensland, 30th November,* 1931).

There are many diverse aspects of the Permo-Carboniferous system in Eastern Australia on which there is no general agreement as yet. It is hoped that the present contribution of one who has been enabled to carry out considerable field research over the enormous Permo-Carboniferous basin of the Great Syncline of Queensland may at least tend to ameliorate that condition and help to advance knowledge a little further towards general elucidation of some of its major problems. While most of the field work has been of a reconnaissance type (with all its obvious limitations), several areas have been mapped in detail and from data supplied largely by the latter it seems possible to formulate queries and deductions regarding the vast areas which are yet imperfectly known and which may largely remain so for many years to come. This paper deals with the Dilly Stage of the Queensland Lower Bowen Series, and attempts to prescribe its distribution in Queensland, the variable physical character of its beds, as well as discuss its probable age. An appendix by Mr. F. W. Booker describes a hitherto undescribed species of *Productus* of cosmopolitan type which, as far as the stratigraphical zoning of the Springsure Dome in Central Queensland has proceeded, appears confined to the Dilly Stage. A large collection of this species has been made during the past year from the districts of Springsure and Saltbush Park (Nebo), and has formed the material described in the appendix. While mapping the Springsure Dome the writer observed, on one horizon, immense numbers of the pedicle valve of a productid that showed abnormal ear expansions that were mostly broken off. A chance recollection of a past reference that had stimulated some interest recalled Diener's figures of a form from the Anthracolithic fauna of Kashmir. By dint of careful searching a number of beautiful brachial valves were also discovered in the hard calcareous concretions enclosed in the soft shales in which the pedicle valves were mostly in a decrepit state with the brachials either obscured or missing. It is clear from the figures of *Productus* (*Linoproductus*) *springsurensis* that odd specimens of it have been found previously in Queensland, but it is certainly the first occasion on which such a complete collection of both valves has been brought together and which has enabled an adequate description to be made available of this interesting form, interesting because it is evidently an additional link between the Tethyan and Pacific faunas.

THE TYPE DISTRICT: At Dilly, a few miles north of Springsure, the beds of this stage were first remarked, many years ago, apparently by Dr. Jack. Beyond a good individual outcrop of the Eurydesma-glacial horizon, the lack of exposures in the surrounding district did not permit of its stratigraphical position in the Lower Bowen being established. In 1929 a Queensland Geological Survey party, under the writer's direction, was enabled by broad mapping of an extensive region to place this horizon in the general sequence. This sequence has needed some modification since detailed work was carried out by the writer under other control in 1930, on portion of the Springsure Dome, about 40 miles southerly from Dilly.

The Dilly Stage, as defined by this latest work, is as follows :—

DILLY STAGE SECTION, SPRINGSURE DOME.

Serocold Sandstone (freshwater and marine)		950 ft.
Overlap		
Dilly Stage (310 ft.+)	*Upper shales (*L. springsurensis* zone) ..	100–140 ft.
	*Shell beds (mainly Spirifer zone)	20–50 ft.
	*Fossiliferous ferruginous shales	30 ft.
	*Sandstone group (with shales)	40–100 ft.
	Eurydesma limestone (15 ft.) in shales ..	55 ft.+

(The base of the Dilly Stage is unknown).

The beds marked * comprise the glacial horizons in the locality. The two small outcrops of the Eurydesma limestone, being the only exposures of this bed that occur on the crest of a local dome, do not contain the glacial erratics which are present in the equivalent bed at Dilly.

The stage appears to be totally marine and is very rich in the remains of varied marine organisms, as all divisions of it are more or less fossiliferous. The shale beds, mostly, are the common type of the yellow, blue and grey shales of the other marine stages of the Lower and Middle Bowen in the district and contain thin seams of gypsum, secondary lime and magnesian efflorescences.

The Eurydesma bed is a shelly limestone plus hard calcareous shale with a most prolific fossil fauna. A preliminary list of the fauna has been published by Dr. Whitehouse (1930, Little Gorge Creek B = Eurydesma limestone). The overlying sandstone group has revealed one fossiliferous sandstone. The ferruginous shales—brown, yellow and red—contain numerous casts of brachiopods, etc. The shell (Spirifer) beds are denoted by myriads of broken and comminuted remains of the original tests and contain bands or lenses of hard shelly limestone though the enclosing matrix is usually shale but varies to soft yellowish sandstone. Loose fragments of *Spirifer*, *Plerophyllum*, etc., litter the outcrops. The preliminary list of fossils from this bed and from the upper shales has been published by Whitehouse (1930, as Little Gorge Creek A). The upper shales are well exposed at the headwaters of a small watercourse—Cattle Creek. In its crumbling shale banks, 40 ft. high, enormous numbers of the newly-described *L. springsurensis* are entombed.

These beds are all exposed about the crest of a local dome and are entirely surrounded by the cliff-forming sandstones of the Serocold Stage, which, in several instances, overlap the upper shales between Cattle and Little Gorge Creeks. There are no contemporaneous volcanic rocks in the Dilly Stage, nor, as far as our knowledge goes, in the complete marine Permo-Carboniferous succession of the Springsure district.

The Dilly Stage appears to have a limited faunistic individuality, that is not partaken of by the other known marine stages in the district, and more definitely, because better known, by the younger marine stages. There are certain reservations that must be given due weight in making such a statement for the overlying stage of nearly 1,000 ft. consists of massive sandstones which are known to be definitely marine in its upper members while, just as definitely, some of them are of freshwater origin. As a whole the Serocold Stage does not generally contain a suitable facies for the preservation of the usual marine organisms. The Lower Bowen section below the Dilly Stage is not well known and it would be unsafe yet to dogmatise as to the downward range of some of the characteristic species of that stage, the base of which has not been definitely identified.

Amongst the large retinue of Permo-Carboniferous fossils the following are of more than ordinary interest from this stage :—

Plerophyllum gregoriana, P. cf. *cainodon, Stenopora crinita, S. ovata, Fenestella spp., Protoretepora ampla, Productus farleyensis, P. brachythaerus, P.* (?) *subquadratus, P.* (*Linoproductus*) *springsurensis, Strophalosia* cf. *jukesi, S. gerardi, S. clarkei, Spirifer* cf. *stokesi, Orthotetes perfidiabadensis, Aviculopecten* cf. *mitchelli, Eurydesma cordatum, E. sp. nov.*

The collections made during 1930 have not yet been either formally listed or described. They include possibly a new species of "*Derbyia*."

With the reservations mentioned *Productus* (?) *subquadratus, Linoproductus springsurensis,* and *Eurydesma* appear restricted to the Dilly Stage in the Springsure district sections.

The position of the main Eurydesma horizon is as listed earlier. Only one specimen of the genus has been collected in higher horizons, either in the upper shales or shell beds. In view of the detailed mapping performed its rarity above the main horizon is notable and the lower horizon may represent its acme. *P.* (?) *subquadratus* is present in the Eurydesma bed and has been found in the sandstone group above it (associated with "*Derbyia*.") *L. springsurensis* occurs sparingly in the Eurydesma beds and reaches its apparent acmaic stage of development in the upper shales. In this zone *Strophalosia gerardi* is numerically well represented, and little else has been found but a large *Mœonia* is represented in the collections by one specimen. The three supposedly restricted forms, in combination and particularly with the adjunction of *Aviculopecten* of the *A. mitchelli* type (restricted to the Lower Marine in N.S.W.), are considered to form a strong nucleus for instituting a limited zonal correlation in the Queensland Lower Bowen.

The marine division of the Lower Bowen lying above the Serocold Sandstones is, to a considerable extent, lithologically similar to the generality of beds in the Dilly Stage ; likewise it forms a conspicuous horizon of glacial erratics of large size. Though extensively collected from, neither *L. springsurensis* nor *P.* (?) *subquadratus* has been found in it though their associate in the Dilly Stage, *L. cora* or *L. farleyensis*, is well represented. Its presence, as well as a rather general lithological similarity, would suggest that the former are possibly not absent through unsuitability of either environment or facies, and it would seem that they are, in ranging upwards, restricted at some horizon below the top of the Serocold Stage. On the present evidence *P.* (?) *subquadratus* may be restricted below the ferruginous shales. *L. springsurensis* since it is so predominant in the highest zone must evidently have a higher range of life than the top of the Dilly Stage. Neither of the Lower Bowen corals, *Monilopora* and *Trachypora*, has been found in the Dilly Stage. They have, however, been recorded in association in the Coral Stage (with *Conularia*) at an interval of possibly 900 ft. below the Dilly Stage. They have also recently been found by the writer in the marine stage above the Serocold Stage, but *Trachypora* is exceedingly rare therein, while *Monilopora* is abundant.

Correlations in the Great Syncline of Queensland.

The zoning of the Dilly Stage on the Springsure Dome enables, for the first time, a definite attempt to be made to correlate the eastern and western beds of the basin. In attempting to correlate Lower Bowen stages on the eastern side of the Great Syncline with the Dilly Stage, a remarkable feature is that those beds that seem faunally allied to it do not appear to have any undoubted glacial erratics so far as observed.

The detailed field study of certain limited portions of the Springsure Dome, in demonstrating overlaps, rapid sequences of alternating freshwater, marine and lagoonal deposits, in addition to faunal and stratigraphic overlaps in other districts, attests the markedly unstable conditions of the Lower and Middle Bowen periods of sedimentation. Physical configuration must have been variable to a degree that has left its impress in dissimilar composition of the vertical columns of the system in distinct areas Through great differences are woven threads of similarity of type ; thus, as an example, a minor type in the amorphous yellow and grey (*Monilopora*) limestones of one of the Lower Bowen stages on the Springsure Dome has its replica in specimens collected from the Dawson River region some 150 miles distant. But while apparently contemporaneous stages in distant districts may be very different lithologically, certain sedimentary types are universal throughout the main basin such as the common bluish, yellowish and grey micaceous shales which are of uniform type and appearance of almost any age of Lower and Upper Marine deposition.

It may perhaps be repeated here that the Great Syncline forms an elongated trough tapering at its northern extremity (lat. about 20° 30′ S.) and passing southwards beneath the overriding and unconformable Mesozoics of the Great Artesian System (lat. about

25° 45′). It is margined by outcropping Lower Bowens (very largely of volcanic derivation) and marine strata of more than one series form, apparently, an almost continuous, if disconnected, marine zone around it. For 400 miles on an almost direct line between the parallels of latitude mentioned above, marine sediments mark the eastern side of the syncline along the inland or western foothills of the coastal ranges. In the latitude of Springsure, outcrops of corresponding stages on the eastern and western sides of the basin have an interval of as much as 120 miles covered by younger beds, apparently without intervening outcrop. The Lower Bowen sedimentation on the western (Springsure) margin was exempt from volcanic accumulations while on the whole of the eatern side contemporaneous volcanic action contributed quotas, in some cases predominantly, and then marine sedimentation could only occur during geologically brief interregna between the deposition of intermittently progressive volcanic deposits. Thus there is a great possibility, considering also the intercalated freshwater beds in the volcanic areas, that land surfaces more habitually existed then, in the area of the present coastal hinterland, than in the more westerly areas such as Springsure, where one may perhaps postulate an increase to maximum deposition of marine strata in the southern half of the syncline.

The apparent absence of glacial horizons in the Lower Bowen marine beds of the eastern margin, even in the stages in which contemporaneity with the Dilly Stage is most strongly implied by the the mutual association of apparently restricted life forms, may be due, in conjunction with the effects of crustal movements, to the great accumulations of volcanic ejecta that were massed on that margin at various periods. These may have represented obstructions interrupting marine transportation of ice floes, for it may be remarked that no terrestrial glacial deposits are known to exist in the Queensland Permo-Carboniferous. Apart from such arguments to account for the lack of glacial erratics, the vagarious distribution of glacial debris from floating and dispersing ice is illustrated locally in the Springsure district itself where in one case the *Eurydesma* bed is littered with small erratics and in two other exposures of it they are absent.

Considering the association of *L. springsurensis*, *P.* (?) *subquadratus*, *Aviculopecten mitchelli* and *Eurydesma* as strongly indicative of Dilly age, with the reservation that the evidence cannot yet be considered conclusive that they, individually or collectively, may not range below that stage, we may consider the occurrence of these forms in combination on the eastern side of the Great Syncline together with other species occurring in that stage or known to be co-zonal.

Mt. Britton (Homevale Bed). *P.* (?) *subquadratus*, *Linoproductus springsurensis*, *A. mitchelli* (*); also *Linoproductus farleyensis*, *A. tenuicollis* (*). (*Girtyites* (?) recorded here but not in Dilly Stage, Springsure).

*Restricted to Lower Marine in N.S.W.

SALTBUSH PARK, NEBO. In beds occurring six miles N.E. of Homestead and continuing north-westwards to at least 15 miles N. of Homestead.

P. (?) *subquadratus*, *L. springsurensis*, *A. mitchelli*; also *Monilopora*.

YATTON.—*P.* (?) *subquadratus* and *Eurydesma cordatum* in unidentified beds; *L. springsurensis*, *Monilopora* and *Trachypora* were found in a comparatively limited zone which is likely to embrace the former two.

CRACOW.—*P.* (?) *subquadratus*, *L. springsurensis*, *A. mitchelli*, *E. cordatum*, *E. sp. nov.* (Dilly type), also *Stenopora* cf. *ovata*, *L. farleyensis*, *P. brachythaerus*.

The Cracow section of A. K. Denmead (1931) includes the *Eurydesma*, *Monilopora* and *L. springsurensis* zones in that ascending order in a section comprising shales, sandstones and limestones with andesites in intermediate flows. It is of particular interest in relation to Dilly because of the grouping of the three common forms of the *Eurydesma* bed there in the lowest specified Cracow horizon and an abundance of *L. springsurensis* in the highest specified zones in both areas.

It thus appears that there are palaeontological grounds for correlating portions of the marine sections in all four eastern localities, enumerated above, with the Dilly Stage. It is not improbable that the stage or portions of it may be represented almost continuously along the eastern margin from Cracow, where it passes under the Artesian System, proceeding northerly to the south-eastern portion of the Bowen River Coalfield.

The following localities have beds with limited claims to provisional equation with the stage:—

HAZLEWOOD CREEK and BLENHEIM (Bowen River System): the former has provided some of our most typical Queensland specimens of *P.* (?) *subquadratus* while *L. springsurensis* occurs at Blenheim.

CAMBOON WOOLSHED and DELUSION CREEK (Dawson River System); Shelly and also chalcedonic limestone with *Trachypora* and very large crinoids, etc. It continues to Delusion Creek, where there is a remarkable crinoidal limestone interbedded with andesites. At Camboon Woolshed the limestone is probably the most conspicuous *Trachypora* horizon yet located in the Great Syncline. On the weight of evidence—intercalation with andesites and the presence of *Trachypora* which, like *Monilopora*, has never been found in the known post-Greta beds of the main basin—this horizon may be definitely placed in the Lower Bowen. Its extension to Delusion Creek takes it within twelve miles of representatives of the Dilly Stage at Cracow and the presence of limestone with *Trachypora* in the andesitic series of both localities, renders it not improbable that these two occurrences are exactly contemporaneous in age. In a northerly direction the writer has rapidly traversed the Camboon Lower Bowen

Series of volcanics, sandstones, conglomerates, etc., and has not been able to separate them, as a series, from the Lower Freshwater Series of the Lower Bowen of Dunstan (1901) at Banana and to the west thereof. It is therefore not beyond the bounds of possibility that beds of Dilly age are represented in the Banana Lower Freshwater. What age, then, are the marine zones of Dunstan's still older Lower Marine Series ? It is very possible that over such an extensive area the scattered fossil localities may represent different zones if not stages. Still lower, and conformably (?), according to Dunstan, are the metalliferous slates, etc., including limestones with *Aviculopecten* and a rugose coral, that he classified as Gympie. A striking feature of his Lower Marine fossil lists is the absence, from rather extensive collections, of such easily recognised forms as *Productus* (?) *subquadratus* and *Eurydesma*, forms which had a most extensive habitat and are found abundantly in a number of Lower Bowen localities of the main basin. It would certainly be premature to draw the conclusion that their absence might indicate a downward limit to the range of the two forms mentioned at an horizon above his Lower Marine Section, but it seems to make desirable a further palaeontological examination of any material collected from Dunstan's Lower Marine and Gympie Series of the Dawson River.

Correlation with New South Wales Lower Marine: There is a ready correlation of the *Eurydesma*-glacial beds of Dilly and Allendale (N.S.W.), which is strengthened by the abundance of *Eurydesma cordatum*, *Aviculopecten mitchelli* and numerous pencilliform *Stenopora* in both zones as well as the mutual records of *Strophalosia clarkei* and *Productus brachythaerus*, though these latter records may need revision. *Monilopora*, which is evidently co-zonal with the Dilly fauna is not known in the Hunter River district, but, according to David (1930), who evidently endorses the Dilly-Allendale correlation, it possibly ascends to the main *Eurydesma* zone at Kempsey. It is known, only recently, that *Monilopora* ascends above the *Eurydesma* horizon in the main basin of Queensland.

Age of the Dilly Stage: Any consideration of the age of this stage entrenches on the delicate and arbitrary question of the division line between Upper Carboniferous and Lower Permian formations, a question that has universally raised more academic discussion between palaeontologists than perhaps almost any other, and a convenient retreat from which was the coining and continued usage of the term Permo-Carboniferous.

It appears for the present that the determination of age will rest largely on the brachiopods and certain bryozoans and pelecypods owing to the absence so far of definite ammonites as horizon markers. Evidently the only possible specimen of the latter found in the entire Permo-Carboniferous basin Queensland is one collected by the writer in 1924 from the Mount Britton (Homevale) bed. This is a very incomplete impression of several whorls and was determined by Dr. Whitehouse (1925) as "impression of a cephalopod (?) resembling *Girtyites*."

In the description of *Linoproductus springsurensis*, Booker has stated that its nearest allies are *Productus waagenianus* (Girty) of the Guadalupian, *P. eucharis* (Girty) of the Phosphoria Formation of South-eastern Idaho and *P. aagardi* of the Spitzbergen Artinskian, all three of recognised Permian age. Girty (1908) provisionally classified the Guadalupian fauna as Lower Permian. Schuchert (1928) placed the upper (Capitan) division of the Guadalupian in the Upper Permian on the ground that the lower division (Delaware) had some ammonite relationships with other American Permian formations which were definitely tied to the Fusulina limestone of Sicily. *P. waagenianus* occurs on about a middle horizon of the Capitan. *P. eucharis* comes from the Lower Permian (Phosphoria). Girty (1927) stated it may be identical with *P. aagardi* (Toula). Our species may also have a close alliance with *P. aff. aagardi* of the Alaskan Lower Permian. Booker gives two other close relationships for the Dilly species, viz., Diener's form of *P. waagenianus* from the Zewan Permian beds and the Uralian form of *P. aagardi* from the Russian Upper Carboniferous. Thus through *L. springsurensis* the Dilly Stage would appear to have at least one definite affiliation with the Tethyan and American Permian. Such an affiliation is not weakened by Etheridge's record of *Strophalosia clarkei* from Dilly, a form which he went to the trouble of declaring (in 1892) had much relationship with *S. goldfussi* which is a conspicuous species of the Zechstein of the European Upper Permian. At Dilly the abundant development of *Strophalosia gerardi* and the presence in its lower beds of the Permian Upper Marine species, *Stenopora crinita*, will make it additionally difficult to maintain an earlier age than Lower Permian for the Stage.

The Dilly Stage may have a time relationship with the *Eurydesma* and *Conularia* faunas of the Salt Range in the latter of which Schuchert states there are nine Australian species, one of those cited (*Chonetes cracowensis*) intriguing the interest since the Dilly fauna seems really established at Cracow, Queensland, where the type of this species comes from. As to the age of these Salt Range horizons Schuchert places them as Middle Permian, C. S. Fox (1928) as Lower Permian, while Dighton Thomas gives reasons for regarding them as of high Carboniferous age.

" If the *Eurydesma* and *Conularia* faunas of the Salt Range are reliable guides they indicate an Upper Carboniferous age for the Lower Marine Series of the Hunter River of New South Wales," according to the last-quoted authority, an interpretation of age that has also secured the adhesion of A. C. Seward. To the contrary, there seems to be an ever-growing body of opinion in Australia that the base of the Permian must at least be placed very considerably down in that Series, and the Dilly Stage with several definite Permian affiliations seems certain to be correlated with a low stage in it and at present, most obviously, with the *Eurydesma*-glacial stage of Allendale. If the *Eurydesma* beds of India and Eastern Australia are approximately synchronous then a considerable body of Australian opinion would appear to closely conform to the Indian view expressed by Fox as to the position of the dividing line between Carboniferous and Permian in regard to that fauna.

It would be outside the ambit of this paper to refer to statements which have appeared in papers abroad, and which have subsequently been cited in Australian related literature that there are no ammonites in the Permo-Carboniferous of New South Wales were it not that any such occurrences should have a bearing on the age of the Bowen Series in Queensland. In a footnote by Whitehouse (1929 *b*) to fossil lists of the Bowen River Coalfield, he showed that a number of the reputed "*Agathiceras micromphalus*" from that field were referable to *Bellerophon*, but the statement allowed that the species from the Upper Marine Series of the Maitland district, referred by Etheridge (1896) to *Goniatites micromphalus* Morr. *sp.*, is a definite ammonoid.

It will now be difficult to maintain that the coral known as *Monilopora nicholsoni* from the Queensland basin is restricted to the Carboniferous owing to the recent discovery of a very large type of it in post-Dilly beds of the Springsure Dome and in the *L. springsurensis* zone of Saltbush Park.

The writer's view, based on his stratigraphic investigations in Queensland, and the faunal determinations available, that the Queensland Permo-Carboniferous fauna dates from the Upper Carboniferous would possibly not be affected by advocacy of a Lower Permian age for the Dilly Stage. If it is really equivalent to some portion of the Lower Freshwater of the Dawson River, as there are at present grounds for believing, there must be a very great thickness of strata below it, involved in Dunstan's Lower Marine and perhaps portion of his Gympie Series, which contains what is usually termed in Australia a Permo-Carboniferous faunal assemblage. The records of these beds, possibly very imperfectly collected from, do not contain *Productus* (?) *subquadratus* nor *Eurydesma*, two characteristic, if not restricted, forms of the Dilly Stage of the Lower Bowen.

BIBLIOGRAPHY.

(1892) Etheridge, R. (Jr.)—Geology and Palaeontology of Queensland, by R. L. Jack and R. Etheridge, Jr., p. 259.

(1896) Etheridge, R. (Jr.)—Pal. Novae Camb. Merid. N.S.W. G.S. Rec. Vol, IV. pt. 1, p. 32, pl. VII.

(1901) Dunstan, B.—Geology of the Dawson and Mackenzie Rivers, Q'ld. Geol. Sur. Pub. 155.

(1908) Girty, G. S.—The Guadalupian Fauna. U.S. Geol. Sur. Prof. Paper 58.

(1915) Diener, Carl—Anthracolithic Fauna of Kashmir, etc. Mem. G.S.I. Pal. Indica Vol. 5, No. 2.

(1925) Whitehouse, F. W.—List of Fossil Fauna, Nebo District, Q.G.M. Jour, p. 474.

(1927) Girty, G. H.—Geology, Etc., of Part of South-Eastern Idaho, U.S. Geol. Sur. Prof. Paper 152, pp. 79 and 80.

(1928) Schuchert, C.—Review of the Late Palaeozoic Formations and Faunas, Etc., Bull. Geol. Soc. America, Vol. 39, pp. 819-821.

(1928) Fox, C. S.—Geology of the Punjab Salt Range, Rec. G.S.I., Vol. LXI., Pt. 2, p. 166.

(1929) Reid, J. H.—Geology of the Springsure District (Q.), Q'ld. Govt. Min. Jour. Vol. 31, pp. 87 *et seq.*

(1929) Thomas, H. Dighton—The late Palaeozoic Glaciation, Nature Vol. 123, No. 3112, p. 946 *et seq.*

(1929) (*a*) Whitehouse, F. W.—Report on Springsure (Q.) Fossils, Q.G.M. Jour. Vol. 31, pp. 156-7.

(1929) (*b*) Whitehouse, F. W.—See Geol. of Bowen River Coalfield, Q.G.S. Pub. 276, p. 80.

(1930) David, Sir T. W. E.—Permo-Carboniferous Correlation, Aust. and N.Z. Assoc. Adv. of Sci., p. 64 (Brisbane).

(1931) Denmead, A. K.—Cracow Repts. Q.G.M.J., Aug.-Sept., 1931.

Appendix to Correlations of the Queensland Permo-Carboniferous Basin.

A NEW SPECIES OF *PRODUCTUS* FROM THE LOWER BOWEN SERIES—QUEENSLAND.

By F. W. BOOKER, B.Sc. (Geological Survey of New South Wales).

PLATES III–IV.

(*Communicated by Mr. J. H. Reid, to the Royal Society of Queensland, 30th November*, 1931).

INTRODUCTION.

The material for the study of this new and interesting species of *Productus* has been made available to me by Mr. J. H. Reid from his private collection, and my thanks are due to Mr. Reid not only for the opportunity to study this interesting form, but for the generous help he has accorded me while working on it. My thanks are also due to Mr. W. S. Dun, of the Geological Survey of New South Wales, for much advice, and to the officers of the Australian Museum and Public Library, Sydney, for their assistance.

GENUS, *PRODUCTUS*, Sowerby.

SUBGENUS, *LINOPRODUCTUS*, Chao, 1927.

SYNONYMS :

Cora, Fredericks, 1928. Bull. Com. Geol. Leningrad, Vol. XLVI, No. 7, p. 789, 1928.

Euproductus, Whitehouse (Nom. nuda), Aust. Assn. Adv. Science, p. 282, 1926.

Anidanthus, Whitehouse (Nom. nuda), Loc. cit.

" Pedicle valve strongly convex, brachial valve flattish to slightly concave in the visceral portion, strongly geniculated towards the front, resulting in the formation of an anteriorly produced long trail. Surface marked by numerous fine, radiating striae and indistinct concentric wrinkles. A double row of spines is invariably present along the margin of the hinge line. Genotype, *Productus cora*, d'Orbigny."[1]

Chao refers the following species to the subgenus *Linoproductus* :

Productus (*Linoproductus*) *lineatus*, Waagen.
P. (*Linoproductus*) *cora*, d'Orbigny.
P. (*Linoproductus*) *tenuistriatus*, Verneuil.
P. (*Linoproductus*) *simensis*, Tchernyschew.
P. (*Linoproductus*) *cancriniformis*, Tchernyschew.
P. (*Linoproductus*) *hemisphaerium*, Kutorga.
P. (*Linoproductus* ?) *subplicatilis*, Frech.
P. (*Linoproductus* ?) *sinensis*, Frech.
P. (*Linoproductus* ?) *mammatus*, Keyserling.

To these must be added *P.* (*Linoproductus*) *aagardi*, Toula, 1875 ; *P.* (*Linoproductus*) *waagenianus*, Girty, 1908 ; *P.* (*Linoproductus*) *eucharis*, Girty, 1919 ; *P.* (*Linoproductus*) *cora var. farleyensis*, Eth. & Dun ; and the new species herein described, *Linoproductus springsurensis*.

Owing to overlapping in researches Fredericks' genus *Cora*,[2] genotype, *Productus cora*, d'Orbigny, is synonymous with Chao's *Linoproductus*, 1927.[3] Chao's subgenus must be accorded priority over Fredericks', having been published in 1927. Fredericks' genera unfortunately are described in Russian, with only a short English summary, which is very vague.

In two footnotes to a paper published in 1926, Whitehouse[4] refers to *Euproductus*, genotype *Productus cora*, d'Orbigny and *Anidanthus*, " a new genus proposed for a new species of productid (figured in Jack and Etheridge, Geology and Palaeontology of Queensland and New Guinea, Pl. 12, fig. 16, and Pl. 44, fig. 13)." *Euproductus* must therefore be regarded as synonymous with Chao's *Linoproductus*.[5]

The two figures referred to as *Anidanthus* appear to represent two very different forms, of which one (Pl. 44, fig. 13) is that herein described as *Linoproductus springsurensis*. I have examined the cast of a specimen showing the external ornament of a pedicle valve from Saltbush Park, Nebo District, which I understood had been referred by Whitehouse to *Anidanthus*. This was referable to *Linoproductus springsurensis*. I have also a photograph of two specimens of *Anidanthus* from Lake's Creek, Rockhampton. These appear to differ very materially from the Springsure and Saltbush Park specimens, particularly in the size and contour of the valves, in the ornamentation and degree of demarcation of the ears. *Productus cora*, var. *farleyensis*, Etheridge and Dun[6] is also referred to *Linoproductus*, Chao.

Linoproductus springsurensis, sp. nov.

Compare *Productus*, sp. indt. cf. young of *P. giganteus*, Martin. Jack and Etheridge, Geol. and Pal. of Queensland and New Guinea, 1892, p. 257, Pl. 44, fig. 13.

Shell small. Pedicle valve much curved, inrolled and spreading transversely. Umbo inflated, pointed and strongly incurved. Ears depressed, flattened and distinctly marked off from the visceral portion of the valve. A shallow sinus is present, but the degree of development varies considerably in individual specimens. The hinge line is very long and straight.

The brachial valve is flat or slightly concave in the visceral portion and is then strongly geniculated and produced to the anterior margin.

The surface of the pedicle valve is marked with fine radiating striae. On the visceral portion of the valve there are on an average about 16 striae in 10 mm.

The following table shows the size of the specimens and the coarseness of the ornament :—

Locality	Length	Breadth	No. of Striae in 10 mm.	
	25 mm.	19 mm.	14	(Type)
	29 mm.	23 mm.	15	
Springsure Dome	31 mm.	21 mm.	18	(Paratypes)
	30 mm.	16 mm.	15	
	32 mm.	25 mm.	16	
	29 mm.	—	14	
	30 mm.	20 mm.	18	
	29 mm.	21 mm.	16	
Saltbush Park	21 mm.	13 mm.	12	
	23 mm.	16 mm.	14	

Near the anterior margin of one or two specimens are a few obscure tubercles, probably the bases of spines. Spines also occur along the hinge line. Concentric wrinkles are developed on the ears and pass into obscure, widely spaced, low undulations on the visceral portion of the valve.

The brachial valve is ornamented with radiating striae, similar to those of the pedicle valve. A number of strong, irregularly spaced concentric wrinkles occur on the visceral portion of the valve. The brachial valve has a well developed cardinal process and a septum extending anteriorly for approximately two-thirds of the distance from the hinge line to the point of geniculation of the valve. The muscular impressions are compact and undifferentiated.

Main Horizon : Upper section of Dilly stage, Lower Bowen, with a known range from the main Eurydesma horizon to the top of the stage.

Localities: Cattle Creek and Little Gorge Creek, Springsure Dome; Saltbush Park, Nebo District ; Mt. Britton ; Yatton Goldfield, Queensland.

Linoproductus springsurensis is closely related to *Productus* (*Linoproductus*) *waagenianus*, Girty,[7] *P.* (*Linoproductus*) *eucharis*, Girty,[8] and *P.* (*Linoproductus*) *aagardi*, Toula.[9]

Girty's description of *P. waagenianus* is as follows :—

" *Productus waagenianus*, n. sp."

" Shell small. Ventral valve much inrolled, gradually spreading transversely. Beak inflated, pointed, strongly incurved, slightly projecting. Ears small, depressed, quadrate, flattened. Sinus absent. Towards the margin the shell developes a few low folds.

" Dorsal valve nearly planate, with a narrow geniculated portion around the front and sides, beak small indistinct, ears undefined.

" Surface marked by radiating lirae, concentric lirae, concentric wrinkles and spines. Lirae very fine, about 14 in 5 mm. ; low, rounded, separated by intervals as wide or wider than themselves. Concentric lirae rather coarse, but indistinct. Wrinkles faint, distant, covering more than half the surface ; strong on ears. Visceral portion with a few rather large nodes, which may have been bases of spines, some of which appear to have been located on the ears, especially near the hinge line. The foregoing description, so far as it relates to the surface, is based on the ventral valve. The surface of the dorsal valve is marked by concentric wrinkles (and presumably concentric lirae) and radiating lirae. The wrinkles on this valve are very strong, regular, subimbricating and rather distant, covering the surface as far as the geniculation. The shape and ornamentation are such as to simulate certain varieties of *Leptaena rhomboidalis*. The wrinkles are so much stronger than those of the ventral valve as to suggest that the two shells do not belong together ; but the other characters are similar, they are associated in the same beds, and nothing has so far come to hand which in either case could be taken for a supplementary valve. I have at present little doubt about their relationship. Were it not for the peculiar character of the dorsal valve it might perhaps have been possible to refer this form to the common *P. cora* ; but with the present association it is out of question."

Diener refers to *P. waagenianus*, Girty a form from the Zewan beds of Mandakpal.[10] He mentions one specimen from the neighbourhood of Sangcha Malla in Eastern Johor, which had previously been identified as *P. Planohemisphaerium*, Netsch and which " may probably be referred provisionally to *P. waagenianus* or *P. eucharis*, Girty."[11]

A speciment previously referred to as *Strophomena analoga*, Phill.[12] is also referred to *P. waagenianus*.

P. aagardi, Toula was the earliest of this group of producti to be described.[13] A free translation of Toula's original description is as follows :—

" A small *Productus* with unusually well arched pedicle valve. This rises steeply from the anterior margin in a sharp bend and falls away steeply to the produced and pointed umbo. The latter projects only slightly over the hinge line and is especially sharp at the umbo, yet incurved. The greatest breadth lies behind the straight hinge line. From this strong wrinkles lead up the sides without reaching the top (of the valve). The shell is coarsely striated ; the striae run straight in the umbonal region but beyond that are more irregular. They are very crowded in the middle of the shell, where their number is augmented by intercalation. A strong median sinus is visible in the centre of the valve. The shell is comparatively thick and no traces of spines are visible on the surface.

" *Productus cora*, d'Orbigny, is perhaps most closely related to our species as regards the form and height of the pedicle valve, but the thickness of the shell, the coarse striations, and the small size of our species are striking.

" Dimensions : Breadth, 20 mm. ; height, 13 mm. ; length, 15 mm. ; breadth of largest specimen, about 28 mm."

The Uralian type of *P. aagardi* figured by Tchernyschew[14] differs considerably from Toula's description and figures. Unfortunately, Tchernyschew's description is in Russian, but his figures show a long hinged, inflated shell with fine striae and larger ears than Toula's specimens, and in addition Tchernyschew's figures do not show a sinus. It is possible that Tchernyschew had a series of specimens showing the transition from Toula's form to his own, but if so he does not mention them. The specimens he figures, however, appear to resemble Diener's Zewan specimens of *P. waagenianus* more closely than they do Toula's original figures of *P. aagardi*, particularly in the finer and more regular striation and the absence of a median sinus.

Girty compares *P. waagenianus*[15] and *P. eucharis*[16] with *P. aagardi*. He states that " *P. waagenianus* is related to the Arctic species *P. aagardi*, Toula, not only in a general way but in the plicated condition of the dorsal valve. It is distinguished from it however by its much finer liration." As Toula does not mention the brachial valve in his description or include a figure of one in his plates it is evident that Girty's comparison is with some other figures, possibly those of Tchernyschew. The same remarks apply to the comparison of *P. eucharis* with *P. aagardi*. *P. eucharis* resembles *P. waagenianus* very closely ; in fact Diener[17] states " the only character of difference which I can find, is the presence of spines in *P. eucharis*, " some of them large enough to occasion the deflection of the radiating lirae." *P. eucharis* is also without a median sinus.

Less closely related is *Productus rewahensis*, Cowper-Reed.[18]

Linoproductus springsurensis is very closely related to *P. waagenianus*, Girty and *P. eucharis*, Girty. The striation of *L. springsurensis* is coarser than that of the Guadelupian form and it is probably nearer the Delaware variety.[19] which has about eight or nine striae in 5 mm. *L. springsurensis* is also closely related to Diener's Zewan form of *P. waagenianus* and to the Uralian form of *P. aagardi*, Toula, figured by Tchernyschew. It differs from all these however in the possession of a shallow, ill defined sinus, which varies considerably in the extent of its development, being present in about sixty per cent. of the specimens examined as a definite shallow sinus. In the rest it is very shallow indeed or represented only by a flattening of the shell along the median line, combined with a flexing of the growth lines and an irregularity of the striae in that part of the shell.

L. springsurensis resembles Toula's Arctic form of *P. aagardi* in the possession of a sinus, but differs from it in the considerably longer hinge line and more inflated and incurved umbo.

Associated with *Linoproductus springsurensis* in the Dilly beds of Springsure Dome is a large Productus referrable to *Productus* (*linoproductus*) *cora*, d'Orbigny, which also occurs with *L. springsurensis* at Saltbush Park, Nebo district. A large *Strophalosia* referrable to the common *S. gerardi* and a Spirifer of the *S. stokesi* type also occur in the same beds. Both these forms occur in the Lower and Upper Marine Series of New South Wales.

REFERENCES.

(1) CHAO, Y. T., Pal. Sinica, 1927, Ser. B. Vol. v, Fasc. 2, Productidae of China, pt. i, pp. 128-147.

(2) FREDERICKS, G., Bull. Com. Geol. Leningrad, 1928, vol. xlvi, No. 7, p. 781 and 790.

(3) CHAO, Y. T., Pal. Sinica, 1927, Ser. B. Vol. v., fasc. 2, pt. 1, pp. 128-147.

(4) WHITEHOUSE, F. W., Aust. Assn. Adv. Science, 1926, p. 282.

(5) MUIR WOOD, H. M., Ann. and Mag. Nat. Hist., 1930, v. 25, p. 104.

(6) ETHERIDGE, R., JUNR. & DUN, W. S., Records Geol. Survey N.S. Wales, 1909, vol. viii, pt. iv, p. 302.

(7) GIRTY, G. H., The Guadelupian Fauna U.S. Geol. Survey Prof. Paper No. 58, 1908, p. 253, pl. xii, figs. 6-7*a*.

(8) GIRTY, G. H., U.S. Geol. Survey Bulletin No. 436, 1910, p. 28, pl. ii, figs, 3-4.

(9) TOULA, F., Neues Jahrbuch fur Mineralogie (Separ. Abdr.), 1875, p. 235, pl. vii, fig. 2.

(10) DIENER, C., Pal. Indica, New Series, 1915, vol. v, Mem. No. 2, pp. 71-72, pl. vi, figs. 18, 19, pl. vii, fig. 6.

(11) DIENER, C., Pal. Indica, 1903, Ser. xv, vol. 1, pt. v., p. 73, pl. iii, fig. 17.

(12) DIENER, C., Pal. Indica, 1899, Ser. xv, vol. 1, pt. 2, pl. 1, fig. 12.

(13) TOULA, F., Neues Jahrbuch fur Mineralogie (Separ. Abdr.), 1875. p. 235, pl. vii, fig. 2,

(14) TCHERNYSCHEW, TH., Com. Geol. Russie, 1902, vol. xvi, No. 2, p. 285, pl. lvi, figs. 1-3.

(15) GIRTY, G. H., The Guadelupian Fauna, U.S. Geol. Survey Prof. Paper, No. 58, 1908, pp. 253-4.

(16) —————————— U.S. Geol. Survey Bulletin No. 436, 1910, p. 28, pl. ii, figs. 3-4.

(17) DIENER, C., Pal. Indica, 1915, New Ser. vol. v, pt. 2, p. 72.

(18) COWPER-REED, F. R., Rec. Geol. Survey India, 1928, vol. lx, pt. 4, p. 376, pl. 32, figs. 1-1*a*, pl. 35, figs. 1-7.

(19) GIRTY, G. H., The Guadelupian Fauna, U.S. Geol. Survey Prof. Paper No. 58, 1908, p. 254.

DESCRIPTION OF PLATES.

Plate III.

Figs. 1, 2 — *Linoproductus springsurensis*, sp. nov. Pedicle valve of Type specimen from Upper Zone of Dilly Stage, Lower Bowen, Cattle Creek, Springsure Dome, Queensland. × I.

Figs. 3-6 — *Linoproductus springsurensis*, sp. nov. paratypes from the same locality. × I.

Plate IV.

Fig. 1 — *Linoproductus springsurensis*, sp. nov. Drawing by Mr. I. W. Helmsing of the exterior of a brachial valve, showing ornament and concentric wrinkling. Locality Cattle Creek, Springsure Dome. × I.

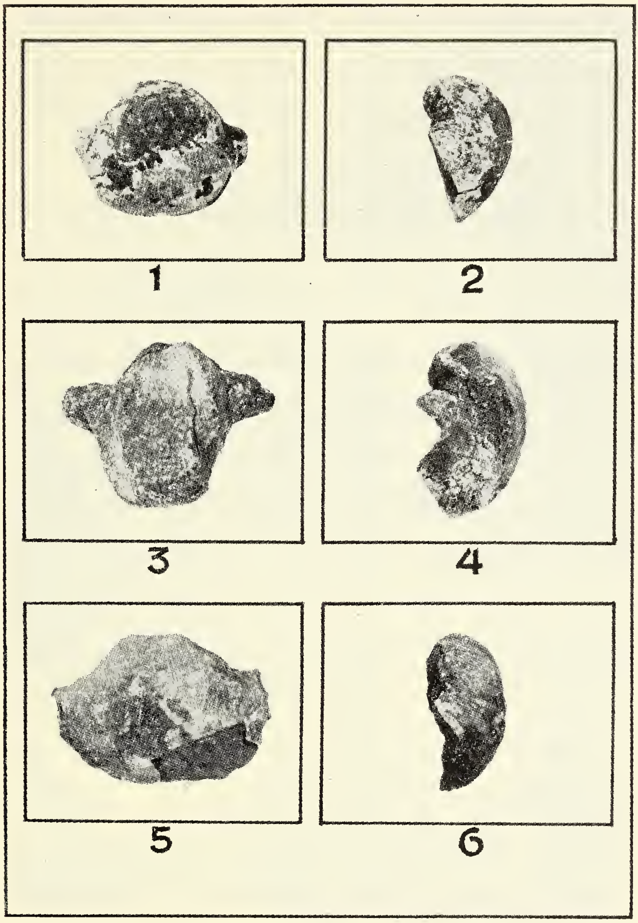
Fig. 2 — *Linoproductus springsurensis*, sp. nov. Photograph of the specimen shown in Fig. 1. × I.

Fig. 3 — *Linoproductus springsurensis*, sp. nov. Interior of a brachial valve showing septum and muscular impressions. Locality, Cattle Creek, Springsure Dome. × I.

Fig. 4 — *Linoproductus springsurensis*, sp. nov. Interior of brachial valve showing geniculation. Locality, Cattle Creek, Springsure Dome. × I.

Figs. 5 & 6. — *Linoproductus springsurensis*, sp. nov. Brachial valves from Saltbush Park, Nebo district, Queensland. × I.

Fig. 7 — *Linoproductus springsurensis*, sp. nov. Cast of pedicle valve from Saltbush Park, Nebo district. × I.

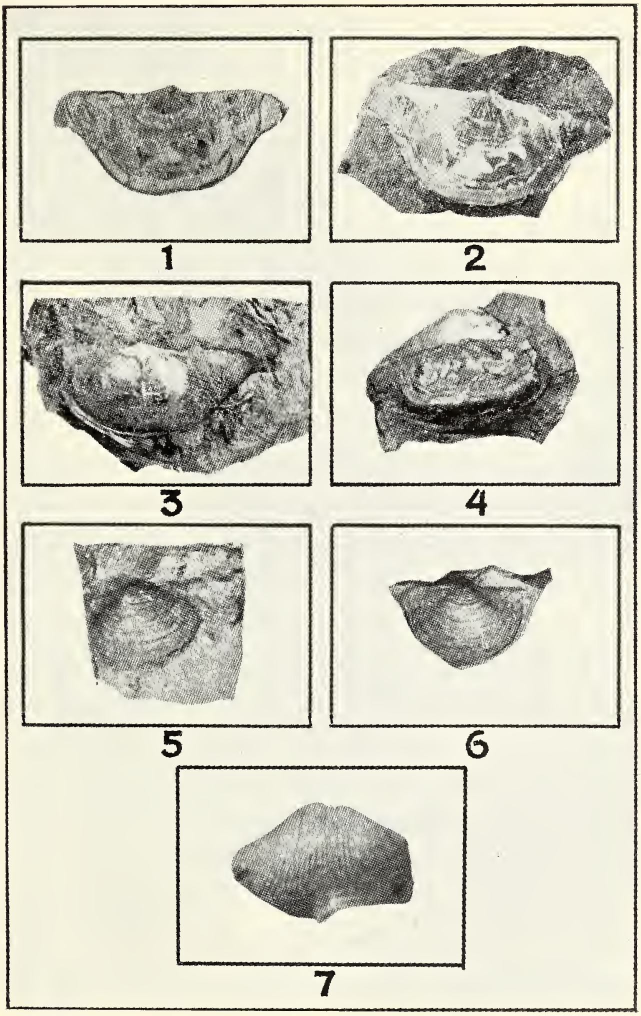


LINOPRODUCTUS SPRINGSURENSIS (sp. nov.)

(1 and 2) Pedicle Valve of Type Specimen.

(3 to 6) Paratypes.

Loc.: Springsure Dome.



LINOPRODUCTUS SPRINGSURENSIS (sp. nov.)

(1 to 6) Brachial Valves.

(7) Cast of Pedicle Valve.

Essential Oils from the Queensland Flora.

Part IV.—Agonis elliptica.

By Thomas Gilbert Henry Jones, D.Sc., A.A.C.I.

(*Tabled before the Royal Society of Queensland, 30th November, 1931*).

In continuation of the investigation of the oils derived from the *Agonis* species growing in Queensland, the oil obtained from the leaves of *Agonis elliptica* has now been examined. Supplies of leaves were obtained from the swampy area a little to the north of Beerwah, in which place several acres are covered very largely with this shrub.

The essential oil which is present in the leaves to the extent only of about .25% proved on examination to be somewhat similar to that obtained from *Agonis Luehmanni*, although in this instance the amount of ocimene was somewhat less. The principal constituent is dextro rotatory pinene 70-80 % with ocimene and sesquiterpenes as minor constituents, little if any, oxygenated bodies being present.

Experimental.

400 lbs. of leaves collected at Beerwah on the 11th and 12th July, 1931, and distilled on the 16th July, gave 450 ccs. of oil with the following constants :—

$d_{15.5}$	·8715
$[\alpha]_D$	+11·5
n_{20}^{D}	1·4756
Ester Value	Nil
Acetyl Value	6

Sodium hydroxide solution extracted a trace only of substance from the oil.

Fractional Distillation of the Oil.

300 ccs. of oil were submitted to fractional distillation at 4 mms. pressure and the following fractions collected :—

Fraction	ccs.	$d_{15.5}$	n^D_{20}	$[a]$ D
(1) 0– 45° C	212	.8572	1.4670	+13
(2) 45– 80° C	14	.8929	1.488	−2.5
(3) 80–100° C	23	.9130	1.498	−2.5
(4) 100–110° C	11	.9299	1.4985	+12
(5) 110–140° C	7	.9588	1.4995	+0

Fraction (1) readily gave a nitrosyl chloride of melting point 105°C., likewise a hydrochloride and on oxidation pinonic acid characterised by its semicarbazone M.P. = 204°C.

The fraction therefore consisted very largely of α pinene.

It was however further fractionated and divided into 6 fractions, the first five of which also gave the characteristic tests for pinene. The sixth fraction however was found to possess the following constants :—

$d_{15.5}$	·834
n^D_{20}	1·4815
$[\alpha]_D$	—2·5

The density suggested an olefine terpene and on further fractionation 6 ccs. of liquid were obtained of density ·828. This possessed the characteristic odour of ocimene.

Reduction of the fraction gave a liquid of density .8164 whence was prepared the solid tetrabromide (dihydro-ocimene tetrabromide) M.P. 88°C. Although difficult to characterise in presence of pinene, these experiments definitely indicated the presence of small quantities of ocimene. No β pinene could be detected.

Fractions (2), (3), (4) and (5) all gave the usual colour reactions with bromine vapour suggesting sesquiterpenes. Analysis indicated the almost complete absence of oxygenated bodies. After further fractionation finally over metallic sodium the following fractions (all with molecular composition $C_{15}H_{24}$) were obtained :—

(*a*) 5 ccs. $d_{15.5}$	·9064	b.p. 70-80°C.	4 mm.
n^D_{20}	1·4962		
$[\alpha]_D$	—6		
(*b*) 15 ccs. $d_{15.5}$	·9146	b.p. 80-90°C.	4 mm
n^D_{20}	1·4985		
$[\alpha]_D$	—3		
(*c*) 10 ccs. $d_{15.5}$	·9305	b.p. 90-100°C.	4 mm.
n^D_{20}	1·4995		
$[\alpha]_D$	+12		

Two sesquiterpenes appeared therefore to be present in the oil, one of which was probably aromadendrene.

The somewhat higher density of the original fraction (5) gave indication in this fraction of a small amount of sesquiterpene alcohol in association with the sesquiterpene.

No solid derivatives could be prepared from these sesquiterpenes and the small amount present in the oil precluded extended investigation.

Thanks are due to Mr. C. T. White, Government Botanist, for his usual courteous assistance, and to Mr. H. A. Slaughter, Glasshouse Mountains, who was responsible for the collection of the leaves.

REFERENCE.

(1) Jones, T. G. H., and White, Proc. Royal Society of Queensland, XLII, 1931, p. 24–27).

Some Notes on Queensland Droughts.

By PROFESSOR J. K. MURRAY, B.A., B.Sc.Agr., Faculty of Agriculture, University of Queensland.

(*Read before the Royal Society of Queensland, 28th September*, 1931).

I. INTRODUCTION.

To define just what is a drought makes for difficulty. The "Weather Map" definition for English conditions is quite inappropriate here. For Australia there may not be an authoritative definition in the opinion of the Queensland State Meteorologist. Our climatic conditions are very different from those of Britain. Rainfall of areas may be similar in annual total, and one regarded as dry, the other wet. The Lockyer Valley receives a greater annual rainfall than London or the Rothamsted Experiment Station; it can, however, hardly be described as a wet district. The number of days on which rain falls, the amount of sunshine received, the mean humidity—these play an important part. Blackall receives an annual rainfall not greatly dissimilar from that of Harpenden, England, where the Rothamsted Experiment Station is situated, but the evaporation from a water surface at Blackall (83″) is almost five times the Harpenden (Herts., Eng.) figure (17″). This leads to the consideration that absolute quantities of rainfall are not of themselves a guide to droughts or good conditions.

The last year of the 1900–1902 drought period had a rainfall 50% below the average for the State. In 1905 the rainfall was 36% below average for the whole of the State.

Those years which have been characterised by the Bureau of Meteorology as very bad years from the point of view of deficiency of rainfall, may be regarded as droughts of a severe type.

II. GENERAL.

Some parts of the State, the Moreton district for instance, have been blessed since 1927 with a run of fair to good seasons, a period at least quite as long as those sequences which meteorological records have shown as normally occurring between droughts. Moreton agriculturists at least may have reason to consider means offsetting the evils of drought, should it occur. Some other sections of the State had a series of bad years beginning with 1926. These, too, may be wise to endeavour to frame a programme calculated to reduce the ill-effects of droughts, since records illustrate the possibility of only short relief periods—no longer than 1930–31. It needs only the picturing of a Queensland drought, added to our other troubles in 1930 and 1931, to cause a realisation of the necessity to safeguard properties and the State, as far as economically possible, against the effects of a drought in the possibly near future. There does appear to be a case for State consideration of means of insurance against drought risks and consequences.

Some droughts (1900–1902) have ravaged the whole continent, others (1926–7) Queensland ; and yet others have been most severe in some parts of the State, while other portions have enjoyed good seasons—1927 and 1928 are recent examples. Other examples of such years were 1897, a very bad year in most parts, but of normal rainfalls on much of the Darling Downs ; 1904 was generally bad, but west of a Normanton-Birdsville line rainfalls were above average. In some areas a disastrous series of very bad years have been experienced. The rainfall for nine successive years at Boulia (average 10.38") was for instance—

1922 ..	6.47	1926 ..	5.43
1923 ..	3.41	1927 ..	3.03
1924 ..	9.31	1928 ..	2.72
1925 ..	5.28	1929 ..	5.15
		1930 ..	8.07

The disastrous 1900–1902 period was for Queensland "the climax of eight bad years." From 1888 the drought years generally in Queensland might include 1888, 1892 (?) 1897, 1900–1902, 1905, 1912, 1914–1915, 1919, 1922, 1923, 1926, 1927, 1928—a total of fifteen years of acknowledged drought in a period of forty-three. A notable feature is their frequency, but it is to be observed that the South East has sometimes received normal rains while the North and West have passed through a very bad year ; many variants of this type occur. Rainfall itself may occasionally be a poor guide to drought conditions, since an abnormal precipitation at one period of the year may cause floods and cause average total rainfall to be recorded, masking, however, periods of grave difficulty. The year of the Mackay-Innisfail cyclones was a case in point. The intensity of an undoubted drought year is added to when the very bad year is preceded and/or followed by a year of sub-normal rains, but hardly of itself a drought year. 1900 and 1901 were dry years followed by a very dry 1902. 1907, 1908 and 1909 were years in which parts of the State received in each less than the normal rainfall, and the cumulative effect of shortage made for a drought.

III. LOSSES DUE TO DROUGHT.

Some features are difficult to assess accurately. There is the undoubted State or even national depression which may be so acute as to result in losses of population, as indicated in the following extract from the Commonwealth Year Book (No. 17, 1924). "In the case of the drought of 1902–3 the departures from Australia exceeded the arrivals for the two years 1903 and 1904 by 12,859" . . . . "for the former of these years the natural increase of population was abnormally low." The loss of purchasing power in the agricultural industries has, of course, its effect on metropolitan centres. Unemployment in secondary industries is experienced, and there is an almost general loss of prosperity in city businesses. There are, too, the widespread repercussions in governmental finance, taxation from many sources showing a marked decline.

The direct losses in the agricultural industries are somewhat difficult to determine, other factors sometimes exaggerating or minimising the drought effect.

Wheat.—The loss may be indicated by an acreage yield of $4\frac{3}{4}$ bushels of wheat in Queensland in 1923 (drought) ; by 57,084 acres in 1926 (drought) yielding 379,338 bushels (average yield per acre, 6.65 bushels), and 1927–28 (good year in wheat area) 215,073 acres yielding 3,783,548 bushels (average yield 17.59 bushels per acre). As indicative of the continental distribution of drought and non-drought areas in the disastrous Queensland year 1926–27, Victoria experienced one of her best seasons, averaging 16.08 bushels of wheat per acre, and harvesting 46,886,020 bushels.

The wheat yield per acre and the total yield for Queensland is subject to very wide fluctuations, owing to the location of the crop on a relatively small, compact area in the South-East of the State, covering at most three degrees of latitude, whereas other crops of Queensland, such as sugar and maize, are distributed over twelve or more degrees of latitude. There is seldom the same intensity of the favourable or unfavourable conditions over twelve degrees of latitude, as may occur over a belt of country covering but three. Moreover, Queensland wheat is grown in a warm country with a summer rainfall, whereas most winter-grown wheats are cultivated in somewhat colder climates with a dominantly winter rainfall.

Sugar.—With sugar, the drought years 1923–24 and 1926–27 have yields of cane per acre of 14.75 and 15.45 tons, while the good years, 1924–25 and 1925–26 gave an average per acre of 18.92 and 19.34. The reductions in yield are not so severe as with wheat, because of the distribution of the cane crop over 1,000 miles of coast line, the drought seldom being uniformly severe over the whole of the latitudes represented ; the increasing trend of sugar cane production north of Townsville may tend to cause wider fluctuations, though the average yield may be higher.

Maize.—In the drought year 1926–27 the yield of maize in Queensland was 2,658,895 bushels at an average yield per acre of 19.33. In the good year 1927–28 the yield was 6,703,518 bushels, and the yield per acre 28.65. Again the distribution of the crop covers more than 1,000 miles of coast line. Very wide differences in average yield, such as those characterising wheat in Queensland, where a good season yield is apt to be hundreds per cent better than the drought one, do not occur with maize. Yield losses to maize farmers are sometimes partially off-set by the high prices prevailing as a consequence of the feeding of starving stock in drought-stricken pastoral areas ; the cattle industry carries consequent abnormal debits and the State the loss on the transport of grains and fodder, at starving-stock rates.

Live Stock.—With live stock, drought losses are very grave, though the effects vary with the type. Rapid recoveries are made with some, as with pigs. The recovery with cattle is naturally slower, a longer period being required to reach breeding age. When prolonged droughts affect the State with only short periods of recovery, the results are apt to be very severe.

Cattle.—In the following figures the effects of market fluctuations also play a part, but the major factor is drought. Cattle and sheep are affected by the respective prices for cattle and sheep products—

1921	7,047,370
1922	6,955,463
1923	6,396,514
1924	6,454,653
1925	6,436,645
1926	5,464,245
1927	5,225,804
1928	5,128,341
1929	5,208,588

Recovery from the 1922–24 droughty conditions affecting many of the pastoral districts was impossible before the 1926–28 drought made further severe reductions.

Horses.—The extensive use of cars, trucks, and tractors has complicated the horse position, and it is difficult to state to just what degree droughts, rather than displacement as power units, has resulted in a lowered number of horses. The figures from 1922 to 1928 are as follows—

1922	713,015
1923	660,385
1924	659,023
1925	637,426
1926	570,690
1927	547,412
1928	522,490
1929	500,104

The influence of heavy droughts as well as that of cars, trucks and tractors in the decline in numbers given above is almost certain.

Sheep.—The loss in numbers owing primarily to droughts has been marked—

1925	20,663,323
1926	16,860,772
1927	16,642,385
1928	18,509,201
1929	20,324.303

The variation in the wool yield has followed a somewhat similar trend. The loss of approximately five millions of sheep, or (say) 25% of the total for 1925, represents a very heavy blow to the sheep industry;

just how heavy is difficult to state. There is, for instance, the reduction in natural increase due to a lowered number of ewes, and a lowered lambing percentage—

	Ewes Mated	Lambs Marked	Lambing Percentage.
1925 ..	8,772,276	4,638,376	52.88
1926 ..	6,557,034	2,245,998	34.25
1927 ..	6,980,529	2,481,955	35.56
1928 ..	7,820,137	3,995,065	51.09

With sheep, owing to a probable positive correlation, under normal financial conditions, between Australian wool production and world prices, it may be held that a somewhat lower number of sheep would not really result in a lowered Commonwealth net return and that the expensive carrying through by hand feeding is not nationally economic. The loss to the State, however, as a consequence of a depletion of its flocks by 25% is not likely to be gainsaid.

Dairying.—The influence of drought years on the dairying industry is indicated in these figures from the 1931 Annual Report of the Queensland Farmers' Co-operative Association—

	Butter Manufactured	Paid Suppliers	Average Price per lb.
1926 ..	8,807,659 lbs.	£564,643	1. 3.38
1927 ..	6,697,134 lbs.	£420,416	1. 3.08
1928 ..	9,741,233 lbs.	£660,670	1. 4.27

The significant figures are those of butter manufactured in the drought period January–December, 1927, compared with those of the year before and after.

The following figures from the Commonwealth Year Book, 1930, similarly illustrate the loss entailed—

QUEENSLAND.

	Butter	Cheese
1925–26	63,001,073	12,580,942
1926–27	51,402,633	9,260,043

On page 11 of 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 one drought (1915) is assessed at more than two million pounds (£2,315,722).

In addition to the direct loss of stock there is also in all the live stock industries, the loss entailed in the purchase or use of foodstuffs to keep stock alive when the duration of the drought may make much of the effort futile, or cause the expenditure on foodstuffs to equal or exceed the value of the animal. There is also the loss of the breeding effort. This is particularly noteworthy in the cattle industries where so long a period is needed to complete an improvement in the herd. It is discouraging to select carefully stud rams and ewes and flock rams with a view to increasing the quality and quantity of wools if, periodically, the improved flocks are cut to pieces by the lack of foodstuffs during the drought. It is similarly depressing for farmers to purchase A.I.S., Jersey or other pure-bred dairy bulls from high-producing lines and then, when the high-producing herd has been bred, lose its valuable members through lack of feed during one of the periodic droughts.

IV. CAUSES OF LOSSES AND MEASURES TO COMBAT THEM.

(*i*) Shortage of Water.

There was a time when the most serious menace occasioned by droughts was the water shortage but, with the great development of supplies from the great artesian basin, which Queensland fortunately possesses, this trouble has been ameliorated to a great extent for our sheep and cattle country. However, in this matter also some thought of conservation is essential, since it seems certain that the ordinary sinking, and the present maintenance of bores, leaves something to be desired if we are to continue to obtain the maximum flow from the artesian basin. The sinking of additional and better care of present dams or tanks is necessary. Assistance is being given by the State in the provision of water facilities to meet the requirements of graziers.

(*ii*) Shortage of and Inefficiency in the use of Foodstuffs.

(*a*) *Pastures Generally.*—Just to what extent pastures can be improved to enable a smaller proportion of the holding to carry the stock is less certain in the sheep and beef cattle industries than it is in dairying. If such can be done, then grazing reserves or their equivalent are possible. Knowing what has been done in the improvement made within two botanical species, wheat (*T. vulgare*) and Maize (*Zea mays*), to enable a greater production from a unit area, it does not call for a great deal of courage to envisage pastures much more productive than those we now have. The solution is one calling for a special research effort, and the great importance of the pastoral interests to Queensland justify a belief that it will be undertaken. Even more is this so when we consider the pasture improvement work done in New Zealand, the southern Australian States and England. The work has been commenced in Queensland, but the problem with us is a much more difficult one, since our climatic conditions are not those under which much of the knowledge at present available has been obtained. Generalisations applied to Queensland on the basis of Southern Australian experience may be as wasteful as the application now of superphosphate to the Queensland black soil wheat areas. The success of Farrer's Federation and Florence in Australian wheat culture, the successful introduction of paspalum and clovers give hope for improvement within grass species and the introduction of species and varieties which will add to the efficiency of our pastures. It is work for a Pasture Research Branch generously provided with funds, and with a personnel of the highest calibre.

The avoidance of over-stocking on pastures, even of a climax type is sufficiently obvious as a drought precaution to need no stressing ; the deterioration of pastures by the encouragement given to dominance by the poorest constituents is one of the worst effects of overstocking.

(*b*) *Inability to Transport Stock.*—In a drought time it is essential to be able to transport stock from drought stricken areas to those more happily situated. The railway completed within recent years from Winton to Longreach is a very valuable drought-fighting feature. There is need for a railway from the Yaraka or thereabouts to the Charleville–Quilpie line. It may be possible to construct such a line, partly or wholly, from Unemployed Relief Funds, and thus convert some of these contributions into State Capital on which no interest will be payable and an asset obtained which would help the pastoral industries to make the best use of the pastures we have. The further link to Bourke would be worthy of consideration, keeping in mind the possible loss of pastoral business to the adjoining State; obviously there must be a limit beyond which an industry in a Commonwealth should not be handicapped to meet provincial interests. The possibilities of the transport of stock by motor truck, as demonstrated by W. A. Russell, Esq., M.L.A., is worthy of attention.

It may be unwise, as well as actuarially unsound to charge to a railway system the losses following on the provision of facilities to meet drought difficulties. Railways providing transport for starving stock at unpayable rates will give their best results at drought times when the losses are recognised as a charge against some other Department of State.

(*c*) *Supplementary Foodstuffs.*—It is possible that further research in keeping with the objective actuating the C.S.I.R. experiments at Meteor Downs may assist in drought-fighting by indicating methods of sheep and cattle feeding which are more efficient than those at present in vogue. The use of licks as pasture supplements has not been fully availed of and may be expected to furnish help also.

(*d*) *Fodder Conservation.*—A number of schemes have been proposed—there is, for instance, the comprehensive one of the Council of Agriculture, details of which are given in the first Annual Report of that body. In the dairying districts the possibilities are easier to visualise. There it is possible now to conserve grains and fodder with a view to carrying the herd through the next drought. The possibilities of hay, silage and grains have only been touched. The conservation of fodder and grains for the West, particularly with the prices of its products at the present low ebb (it is but an ebb) presents grave difficulty, but I cannot believe it is insuperable. Once again we have maize at a price in the vicinity of 2s. 3d. a bushel, and the conserving of grain at that price should be sound business. This State can grow large quantities of maize and lucerne to meet its drought needs; it has also by-products such as the meals and molasses.

(*e*) *Education.*—There is a definite need for increased knowledge of animal nutrition among graziers and farmers. For the future this can be done most effectively by encouraging graziers' and farmers' sons to attend University and State Agricultural College courses. Immediately, the furtherance of the Adult Schools of Instruction and the constant provision of suitable articles on nutrition in pamphlets, newspapers, and periodicals will be helpful. Without a sound knowledge of nutrition or a skilled guidance, drought-feeding and the purchase of foodstuffs for starving stock, is apt to lack something in economy.

(*f*) *Weather Forecasting.*—With notable advances in astronomical and physical knowledge, it is difficult to believe that a research organisation with a personnel highly trained in Mathematics, Physics and Astronomy would not within a reasonable period be able to forecast drought periods. With such forecasting, droughts would lose the major part of their difficulties. The greatest single service that science could confer on the farming and grazing industries might well be reliable short and long distance weather forecasting. The possibilities presented by such a service in the increased efficiency of agriculture would probably surpass those of plant-breeding effort, splendid as these are.

So important does the United States of America consider the weather forecasting and meteorological services to be in agriculture that the Weather Bureau is a branch of the Federal Department of Agriculture. With perspective of the order that some churches possess and that an agriculturally based nation should have, research in weather-forecasting should be a major project.

To assess the losses of a severe Queensland drought at £10,000,000 is probably not to exceed reasonable figures. The sheep, cattle and dairying and merchandising units should find it worth while to prepare for a contingency of the kind ; and the State may consider the matter of sufficient importance to explore all avenues which present possibilities of lessening the damage which droughts assuredly cause.

I am indebted to the Queensland Divisional Meteorologist, the Council of Agriculture, and the Year Books of the Commonwealth and of Queensland. I have drawn also on an article " Droughts " appearing in the *Queensland Agricultural College Magazine* in 1927.

The Royal Society of Queensland

REPORT OF COUNCIL FOR 1930.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its Report for the year 1930.

Nine original papers were read before the Society, and published during the year. In addition, the following addresses were delivered :—" The Biological Control of Prickly-pear," by Mr. A. P. Dodd ; " The Role of Diseases in the Biological Control of Prickly-pear," by Mr. H. K. Lewcock, M.Sc. ; " The Sugar Industry," by Dr. L. S. Bagster ; " The Development of a Mining Industry by Modern Scientific Methods," by Professor H. C. Richards, D.Sc.

The Council wishes to acknowledge generous subsidies amounting to £70 10s. from the Queensland Government towards the cost of printing the Proceedings of the Society. Appreciative acknowledgment is also made to the University of Queensland for housing the library and providing accommodation for meetings.

In connection with the financial statement, it will be noted that only half the usual Government subsidy is shown. For a considerable time the Government has paid half our Government Printer's bill for printing our Proceedings, the amount of subsidy being limited to £150 per annum. This subsidy has been of very great value to us, enabling us to publish much more than would otherwise have been possible. There are probably members who do not realise that it is only by publishing a respectable volume of new work every year, that we obtain the 200 volumes of the proceedings of other scientific societies which makes our library so extremely valuable to nearly all scientific workers. Should we fail to keep our publications at a fair level, we will certainly lose our exchanges, and might find it extremely difficult to regain the lost position. As the fiscal year of the Government ends on 30th June, we had the subsidy up to that date. Since then we have had no subsidy, and certain papers had to be held over—a procedure which we all deplore. A deputation to the Premier, in August last, pointed out that all the Government subsidy as well as all our subscriptions goes to building up this essentially national library —the only one of its kind in Queensland—that no member of the Society receives honorarium or pay for anything done for the Society, and that the work of the Society was of great importance in the development of the State. The Premier, Mr. Moore, received us most sympathetically, stated that he quite recognised the national importance of keeping our work and our library going, and trusted that he would be in a position next financial year to assist us again with the printing of our Proceedings.

At a time like this there is a tendency for members to meet a dwindling private income by dropping their subscription to our Society. Fortunately, so far, only a few have felt this course to be necessary, and we trust that few others will follow suit. There are many people in Queensland who, if they knew of the need for help towards publishing in Queensland the scientific work of Queenslanders would readily assist by giving the small annual subsidy which we ask for membership. Your Council trust that all members, realising the difficult position the Society is in, will strive during this 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.

During the A.A.A.S. meeting in Brisbane last May, a conference was held which was attended by delegates from all the Royal Societies in Australia. The purpose of the conference was to discuss the possibility of forming a Royal Society of Australia. After a lengthy discussion the delegates agreed that the idea was impracticable at the present time.

The membership roll consists of 4 corresponding members, 7 life members, 167 ordinary members, and 2 associate members. During the year there were 5 resignations, and 13 new members were elected. The death of Mr. R. C. Cowley is reported with regret.

There were eleven meetings of the Council, the attendance being as follows :—E. W. Bick, 9 ; W. H. Bryan, 10 ; R. W. Cilento, 2 ; G. H. Hardy, 10 ; J. B. Henderson, 8 ; D. A. Herbert, 11 ; T. G. H. Jones, 9 ; J. S. Just, 6 ; H. A. Longman, 4 ; J. P. Lowson, 0 ; F. A. Perkins, 10 ; H. C. Richards, 9 ; C. T. White, 5 . Mr. Francis was granted leave of absence for the year.

J. B. HENDERSON, President.

F. A. PERKINS, Hon. Secretary.

THE ROYAL SOCIETY OF QUEENSLAND.

Cr. STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDING 31st DECEMBER, 1930. Dr.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
Balance at 31st December, 1929	29	1	7	Government Printer—			
Subscriptions	144	7	6	Volume Proceedings..	159	5	0
Government Subsidy on Printing	70	10	0	Abstracts and Stationery	13	11	7
Sale of Reprints and Volumes	8	10	6	Hon. Secretary (Postages)	11	0	0
Exchanges	0	5	6	Hon. Librarian (Postages)	1	0	0
				Assistance in Library (Card Indexing)	10	10	0
				State Government Insurance	0	13	0
				Bank Charges, June, and Closing Account, Queensland National Bank	0	10	0
				Exchanges (Debited)	0	6	2
				Cash in Hand	0	12	0
				Balance in Commonwealth Bank, 3rd January, 1931 ..	55	7	4
	£252	15	1		£252	15	1

Examined and found correct.

JOHN S. JUST, Act. Hon. Auditor.

2nd March, 1931.

E. W. BICK, Hon. Treasurer.

Abstract of Proceedings, 30th March, 1931.

The Annual Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 30th March, 1931. The President (Mr. J. B. Henderson) occupied the chair, and about sixty members and visitors were present. An apology for absence was received from Miss Bage. The minutes of the previous meeting were read and confirmed. The following were proposed for ordinary membership :—Miss Cue and Messrs. Kyle and McDougall, proposed by Mr. Perkins and Dr. Herbert, and Messrs. F. C. Bennett, J. B. Brigden, W. L. Payne, and Dr. Reye, proposed by Mr. Henderson and Prof. Richards. The Annual Report and Balance -sheet were adopted.

The following officers were elected for 1931 :—

President : Dr. D. A. Herbert.

Vice-Presidents : Mr. J. B. Henderson, F.I.C. (*ex officio*) and Dr. T. G. H. Jones.

Hon. Secretary : Mr. F. A. Perkins, B.Sc. Agr.

Hon. Treasurer : Mr. E. W. Bick.

Hon. Librarian : Mr. W. D. Francis.

Hon. Editors : Mr. H. A. Longman, F.L.S., C.M.Z.S., and Dr. W. H. Bryan, M.C.

Hon. Auditor : Prof. H. J. Priestley, M.A.

Members of Council : Dr. R. W. Cilento, Mr. J. S. Just, M.I.M.E., Dr. E. O. Marks, Prof. H. C. Richards, D.Sc., and Mr. C. T. White.

Mr. J. B. Henderson delivered his Presidential Address, entitled "Unused Knowledge." His Excellency the Governor moved a vote of thanks, which was carried by acclamation. Prof. H. C. Richards expressed the Society's appreciation of the presence of His Excellency the Governor.

Abstract of Proceedings, 27th April, 1931.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 27th April, at 8 p.m. The President, Dr. D. A. Herbert, in the chair, and about thirty members and visitors present. An apology was received from Mr. Bick. The minutes of the previous meeting were read and confirmed. The following were unanimously elected members of the Society :—Miss J. Cue, B.Sc., Messrs. W. M. Kyle, M.A., W. McDougall, B.Sc., F. C. Bennett, B.Sc., W. L. Payne, J. Brigden, M.A., and Dr. Reye. The following were proposed for ordinary membership :—Miss E. Duncan, B.Sc., by Messrs. Stoney and Perkins ; Dr. J. G. Drew, by Mr. Henderson and Professor Richards ; Mr. N. Fisher, B.Sc., by Dr. Bryan and Mr. White.

Dr. W. H. Bryan exhibited an interesting basaltic agglomerate from the hill known as Mt. Tarampa, in the Lockyer Valley, near Tarampa.

This exhibit was commented on by Mr. Tryon.

Mr. H. A. Longman exhibited a specimen of *Demansia guttata* Parker, which had been sent to the Queensland Museum by Mr. A. McLeod, Hazelwood, Longreach. This species was described from two specimens collected at Winton by Captain (now Sir Hubert) Wilkins for the British Museum. The snake exhibited was the third to be recorded. Comments were made on this exhibit by Dr. Marks and Mr. Tryon.

The President extended a hearty welcome to Mr. Francis, the Hon. Librarian of the Society, on his return from Europe. Mr. Francis gave an account of his trip abroad, describing the different herbaria in which he had worked, and the botanists with whom he came in contact.

Mr. C. T. White read a paper entitled "Two Previously Undescribed Queensland Myrtaceae."

The paper describes two new species of Myrtles from Queensland. The first of these is *Darwinia Porteri*, first collected by Mr. George Porter on rocky hills near Watsonville, North Queensland. The genus is an interesting one as it is confined to Australia, most of the species being natives of Western Australia. The genus commemorates the famous naturalist, Charles Darwin, and was previously only represented in Queensland by one species. It is a pretty little shrub with red and yellow flowers and when placed in water retains its freshness for quite a long time.

The second plant is a new species of Tea Tree or Melaleuca collected at Traverston at the mouth of the Burrum River by the author, and it has been named *Melaleuca Cheelii* after Mr. Cheel of the Botanic Gardens, Sydney, in recognition of his work on this genus of plants.

This paper was commented on by the President.

Professor Hawken then took the chair, and the President, Dr. D. A. Herbert, read a paper entitled "The Movements of *Neptunia gracilis*, a Native Sensitive Plant."

Neptunia gracilis is a native sensitive plant whose leaves close rapidly when touched or wounded, reopening slowly until in ten or fifteen minutes they are again in their normal position. At night they close, but to a greater extent than they do when wounded. In a wounded leaf the stimulus is transmitted along the leaf, and also slowly across the axis to opposite leaflets, and not along the axis and back down the other side.

An extract of Neptunia leaves produces a normal response in those of the American sensitive plants, *Mimosa pudica* and *Mimosa*

Spegazzinii, but curiously does not produce any movement in the leaves of Neptunia itself. Extracts of a native species of wattle, *Acacia podalyriaefolia*, and of various other leguminous plants, were found to act as a stimulant in the same way, so that the property of producing a stimulant is not restricted to plants such as Mimosa and Neptunia, which show rapid movement. Non-leguminous sensitive plants such as *Averrhoa* do not respond to the substance.

This paper was discussed by Messrs. Hines, Tryon, Longman, Dr. Marks and Professor Hawken. Professor Richards then moved a vote of thanks to Mr. White and Dr. Herbert which was carried by acclamation.

Abstract of Proceedings, 25th May, 1931.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 25th May. The President, Dr. D. A. Herbert, was in the chair. Apologies were received from Messrs. Henderson, White and Perkins. The minutes of the previous mee ing were read and confirmed. The following were unanimously elected members of the Society :—Miss E. Duncan, B.Sc., Dr. J. G. Drew and Mr. N. Fisher, B.Sc.

Dr. Lockhart Gibson exhibited the inflorescence of a papaw plant, which had been cut back in you h. The inflorescence also bore young fruit. In addition to male and female flowers, the plant bore flowers, exhibiting stages intermediate between the male and females. It is sometimes claimed that male plants of this species can be converted into females by cutting back before the flowering period. The exhibitor remarked upon the occurrence of hermaphroditism in human beings. The President, Mr. Bick, Dr. E. O. Marks, and Mr. W. H. Parker, a visitor, commented upon the exhibit.

Dr. T. G. H. Jones read a paper by himself, and Mr. M. White, M.Sc., entitled " Essential Oils from the Queensland Flora : *Agonis Luehmanni* Bailey."

Agonis Luehmanni is known only to occur on the tops of some of the Glass House Mountains. The yield of oil was .25%. Constituents of the oil proved to be principally pinene 60%, ocimene, aromadendrene, sesquiterpene alcohol, and a small amount of a crystalline yellow solid. This result is in contrast with that from *Agonis abnormis*, the oil of which consists primarily of sesquiterpenes.

Dr. T. G. H. Jones gave a short lecture on " Essential Oils." The lecture dealt with the general properties of essential oils and the methods of extracting them. The primary method was that of distillation in steam, but for perfumery extraction with suitable solvents was frequently resorted to. This yielded better perfumes. The steps necessary in the general examination of essential oils were then discussed, particularly the determination of important physical and chemical constants. Reference was then made to the essential oils from Australian plants, particularly those from the eucalypts. The theory of Smith and Baker, connecting leaf v nation and chemical constituents, and the possible evolution of the eucalypts was finally dealt with.

The President, Mr. Bennett, Dr. E. O. Marks, Mr. Francis and Dr. Lockhart Gibson took part in the discussion which ensued.

Abstract of Proceedings, 29th June, 1931.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 29th June, at 8 p.m. The President, Dr. D. A. Herbert, in the chair, and about seventy members and visitors present. Apologies were received from Dr. Bagster and Mr. Francis. The minutes of the previous meeting were read and confirmed. The following were proposed for ordinary membership: Messrs. B. Blumberg, B.Sc., and D. C. Fison, B.Sc., by Messrs. Perkins and Hitchcock, and Mr. Cummings by Messrs. Henderson and Perkins.

Dr. T. G. H. Jones read a paper by himself and Mr. L. Hitchcock, B.Sc., entitled "The Fixed Oil from the seeds of the Noogoorra Burr, *Xanthium pungens*."

The investigation of the oil from the seeds was undertaken in order to determine whether it possessed economic value. The yield of oil obtained by extraction of the finely ground burr, by low boiling point benzoline, was 8%, considerably lower than that obtained by extraction of the seeds themselves 25%, a process unpracticable on the large scale. The oil was found to be a mixture of the glycerides of oleic and linolic acids with smaller amounts of saturated glycerides and can be classified as a semi-drying oil. Although of some economic value, the difficulty of isolating the oil from the burr would render the process of little value as a source of oil.

This paper was commented on by Mr. Bennett and the President.

Mr. F. W. Moorhouse delivered a lecture entitled "Recent Marine Biological Work on the Barrier Reef." He described his experiences while carrying out research work on the life history and habits of the green turtle, trocus, and sponges. The green turtle lays up to 195 eggs at a time, returning to the beach to lay at intervals of about a fortnight, returning as many as seven times in three months. Only the females came ashore, the largest animal seen having a back measurement of 48 inches, and the smallest measured 35 inches. The incubation period lasted from 9½–10½ weeks according to the situation of the nest. On hatching the young turtles remain in the nest until after dark and then run with amazing speed straight to the sea. Mr. Moorhouse gave a brief account of the rate of growth of trochus and sponges.

A vote of thanks, moved by Prof. Goddard and supported by Prof. Richards and Mr. Longman, was carried by acclamation.

Abstract of Proceedings, 27th July, 1931.

The Ordinary Monthly Meeting was held in the Chemistry Lecture Theatre of the University on Monday, 27th July, at 8 p.m. The President, Dr. D. A. Herbert, occupied the chair, and about thirty members and visitors were present. Apologies were received from Prof. Goddard, and Messrs. L'Estrange and Henderson. The minutes of the previous meeting were read and confirmed. Messrs. B. Blumberg, D. Fison, and Cummings were unanimously elected ordinary members of the Society. Mr. R. Wilson was proposed for ordinary membership by Messrs. Bick and Perkins.

Mr. G. H. Hardy read a paper entitled " Aphididae in Australia."

This paper gives an account of the Aphides found to occur in Australia, only one being regarded as definitely indigenous. Twenty genera are recorded, those of the subtribe Pentalonina being treated in full. A list of identified aphides and their host-plants is given, and also a list of indigenous plants found harbouring aphides in Queensland.

Mr. C. T. White exhibited specimens of three species of *Aceratium* all from North-eastern Queensland. The genus was previously only known to consist of twelve species, ten in New Guinea, one in the Molucca Islands and another in the New Hebrides. The genus belongs to the family Elaeocarpaceae and has not previously been recorded for Australia. Descriptions of the Australian species have been drawn up and will be published at an early date.

Dr. Bagster performed a very interesting experiment using ether to demonstrate critical phenomena in a liquid-gas system.

Mr. H. J. Hines demonstrated (*a*) A new colormetric method for the determination of P_2O_5 and As_2O_5 (Zinzadze. Z. Pflanz. Düng., 1930, 16A, 129). (*b*) An electrical method for the reduction of draft in ploughing (Crowther and Haines J. Agric. Sci., 1924, 221). (*c*) The Zeiss Cardiod Condenser.

Dr. Herbert exhibited (*a*) *Nostochopsis lobatus* Wood a blue green Alga from the Albert River. (*b*) *Rafflesia manillana* flowers collected at 2,000 feet altitude on Mt. Maquiling, Philippine Islands. This plant is parasitic on *Cissus* sp. and the flowers only are external, the vegetative parts being reduced to strands in the host tissues. (*c*) On behalf of Mr. L. F. Hitchcock a specimen of the bark of *Sterculia* sp. from the West Indies prepared to show the reticulated rings of bast fibres.

Mr. Perkins exhibited (*a*) A female gall of *Apiomorpha excupula* Full. (Fam. Coccidae) on *E. paniculata* collected at Bauple, Q., by Mr. F. Sheldon Stringer. This is a new record for the State and also a new host record. (*b*) Specimens of the Buffalo Fly (*Lyperosia exigua*) collected on Mornington Island by Dr. I. A. Mackerras.

Mr. McCall exhibited an Analytic Quartz Lamp. This is a mercury vapour lamp so fitted with two Wood's filters that ultra violet rays are projected horizontally and vertically. The vertical rays fall inside movable black curtains, so that specimens may be examined for fluorescence in daylight. The effect of the ultra violet rays was shown on various drugs and chemicals, also on minerals and precious stones.

Abstract of Proceedings, 31st August, 1931.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 31st August, at 8 p.m. The President, Dr. D. A. Herbert, occupied the chair, and about seventy members and visitors were present. Apologies were received from Messrs. Kyle and Francis. The minutes of the previous meeting were read and confirmed. Mr. P. S. Hossfeld, M.Sc., was proposed for ordinary membership by Professor Richards and Dr. Bryan. Mr. R. Wilson was unanimously elected an ordinary member of the Society.

The evening was devoted to the celebration of the Michae Faraday centenary, and the following addresses were given :—

"Michael Faraday : Biographical Sketch," by H. A. Longman F.L.S.

"Faraday as a Physicist," by Prof. T. Parnell, M.A.

"The Chemical Aspects of Faraday's Work," by Prof. L. S. Bagster, D.Sc.

"The Engineering Aspects of Faraday's Work," by J. S. Just, M.I.M.E.

A vote of thanks to the speakers, moved by Mr. W. M. L'Estrange was carried by acclamation.

A paper by Mr. H. J. G. Hines, B.Sc., entitled "Investigation of Queensland Soils, No. 1, Properties as Shown by Single Value Characteristics," was laid on the table.

This paper records results obtained in a preliminary examination of some Queensland soil types. Values are recorded for 63 soils of air-dry moisture, ignition loss, moisture at the sticky point, and Keen-Racskowski box data. Confirmatory of other workers all the above values give useful information, applicable to survey and classification.

The ignition loss is of doubtful value as a measure of the colloid content of the soil owing to its variation with the chemical nature of the collodial material. The soils were grouped according to profile characteristics, marked differences occurring between calcareous and non-calcareous soils. In the latter group a gradation of properties exists through the sequence yellow earths, red earths, laterites.

Abstract of Proceedings, 28th September, 1931.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 28th September, at 8 p.m. The President, Dr. D. A. Herbert, occupied the chair, and about thirty members and visitors were present. An apology was received from the Minister for Agriculture. The minutes of the previous meeting were read and confirmed. Mr. P. S. Hossfeld, M.Sc., was unanimously elected an ordinary member of the Society.

The main business of the evening was an address by Prof. J. K. Murray, entitled " Some Notes on Queensland Droughts."

The Queensland Council of Agriculture estimated the loss of the dairying industry due to the 1915 drought at £2,300,000. Severe losses occur as a consequence of interrupted schemes of stock improvement ; feeding drought stricken cattle may be an entire loss.

To decrease the losses amelioration of the causes is necessary. Greater efficiency in the use of the Artesian Basin water supply and increased conservation of run off. Increasing the carrying capacity of pastures and provision of pasture reserves. A Pasture Improvement research branch is an essential. Improvement of stock transport facilities to enable the movement of stock to regions experiencing a better season ; the charging of railway losses on such transport to a Department of State other than the Railways Department. Research in the matter of pasture supplementary foodstuffs and substances and drought fodders. Conservation of grains and fodders when prices are abnormally low, vocational education of farmers' and graziers' sons so that, by extending the knowledge of animal nutrition, the use of pastures, their improvement and drought feeding of cattle, etc., might be more efficiently done. The establishment of an Australian Long Distance Weather Forecasting Bureau with a personnel highly trained in Mathematics, Physics and Astronomy represents the most important and promising strategic measure in the ultimate minimising of drought effects.

The lecturer indicated the more than usual desirability of preparing for drought during the present crisis ; a drought added to our present difficulties would be a grave occurrence.

Droughts are taken to mean those seasons in which a major portion of the State received less than average rainfall. The English definition is not applicable. Evaporation from soils and abnormalities in distribution influence the worth of rainfall for water reserves and pasture production ; the Blackall evaporation figure is five times that of Harpenden, England, though the annual rainfall is not greatly dissimilar.

Very severe drought periods have been the culmination of two or more years' shortages (1900-1902) ; the rainfall for 1902 was only 50% of the average for the State and followed two years of shortage (1900-1901). Boulia experienced eight consecutive years with a rainfall below normal. The lesser droughts vary in incidence. One portion of the State may be gravely affected ; another may experience a good season.

The consequences of droughts may include losses of population, decreases in national income, governmental difficulties in finance, distress in metropolitan and rural areas, loss of farm and grazing capital.

With Queensland crops the losses may be instanced by decreases in acreage and yield per acre. The 1923 and 1926 droughts gave wheat per acre yields of $4\frac{3}{4}$ and $6\frac{1}{2}$ bushels ; in the latter year Victoria experienced one of her best seasons. These two years depressed the sugar cane yields from an average of about 19 tons to 15 tons per acre despite the distribution of the crop over 1,000 miles of coast line ; maize, similarly distributed, was similarly depressed in yield in 1926.

Drought, as a major factor, was responsible for a decrease in the number of cattle from seven to five millions between 1921 and 1928.

The drought period, 1926-27, reduced the sheep from twenty to sixteen millions, and the lambing percentage from 53 to 34.

A vote of thanks moved by Prof. Richards, and supported by Messrs. Bennett, Williams, Jones, Marks, Gipps, Kemp and the President, was carried by acclamation.

Abstract of Proceedings, 26th October, 1931.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 26th October, at 8 p.m. The President, Dr. D. A. Herbert, occupied the chair, and about thirty members and visitors were present. Apologies were received from Messrs. White and Francis. The minutes of the previous meeting were read and confirmed. Mr. J. E. Ridgway was proposed for ordinary membership by Messrs. Reid and Perkins.

Mr. J. H. Reid exhibited some fossiliferous limestone boulders from Bannockburn, near Rockhampton. The matrix consisted of pebbles of quartz, and andesite in calcareous grits. *Favosites*, *Tryplasma*, and four other coral genera occurred, designating a Devonian age. The boulders are of interest because they were probably contemporaneous with an horizon at Silverwood where similar boulders occur. It is not suggested that the limestone boulders at Bannockburn have a glacial origin, and no boulders of granite, schist, etc., have yet been observed. Professor Richards and Drs. Bryan, Marks, and Whitehouse commented on this exhibit.

The main business of the evening was a lecture by Dr. F. W. Whitehouse on " Some Problems of Queensland Palaeo-botany."

The Lower Mesozoic sediments of Queensland are extraordinarily rich in fossil plants ; and in spite of the fact that a number of monographs have been published by Walkom and others on these floras there are still many undescribed species. Recent work suggests that the following stages may be recognised in these deposits :

4. A Middle Jurassic Stage, characterised particularly by *Otozamites*, *Sagenopteris*, *Taeniopteris spathulata* and *Phlebopteris* (? *Laccopteris*), but without *Thinnfeldia.*

3. A Lower Jurassic (Liassic) Stage, characterised by the association of *Taeniopteris spathulata*, with *Thinnfeldia* and having present also *Ptilophyllum*, *Coniopteris hymenophylloides*, *Araucarites*, *Anomozamites*, *Johnstonia* (?), *Linguifolium*, etc.

2. An Upper Triassic Stage without *Taeniopteris spathulata* and characterised by normal forms of *Thinnfeldia*, *Stenopteris spp. nov.*, *Sphenopteris superba*, *Yabeiella*, *Fraxinopsis*, *Linguifolium*, *Dictyophyllum*, *Ginkgoites*, etc.

1. A Lower Triassic Stage characterised by abundant *Schizoneura*, species of *Thinnfeldia* with very large pinnules, *Glossopteris*, *Asterotheca*, *Linguifolium*, *Yabeiella*, *Fraxinopsis*, *Nilssonia*, etc.

The distribution of plants in these stages, and the suggested correlation of the several series of Australian Lower Mesozoic rocks with them was illustrated.

The floras of these beds are particularly interesting because of the occurrence in them of certain apparent angiosperms, together with some very interesting hemicycads. Hitherto, only two types of angiosperms have been described from Lower Mesozoic rocks. Thomas has described certain fruits and flowers associated with leaves of *Sagenopteris* in Jurassic beds in Yorkshire ; and a similar association has been described by Seward from Greenland. Furthermore, Wieland has described a genus of fruiting body, which he called *Fraxinopsis*, from Triassic beds in Argentine that was associated with a type of leaf to which Oishi has given the name *Yabeiella.* This type of leaf has been recorded in other countries but no further fruiting bodies have been described.

Here in Queensland we find, in the Middle Jurassic beds of Durâka, impressions of flowers and fruiting bodies associated with the leaves of *Sagenopteris*, similar in external appearance to those described by Thomas and Seward. Furthermore, in both our Upper and Lower Triassic beds, *Fraxinopsis* occurs here associated with *Yabeiella.* In addition, in the Upper Triassic beds of Ipswich, there is at least one other undescribed fruit of Angiosperm type. Specimens of these forms were exhibited.

The beds are interesting also from their wealth of hemicycads. Specimens from Queensland were exhibited of many forms, including :

(1) Female flowers of *Williamsonia* attached to fronds of *Ptilophyllum* ; and

(2) Flowers apparently of a new genus akin to *Williamsoniella*. These forms occur with fronds of *Taeniopteris*, *Linguifolium* etc., but it cannot be determined with which type of frond they are connected.

The relationship of the hemicycads to other groups (angiosperms, cycadofilicales, etc.), was discussed, and the suggestion was made that possibly *Glossopteris*, which in the Permian had developed several distinct structural types, might be the ancestral group of both the hemicycads and the early angiosperms.

Specimens of *Glossopteris* from the Lower Triassic beds representing two of the structural types found in the Permian were recorded and exhibited.

Mr. Reid and the President took part in the discussion which ensued. A vote of thanks to the lecturer was carried by acclamation.

Abstract of Proceedings, 30th November, 1931.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University on Monday, 30th November, 1931.

The President, Dr. D. A. Herbert, occupied the chair, and about 25 members and visitors were present. Apologies were received from Messrs. Jones, Hardy and Longman.

The minutes of the previous meeting were read and confirmed. Mr. J. E. Ridgway was unanimously elected an ordinary member of the Society.

Two papers, " Two Previously Undescribed Rutaceae from S. E. Queensland " and " A Previously Undescribed Dipterocarp " were read by Mr. C. T. White. A paper by Mr. G. H. Hardy, entitled "Australian Flies of the Genus Actina," was laid on the table.

The following papers were read by Mr. J. H. Reid :—" Correlations of the Queensland Permo-Carboniferous Basin : The Dilly Stage of the Lower Bowen," by Mr. J. H. Reid ; and " A New Species of *Productus* from the Lower Bowen Series, Queensland," by Mr. F. W. Booker. These papers were discussed by Dr. Bryan, Mr. Denmead and Dr. E. O. Marks.

A paper by Dr. T. G. H. Jones, entitled " Essential Oils from the Queensland Flora, Part IV. : *Agonis elliptica*," was laid on the table. This paper was commented on by Mr. White and the President.

Publications have been received from the following Institutions, Societies, etc., and are hereby gratefully acknowledged :—

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Vol. XLIV., No. 1.

Proceedings of the Royal Society of Queensland.

Presidential Address.

By D. A. Herbert, D.Sc., Department of Biology, University of Queensland.

(Delivered before the Royal Society of Queensland, 29th March, 1932).

The Royal Society of Queensland performs three functions in the life of the community. It endeavours to set a high standard of scientific research, it publishes the results of current investigations of scientific workers in the State and beyond it, and by exchange it is accumulating a valuable library of the publications of kindred societies in all parts of the world. Realizing that the Society has a wider duty as a unit in the great co-operative organization of modern science, the Council has steadily pursued its objective of having the Proceedings, embodying the work of Queensland investigators, available in all the main centres of research. The Proceedings have consequently increased in importance as a medium for publication of results of more than local importance. In common with other sections of the community, the Society has just passed through a difficult year. The Government grant, which in more prosperous years supplemented the members' subscriptions in supporting the work of publication and exchange of scientific periodicals, is no longer available. The Council has, however, been able by rigid economy to publish its forty-third volume of Proceedings, and to end the year with a small credit balance. The Library Committee, under the direction of Mr. Francis, has worked continuously at the reorganization of the Society's chief possession, its library, and the work is nearly complete. Mr. H. A. Longman is retiring from the editorship of the Proceedings and we tender him our best thanks for his years of painstaking work.

It is with sincere regret that I record the deaths of three of our colleagues.

By the death of Mr. C. W. Bundock, B.A., the Society has lost one of its oldest members. Mr. Bundock was a pastoralist in the Beaudesert district, and a member of one of the pioneering families of the Richmond River District. He graduated from the University of Sydney in 1878, and in 1912 was admitted *ad eundem gradum* to the degree of Bachelor of Arts in the University of Queensland.

Professor H. J. Priestley, M.A., who was educated at Mill Hill School and Jesus College, Cambridge, came to Queensland to the Chair of Mathematics in February, 1911, as one of the first four professors appointed to the teaching staff of the newly formed University. He identified himself with every phase of University life, and many Societies received his unobtrusive help. His connection with the Royal Society included a term as President, and many years as a committeeman and honorary auditor. By his death we, as a Society, lose one of our most valued members, and as individuals, a sincere personal friend.

Mr. R. A. Wearne, B.A., Principal of the Central Technical College, passed away in March, 1932. Mr. Wearne's interests covered a wide field, but were mainly in the subject of vocational training, and under his principalship the Central Technical College became the second largest institution of its kind in Australia. Mr. Wearne's work in geology led to the publication, in 1911, of a paper entitled "Notes on the Geology of West Moreton, Queensland," in the Proceedings of the Royal Society of New South Wales.

* * * * * * *

The Relationships of the Queensland Flora.

In dealing with the affinities of floras, it is usually the custom to compare the lists of native plants. Through a consideration of the types which are common or closely related, and their geographical distribution in the countries concerned, conclusions are reached as to the migration of antecedent floras whose mixing and sifting have culminated in the present plant populations. The statistical method of analysis was applied to the floras of Australia by Hooker[1] in 1860, and the development of Indian features in the north-west, Polynesian and Malayan in the north-east, New Zealand and South American in the south-east, and South African in the south-west, with New Zealand, Andean, Fuegian and European genera and species on the mountains was pointed out. An important point brought out by Hooker's analysis was that the families of Australia were almost all also found elsewhere, and though various families reach different degrees of development, many of the largest families here are the largest in the world as a whole. Statistical analysis has been given a much wider scope by Willis,[2] who, on a study of the distribution of endemic species in relation to that of wides, was led to formulate his "Age and Area" hypothesis. This he expresses as follows: "The area occupied (determined by the most outlying stations at any given time, in any given country, by any group of allied species, at least ten in number), depends chiefly, so long as conditions remain reasonably constant, upon the ages of the species of the group in that country, but may be enormously modified by the presence of barriers such as seas, rivers, mountains, changes of climate from one region to the next, or other ecological boundaries, and the like; also by the action of man, and by other causes." Applying this principle, Willis, by a consideration of the distribution of endemic and wide-spread species, has determined the relative age of groups in particular areas. In New Zealand, for example, the massing of endemics in particular regions leads him to the conclusion that there have been at least three distinct invasions. The northern group is considered as probably Indo-Malayan, the central perhaps Australian, and the southern perhaps a younger invasion of northern hemisphere types through the south. Since its first appearance, the hypothesis and its varied implications have been subjected to a continuous fire of criticism. Much of this has not been of particular value, concerning itself with special cases of small groups to which the hypothesis cannot be applied, but the provisos in the more recent statements represent patches where the critics have scored direct hits. If the modifications of the hypothesis could be allowed for with any degree of accuracy, we should have a very valuable criterion for the determination of the origins of our native flora. Unfortunately this is not always the case. Even in the case of New Zealand, on which Willis bases so much of his argument, ecological control must be taken into account.[3] New Zealand had its own ancient flora (two dicotyledons have been recorded as associated with Cladophlebis in the lower Cretaceous) which is now closely associated with sub-antarctic elements, and this combination is a temperate element; in addition, there is a long-established palaeotropical element with its own endemic genera and species. Past and present climates and earth movements have shaped these into the present plant population. The Age and Area hypothesis does not stand a fall by such tests, but they certainly indicate the caution with which it must be applied.

Any study of the relationships of a flora, as a whole, cannot be simply statistical. It must take into account the factors which modify the operation of the Age and Area principle, and, in Australia, the wiping out of types over tremendous areas by past climatic changes must never be lost sight of. Before we can examine the external relationships of a flora we must deal with its internal relationships—the opportunities for migration and establishment, the factors governing local distribution of its associations, and the past geological history which has so largely determined what raw material should be available for environmental factors to shape into the present flora.

In this paper, therefore, it is proposed to consider first the internal structure of the Queensland flora in relation to past and present conditions, and to follow from this to its relationships with the floras of other countries. Here we have a land area of 670,500 sq. miles of diversified physiography and climate, with abrupt climatic barriers and gradual climatic control; with highlands trending north and south and so permitting the northward extension of southern types, with isolated mountain floras, with land connections to the south and west, with recent land connections with New Guinea and the smaller continental islands fringing the coast, and with oceanic islands which, with no endemic flora of their own, are peopled with the waif plants of the region. We have, in short, great opportunities for the mixing of the available types and a great diversity of environments for their rearrangement.

The main associations of the Queensland flora have been described briefly by Domin,[4] but the best general account is by White,[5] in the Handbook for Queensland, written for the 1930 meeting of the Australasian Association for the Advancement of Science. In this publication the Forestry Board presents a good general account of the associations of forest trees. Francis[6] has given a valuable account of the rain forest trees (with the exception of those confined to the tropics), and a description of the rain forest on the Eungella Range,[7] with some remarks on its relation to the main northern and southern rain forests. Miss Gibbs[8] has described the vegetation of Bellenden Ker, and her description has added interest because her visit was made during the wet season. Various lists of plants from particular areas, *e.g.*, that of Shirley for the MacPherson Range, lose much of their ecological value because the plants are listed without notes as to their association.

The associations may be classified as follows:—

1. Rain forests.
2. Mangrove forests.
3. Open forests, ranging from the wet sclerophyll forests occurring along the coast to the attenuate savannahs of the arid interior.
4. The Grasslands of the rolling downs.
5. Strand vegetation—other than mangroves.

Rain Forests.

The most luxuriant type of forest in Queensland is the rain forest which reaches its best development in areas with more than 50 inches of rainfall per annum. It is restricted to the coastal plains and highlands where it forms a discontinuous belt. It has been described by Francis, White, Domin, and others.

The individual members of the rain forest vary greatly in their physiology; and moisture, light, and heat requirements are by no means uniform. The rain forest trees of the upper story for the most part have leathery leaves. McLean[9] and others have shown that there is a considerable variation in humidity in the upper levels of the forest, and Shreve,[10] working in Jamaica, has found that the transpiration of the rain forest trees is comparable with that of the most hygrophilous desert plânts. Beneath the canopies of the upper stories the variation in humidity during the day becomes less and less marked, and such plants as the filmy ferns occupy positions where conditions approach uniformity. Here, too, on the floor of the rain forest, the light intensity may be only 1/140 of that in open sunlight, and shade-loving species unable to thrive outside cover the feebly illuminated ground and trunks. Survival of young tree species is made possible by the possession of a suppression period. According to Brown's curves[11] for the rate of growth of *Parashorea malaanonan*, for example, it would require 71 years for an average tree of this species to reach a diameter of 5 cm. in the forest, though growth is more rapid when it has reached the canopy. A suppression period is an important factor in the struggle for existence in the crowded rain forest, and sun-loving types, such as *Eucalyptus*, have no chance of becoming established there.

In the matter of temperature, the fluctuations in the canopy are greater than those at the base of the trees. The average maximum temperature is some degrees higher in the tree tops than below, and the average minimum is slightly lower. The shade plants of rain forests are, therefore, under more uniform conditions of humidity, light and heat than the trees under which they grow. In the typical rain forest practically all the available space is covered with luxuriant epiphytic and terrestrial vegetation. Where conditions become less favourable, as in regions of decreased rainfall, the more xerophytic types—the trees—are best equipped for survival, and may form an association in which the hygrophytic types have disappeared, though the more xerophytic epiphytes, such as *Platycerium* and species of *Dendrobium* are often present. Such associations are common along the coast of Queensland, and along rivers. Were it not for the fact that they show all shades of gradation to the most luxurant types of forest, they would have no claim to consideration with rain forest, being often definitely sclerophyllous, with many of their members (*Tristania conferta*, etc.) passing out into the open Eucalyptus forest.

The effect of temperature on rain forest is apparent when a comparison is made of these forests along the coast of eastern Australia. The rain forests of the MacPherson Range and the Richmond River are almost as luxuriant as those of the Cairns region, but though many genera are common to the two regions, temperature is a limiting factor which limits the range of many species, both in a northerly and a southerly direction. Francis gives a short account of the mingling of types in the Eungella Range. It must be borne in mind that there is no hard and fast frontier between the two, though the transition becomes sharper north of Maryborough. In southern Queensland and the Northern Rivers of New South Wales many characters of tropical rain forest persist—plank buttresses, density of vegetation, exclusion of eucalypts, and predominance of the characteristic appearance of the northern forests. To the south these characters become less pronounced, and the Queensland type of rain forest has its southern outpost in eastern Victoria where trees such as *Tristania* *conferta*, *Eugenia Smithii*, *Eucryphia Moorei*, *Acronychia laevis*, *Elaeocarpus holopetalus*, *E. reticulatus*, *Livistona australis*, and such climbers as *Vitis hypoglauca*, *Smilax australis*, *Rhipogonum album*, *Eustrephus latifolius*, *Geitonoplesium cymosum*, *Marsdenia flavescens*, and *M. rostrata*, and other species (including *Dendrobium speciosum*) occur. These, for the most part, are not necessarily heavy rainfall plants in Queensland (where they often invade open formation), nor are they in Victoria, as they do not occur in the typical Victorian rain forest. There they are restricted to a small area in the east where temperature conditions, influenced by a warm ocean current, allow their survival. A few species of typical open forest plants of a northern type, such as *Angophora intermedia*, also extend to East Gippsland.

In North Queensland, in the regions of high rainfall, rain forest grows on practically all types of soil, and covers all slopes. High temperatures and high rainfall are essentially the optimum conditions for its growth, as here it approaches most nearly to independence of soil conditions. As the tropics are left, however, and temperature conditions become less favourable, there is an increasing tendency for it to be restricted to sheltered gullies, southern slopes, and special types of soil (in south Queensland and northern New South Wales mainly those derived from basalt). In southern New South Wales shelter becomes increasingly important, as in the Blue Mountains and the Illawarra Range, and the sifting effect of temperature is shown in the decreasing number of northern types.

Mangrove Forests.

Mangrove forests live under peculiar soil and atmospheric conditions. At high tide the salt content of the upper layers of the soil is somewhat higher than that of sea water, but at low tide it gradually increases, and when evaporation is very rapid it may even reach 12%. This, in itself, is a fluctuation not experienced by other associations, but the mangroves have, in addition, marked and rapid changes in saturation deficit, strong insolation and frequently strong winds. F. C. von Faber's[12] researches have demonstrated that the success of the mangroves depends mainly on their powers of obtaining water at high tides through the development of high osmotic pressure and devices for its regulation. Some mangroves such as *Bruguiera*, *Sonneratia*, *Lumnitzera*, and *Xylocarpus* can adapt themselves to life in soil with relatively low salt content, but all of the others are more or less obligate salt plants.

Were the changes in the salt content of the soil the only unfavourable factors in mangrove habitats, we should have more species colonizing the tidal flats. As it is the first colonists are usually such types as *Avicennia* and *Rhizophora*, but when the forest is well established there appear a number of types which possess the faculty of regulating osmotic pressure (*Barringtonia*, *Clerodendron inerme*, etc.). These are the hangers-on of the mangrove forests. Where atmospheric conditions are most favourable, the mangrove forest reaches its greatest luxuriance, and, generally speaking, such conditions are found near rain forests. In North Queensland and in North Australia the genera *Rhizophora*, *Bruguiera*, *Ceriops*, *Sonneratia*, *Aegiceras*, *Avicennia*, *Excaecaria*, *Lumnitzera*, *Xylocarpus*, *Aegialitis*, *Acanthus*, and *Acrostichum* are true mangroves. In North Queensland *Nipa* is also found. These genera are found through Malaya under similar climatic conditions. Where conditions become more arid, the mangrove forest has increasing difficulty in obtaining its water supply, and the outpost in arid coasts is *Avicennia officinalis*, which, with its enormous osmotic pressure, is best equipped for survival. As the tropics are left and lower temperatures are added to the unfavourable conditions to be contended with, mangrove after mangrove drops out of the association. In southern Queensland *Rhizophora*, *Bruguiera*, *Excaecaria*, *Aegiceras* and *Avicennia* occupy the available territory, but when Victoria is reached, *Avicennia* is the last outpost. Though *Avicennia* extends to Chatham Island (lat. 44 deg. S.) which is in approximately the latitude of Hobart, it is not found in Tasmania.

In the mangrove we find aridity in the tropics is evidenced by the falling off in numbers as we go west along the tropical coast from North Australia, and low temperatures as we leave the tropics acting as limiting factors in the present distribution. This is in spite of the fact that the opportunity for immigration of the species is there, and is an instance of the importance of present conditions, in this case climatic, in sifting the available material.

Open Forests.

Between the luxuriant rain forest of parts of the Queensland coast and the bare gibber plains of the interior is a long transition of sclerophyllous formations. As has been pointed out, the rain forest itself shows transitions to a more sclerophyllous type, the sclerophyllous trees commonly surviving apart from their more hygrophilous associates in localities with an annual rainfall down to 35 inches. As a rule, however, there is a sharp transition between rain forest and sclerophyllous eucalyptus forest both in floristics and physiognomy. The relationship between the members of the wet sclerophyll forest (say the blackbutt forests of the Nerang district) and the dry "wallum" vegetation is closer than that between blackbutt forest and rain forest, though the latter types may be in contact with one another.

The wet sclerophyll forests are found in Queensland, mainly in the Nerang, Blackall Range, and Fraser Island districts, but smaller areas are found associated with many of the South Queensland rain forests. Commonly in the etocone, between the two types, such rain forest trees as *Melia azederach*, *Elaeocarpus cyaneus*, *Diploglottis Cunninghamii*, and herbaceous types such as *Alpinia coerulea* and *Alocasia macrorrhiza* wander out and become mixed with the open forest types. On the other hand, the open forest types have little chance of colonizing the rain forest ; it is a closed formation where competition is already terrific, and the light-demanding open forest plants are not equipped to compete in the gloom.

Evaporation and monthly distribution of the rainfall are important factors in the distribution of open forest. Thus, in areas with an annual rainfall of over 40 inches, North Australia has a drier type of vegetation than corresponding areas along the east coast where the precipitation is better distributed. Other things being equal, regions with summer rainfall are drier than those with winter rainfall, because of evaporation, and we find along the Queensland coast a much poorer development of wet sclerophyll forest than in New South Wales. A general idea may be obtained from the recently issued map compiled for the Council for Scientific and Industrial Research by Prescott.

The major types of open forest in Queensland, starting from those which border the rain forest, are (*a*) wet sclerophyll forest ; (*b*) sclerophyll forest or savannah (including the depauperate "wallum"), generally dominated by *Eucalyptus* ; (*c*) inland savannahs which dot the rolling Mitchell and Flinders grass downs as more or less pure stands of *Acacia*, such as brigalow (*A. harpophylla*), lancewood (*A. Shirleyi*), boree (*A. homalophylla*), mulga (*A. aneura*) with which may be associated other trees, such as Wilga (*Geijera parviflora*), Whitewood (*Atalaya hemiglauca*), etc., and, in the case of the brigalow scrubs, the beelah (*Casuarina lepidophloia*) ; (*d*) the steppe savannahs usually grouped as mulga, dominated by Acacias, such as *A. aneura*, and poor in eucalypts ; (*e*) the attenuate steppe savannah of the porcupine grass (*Triodia*) country where the Acacias cease to dominate, and such trees as *Duboisia Hopwoodii* and stunted eucalypts occur ; (*f*) the fringing river savannahs of the interior, where eucalypts, such as Coolabah (*E. microtheca*) and the pan-Australian *E. rostrata* (a red gum) assert themselves locally.

Details of the factors influencing distribution of types in the arid parts of the State remain to be worked out. Soil is all important in the distribution of the inland scrubs, the savannahs of the downs ; gidgee (*Acacia Cambagei* and *A. Oswaldi*) prefers black soils, and mulga (*A. aneura*) is generally on red soils. These inland scrubs are related to the mulga steppe savannah, and though their development is restricted by edaphic factors, they show a transition between it and the sclerophyll eucalyptus forest nearer the coast. The fringing forests of the rivers and dry water-courses of these regions give another indication that water supply is a limiting factor in the distribution of eucalypts. Over 70 eucalypts occur in the Northern Rivers district of New South Wales and in South Queensland, but in the arid country to the west of this strip, there are only about 20, and most of these are restricted in habitat. Such a control over the dominant genus of the coastal open forests naturally exaggerates their floristic zonation from the coast to the interior, though the ecological graduation is comparatively smooth.

Grassland.

Extensive grassland occurs in Western Queensland in a more or less continuous belt from the Gulf to the New South Wales border on the rolling downs, and extends in that State to the Liverpool Plains, *i.e.*, practically the whole length of the region, with rain falling mainly in summer.

The grasses of this region include the Mitchell Grasses (*Astrebla spp.*), the Flinders Grasses (*Iseilema spp.*), Kangaroo Grass (*Themeda australis*), and others. The summer rains also bring up an ephemeral crop of annuals—composites, legumes, etc.—and floristically the whole vegetation is Australian in type. Over large areas it is mixed with savannah woodland. The factors responsible for the absence of trees in Queensland grasslands remain to be investigated, but attention may be drawn to Ramann's work on the Russian steppes.[13] The month of greatest rainfall is June, with 5-7 cm. The relative humidity through the summer is 60-70 per cent. The evaporation is very strong, and, at the end of summer, dry winds sweep over the steppes. The herbaceous vegetation draws its water supply from the superficial layers of the soil, and dries up when this is not available. Lack of water in the deeper layers prevents the growth of trees. In America, Weaver has found that some prairie plants, though not all, are specially adapted in root structure to what water is available; and this would appear to be the case with many of our grasses. Whether we can agree with Lundegardh[14] that absence of trees is due simply to a lack of water in the deeper layers of the soil is debatable on account of the reciprocal effect of trees on the water table, and the whole matter in Queensland is one which needs the earnest attention of the soil technologist and the botanist working in fullest callaboration.

Littoral Vegetation.

Above high-tide mark the vegetation is definitely zoned as it is elsewhere where water content changes along a definite front. On sandy beaches in North Queensland the trailing sand binders, such as *Ipomoea pes-caprae* fringe the bare strip of sand, and *Vitex trifolia* is not far behind. The vegetation of the strand is a curious assemblage of the waif plants of the coast mixed, more particularly behind the dunes, with plants which are commonly found in other associations. Where the hills slope down sharply to the water's edge the zonation is not so apparent, and the narrow strip of strand vegetation may almost disappear.

Opportunity for colonization coupled with peculiar environmental conditions, determine the nature of this type of association. Sea-borne seeds do not always become established; *Eucalyptus* is not found in South America, though its fruits have been picked up on the Chilean coast; nor do those of *Parinarium laurinum* on the Queensland coast, where they are often cast up. Many species, however, are successful, as for example, *Entada scandens*, and even pads of *Opuntia inermis* which are washed up on islands in Moreton Bay after being carried out to sea from the Brisbane River. The spread of littoral species inland is usually limited by ecological conditions, but on sandy coastal plains they may extend for great distances from the coast. Some, such as *Entada scandens*, *Hibbertia volubilis*, and *Stephania hernandiaefolia* are found inland in rain forests. *Entada scandens*, with its wide distribution in America, Africa, Asia and Australia, has apparently spread originally from the strand as an invader, but *Hibbertia volubilis* and *Stephania hernandiaefolia*, in view of their floristic relationships, have probably spread to the coast from inland. *Acacia longifolia* var. *Sophorae* and *Scaevola Koenigii* are Australian in their relations, the former restricted because its seeds sink in salt water and cannot be transported, the latter distributed through the Pacific by ocean currents.

Oceanic islands, on which overland colonization of the strand by types wandering from inland formations is impossible, are peopled by the waif plants of the area. A typical flora is that of Masthead Island as described by Longman,[15] and his list may be taken as a typical one of plants which surmount the sea barrier, by virtue of their adaptation to water, wind, or bird carriage. The restricted nature of many of the oceanic island floras is, however, also partly due to failure of establishment of species because of the limited environmental range. They show their own characteristic zonation within their range of edaphic variation, and where this variation is great, as on Krakatau, the colonizing species are correspondingly more numerous.

Land connection with inland formations may certainly modify the strand flora to a considerable extent, but the sharp exclusion of the majority of inland types from its composition is another instance of the tremendous effect of ecological conditions in controlling the composition of the flora.

THE RELATIONSHIPS OF THE FLORA.

The Fossil Record.

On October 26th, 1931, Dr. F. W. Whitehouse[16] exhibited before this Society impressions in Middle Jurassic rocks of flowers and fruiting bodies associated with leaves of *Sagenopteris*, and similar in external appearance to those described by Thomas[17] from the Lias of the Yorkshire coast and from Greenland; and also *Fraxinopsis*, which occurs in Queensland, associated with *Yabeiella* in both Upper and Lower Triassic beds, and which is figured by Wieland[18] from the Rhaetic strata of the Minas de Petroleo, south-west of Mendoza, in Argentina. Such records indicate the ancient nature of angiosperm inhabitation of the continent.

A general account of the Cainozoic flora of Australia is given by Chapman,[19] and, as this is readily available, a few remarks only need be offered. The evidence rests practically entirely on the leaf impressions, and in view of criticisms levelled at the work of von Ettingshausen, and of Unger, there is a tendency to avoid reference of fossil leaf types to extra-Australian genera. *Quercus*, for example, is found in New Guinea at the present day, but Ettingsahausen's assignment of a type from Darra to this genus is questioned, though his identification of *Banksia*, *Cinnamomum*, *Diemenia* and *Eucalyptus* is accepted. The same caution is not observed in the acceptance of the idea that the bloodwoods are an archaic type and that other types are necessarily more modern; and we find Chapman concluding from a mixture of such types in beds underlying the older basalt in Victoria that the age can hardly be Eocene, but may be Miocene.

The fossil evidence does, however, indicate several important points. The eucalypts and various types now characteristic of both open forest and rain forest were well developed in the early Tertiary. Though the rain forest types are not necessarily tropical, they do indicate warmer conditions than obtain in those localities at the present day. Strong evidence of past warmer conditions is afforded by the extinction of plants, with the bloodwood type of leaf, from

Tasmania and southern Victoria. The present distribution of these types is controlled strictly by climate, as has been shown in a previous paper, and the southern range represents a re-invasion after the last glacial period.

We must commence an enquiry of the relationships of the present flora, therefore, by recognizing that the continent has been inhabited by a diversity of both rain and open forest types since, at least, the early Tertiary, and that their geographical range has, in the past, been profoundly modified by climatic and geological change. In other words, the sifting effect of environment has been operating for a long time, and the mixing of types of various origins, and the elimination of others, has culminated in our present flora.

The Association as an Indication of the Affinity of the Flora.

The frequency of any species usually falls off rapidly as the optimum habitat is left behind, and the boundaries of adjacent associations are often remarkably sharp. Rain forest often rises up like a dark wall at the edge of the open Eucalyptus forest. In the interior of the State the association of stunted shrubs and porcupine grass is strikingly different from the adjacent mulga on the red soils. The association consists of species which are suited to a particular habitat, and, in a general ecological survey, the association and not the species, becomes the unit. As the factors which influence the habitat (rainfall, evaporation, temperature, wind, soil, physiography and biota) are so complex, the sifting effect of environment modifies migrating associations considerably. Some members may drop out entirely, others may wander beyond the association and become established in other communities. When large distances are involved the gradual dropping out of species and their replacement by others may, in due course, produce an association of quite different composition. As an instance of the change of an association by the dropping out of species and their replacement by others, we may take *Eucalyptus alba*, which, in North Queensland, is associated with *E. tessellaris*, *E. terminalis* and *E. tereticornis*; in the Kimberleys (W.A.) it occurs with *E. Spenceriana* and *E. miniata*; and in Papua with *E. papuana*, *E. tereticornis* and *E. clavigera*. Francis, in his paper on the Eungella Range, gives examples of rain forest trees of southern distribution which are replaced to the north by megathermic species; here northern and southern types are mingled, and to the north and south the sifting effect of climate is seen at work. The wandering of species from one association to another is exemplified by such rain forest species as *Flindersia australis*, which, not uncommonly round Brisbane, is found in the open forests, and *Alphitonia excelsa*, which is particularly common in both types of forest; many orchids, such as *Dendrobium speciosum*, and ferns such as *Asplenium nidus*, which are epiphytic in the rain forest, find suitable conditions on rocks in the open forest. Even species of very restricted habitat may wander occasionally; and, in the MacPherson Range, isolated beech trees (*Nothofagus Moorei*) may be found scattered through the rain forest.

The association is, therefore, a community of species banded together in a suitable environment, and its different members may differ widely in their tolerance, and in ability to compete successfully in other associations. Some of its members thrive only in a very restricted set of conditions, as is the case with the hygrophytes of the rain forest floor. To the Hymenophyllaceae the shelter of the other plants is all important, as here the favourable conditions of humidity and temperature prevail. When the trees are cleared, *Alocasia macrorrhiza* and other plants of the forest floor often suffer from frost in South Queensland. To such species, membership of a particular association is more or less obligate, but shelter is their principal requirement from the other members of the association.

The idea of the wandering of associations rather than of individual species has been particularly useful in the study of distribution, but the type of association needs careful consideration. The obligate association of host and restricted parasite has provided a valuable method for the working out of dispersal lines, though most of the work up to the present has been in the field of zoogeography, where its significance has been ably worked out by von Ihering, Harrison, Metcalf, and others. Association of host and parasite in widely separated areas affords a valuable criterion of common origin, and this will be referred to particularly when antarctic relationships are considered later in this paper.

A number of factors are instrumental in breaking up this intimate association, as is shown by a few cases which indicate why the data for von Ihering's method are not always available for settling problems in plant distribution.

Artificial breaking up of host-parasite associations is shown in the introduction of wattles to South Africa, and of prickly pear to Australia. In the case of the rusts, Arthur[20] has pointed out that dryness of the air may influence viability of spores, even killing them before an opportunity for growth arises, and that mountain chains are barriers in that they interrupt the continuity of both the host and favourable meteorological conditions for plant disease. Soil moisture is also important to such types as *Tilletia.* Temperature is often important in determining the success or otherwise of fungal attack. The optimum temperature for infection of wheat, by the bunt fungus *Tilletia tritici*, is between 16 deg. and 20 deg. C.; whereas the optimum for its host, wheat, is 25 deg. C. When wheat germinates at high temperatures, therefore, the fungus is at a disadvantage, and to this is attributed the freedom from smut of wheat grown in South Russia, India, and elsewhere. Another fungus attacking wheat. though not restricted to it, is *Helminthosporium sativum*, the optimum infection temperature of which lies between 28 deg. and 32deg. C., which is considerably higher than the optimum for its host. Here then are two factors—moisture and temperature—which may break up the host-fungal parasite association. An obligate parasite cannot usually, however, wander to another association, as may an autotrophic plant, and so pays the penalty of its extreme specialization, and disappears. Survival of such an association indicates, in separated localities, a common origin, and also that environmental conditions are suitable for both, and that those conditions have persisted during its history.

Palaeotropical Affinities.

The tropical rain forest of North Queensland is essentially Malaysian in physiognomy and floristics, but the Malaysian flora is by no means uniform. Wallace's Line, as revised by Merrill,[21] runs north between Bali and Lombok, Borneo and Celebes, Palawan and the rest of the Philippine group, turning east between Luzon and Formosa. It constitutes an important biological boundary to the western Malaysian flora and fauna, and follows approximately the eastern margin of the Asiatic continental shelf. Another important boundary, Weber's Line, approximately follows the Australian continental shelf, running between Australia and Timor, passing between New Guinea and Ceram, and to the west of Halmaheira. It constitutes the western boundary of the eastern Malaysian type of flora and fauna. In between the two boundaries we have an unstable insular area in which the two types meet, and in which intermittent isthmuses have permitted an exchange and migration of types from time to time. This archipelagic region has acted as a barrier against free interchange between east and west, and the flora and fauna of the two masses have developed along their own lines. Merrill finds that 356 western Malaysian genera of flowering plants do not reach eastern Malaysia, while about 225 genera of eastern Malaysian genera are not found west of Wallace's Line. Many of these, however, have been recorded from the intermediate region, 218 and 56 respectively being found in the Philippines. Merrill stresses the point that neither Wallace's Line nor Weber's Line constitutes a true biogeographic boundary, but that the two approximately define the limits of the two centres of origin and distribution, Sunda Land on the west, and New Guinea in the east.

Miss Gibbs,[22] working on the flora of the Arfak Mountains in Dutch N.W. New Guinea, had previously stressed the point of New Guinea's being a centre of distribution for many so-called Polynesian, Australian, and to a lesser extent, Malayan types, remarking that the Papuan species are not only older in type, but also with extraordinarily pronounced specific differentiation. Endemic mountain types, for example, are widely spread in New Guinea. The general relationships of the Papuan pteridophytes and bryophytes are Polynesian rather than Malayan, though endemic Papuan in type. Skottsberg makes similar claims for the ancient types of the Pacific floras, and strongly combats some of Guppy's deductions as to Indo-Malayan post-glacial immigration.

All the high Polynesian Islands contain a high percentage of endemics, but scattered through them are many types of Malayan affinity. Skottsberg,[23] who knows the Pacific floras well from first-hand experience, regards them as the present remains of an old flora with many eu-Pacific types, but with a fair number of types with Australian, Malayan and American affinities. He regards the Pacific floras as having a number of centres of concentration at the present time—New Caledonia and Fiji in continental western Pacific, and Hawaii in the central Pacific, Juan Fernandez and the Desventuradas in the south being examples. Though from a geological point of view the Hawaiian Islands are young, the characteristic plants of this region can only be satisfactorily accounted for by an assumption of more intimate association with other land masses than exists at present, and the evidence compiled by Campbell[24] shows the pronounced relationships with both New Zealand and Australia. As Merrill has pointed out, the Pacific, from a botanical point of view, is not a unit (except in the extreme north), the vegetation of the east and west sides differing radically because of past geological history and present climatic conditions. There is, however, running through it, that thread of ancient types which, though mixed with plants of Indo-Malayan and southern affinities, marks it as something more than a collection of waifs and strays from the present continental masses. It seems reasonable to regard the palaeotropic element in Polynesia as an ancient one, the present day representative of an old wide-spread flora, never more homogeneous than it would be allowed to be by prevailing climates and geological conditions. Sifting by changing geological and climatic factors has given rise to those differences which are to-day apparent in the floristics of the western Malaysian, eastern Malaysian, Australian, Polynesian, and New Zealand palaeotropic communities. A simple example of the operation of this principle is seen in the distribution of the genus *Mida* (Santalaceae). Formerly found in Juan Fernandez and New Zealand, it has become extinct in the former, and has become a New Zealand endemic.

The Australian branch of the palaeotropic element is easily recognised as distinct from the typical Australian element. The area it covers is restricted primarily by climatic factors, as has been pointed out, though it has a wide range in Australia. Formerly it covered a much greater area, as the fossil record from New South Wales and Victoria indicates, and its present area represents a considerable contraction of its territory. Increasing dryness must have been a more important factor than temperature changes, in view of the present latitudinal range, and also the relative poverty of types in North Australia and the North-West. In Western Australia where the rainfall conditions are extremely unfavourable, especially in the sub-tropical region, only vague indications of the Malaysian element are to be found beyond the tropics, in the presence of such genera as *Albizzia*, *Owenia*, and *Vitis*, which extend beyond the rain forest.

Types found in Papua, but which have not reached Australia, are the important timber family Dipterocarpaceae, the Begoniaceae, the genus *Quercus*. Some northern types, such as *Rhododendron* and *Agapetes* extend to the Bellenden Ker range. In Queensland the development of large numbers of endemic genera not recorded from extra Australian localities—(*Pentaceras*, *Akania*, *Bosistoa*, *Pleiococca*, *Medicosma*, *Pagetia*, *Wilkiea*, *Daphnandra*, *Schizomeria*, *Ceratopetalum*, *Castanospermum*, etc), of genera extending to New Zealand—*Pennantia*, *Quintinia*, *Notelaea*, etc.), indicates the ancient character of this element in Australia. Eastern Malaysia and Western Malaysia differ considerably from one another, but North Queensland shows a further differentiation from New Guinea, North Australia from North Queensland, and South Queensland from North Queensland. The differences are sufficiently accounted for by the long continued sorting of types by climate without reference to the relative ages of the palaeotropic element in the different areas under consideration, just as the sorting of the mangroves has taken place.

The mangroves are another aspect of the distribution of palaeotropic types. They belong to a wide range of families of tropical distribution. In some cases, as in *Excaecaria*, other members of the genus are found in the rain forest. *E. Dallachyana* and *E. parvifolia* are Queensland rain forest trees ; *E. agallocha* is a mangrove. The family Rhizophoraceae contains a large number of mangroves (*Rhizophora*, *Bruguiera*, etc.), but *Carallia* and *Gymnotroches* have about a dozen rain forest species. Other examples might be cited. Anatomical and physiological examination shows that mangroves differ in degree only fron many rain forest trees in their peculiar structures, and they must be regarded as an ancient adaptation of tropical types to a peculiar environment. In view of this, the rapidity with which they colonize suitable areas, and the way they exhibit the same type of distribution as the rain forest trees along the coast, indicates that the Australian palaeotropic element is restricted in range by climate and not by age.

The Antarctic Affinities.

The present flora of Antarctica consists of a grass, *Deschampsia antarctica*, which, with a few cryptograms, represents the remnants of a much more luxuriant flora. The Tertiary flora contained dicotyledonous types which have been referred to *Knightia*, *Drimys*, *Laurelia*, and *Nothofagus* ; and amongst the conifers *Araucaria* and a type allied to *Sequoia*. These are living genera, *Knightia* being found in New Zealand and New Caledonia ; *Drimys* in South America and New Zealand, through Australia to the mountains of Borneo ; *Laurelia* in New Zealand and Chili, and *Nothofagus* in South America, New Zealand and Australia as far north as the MacPherson Range. *Araucaria* has a southern hemisphere circum-Pacific distribution, ascending the mountains in New Guinea. The distribution of the present day representatives of this flora is sub-antarctic, and in Australia is naturally best developed in Tasmania and some of the mountain tops of Victoria. In Queensland it reaches its best development in the beech forests of the MacPherson Range, which, at an altitude of over 3,000 feet, occupy the ridges, and are flanked by rain forest of the palaeotropical type. In the southern States, particularly in the Tasmanian mountains, the antarctic element is much more widespread and is represented by more types. In Tasmania *Nothofagus*, *Drimys*, *Ourisia*, *Prionotes*, *Nertera*, *Oxalis magellanica*, *Acaena*, *Donatia*, *Azorella*, *Gaultheria*, *Pernettya*, *Embothrium*, *Lomatia*, *Drapetes*, *Dacrydium*, *Fitzroya*, *Gaimardia*, *Astelia*, *Oreobolus*, and *Uncinia*, are amongst the plants characteristic of the present South American flora, though some of them, such as *Lomatia*, are probably not originally American, and would indicate that this collection of sub-antarctic plants is just such a mixture as is the palaeotropical element. In Tasmania and in New Zealand the antarctic element is interwoven with the Australian and the Palaeozealandic elements respectively. In Victoria, as in Tasmania, we find *Nothofagus Cunninghamii* growing side by side with *Eucalyptus* and *Acacia*. *Nothofagus* re-appears after a gap in its distribution in Central New South Wales, and from there *Nothofagus Moorei* extends to Queensland. In the MacPherson Range it occurs with such non-antarctic types as *Cuttsia* and *Quintinia*, and its most conspicuous epiphyte, the beech orchid which is, at present, referred to *Dendrobium falcirostris*, is a palaeotropic type. The sub-antarctic genus *Drimys* is conspicuously associated with the beech in Australia, *D. dipetala* being the MacPherson Range species, but when *Nothofagus* disappears from the antarctic element in Queensland, *Drimys dipetala* continues northwards to the Eungella Range. *D. oblonga* occurs at 5,000 feet on Bellenden Ker ; *D. cyclopum* at 8,000 feet on Mt. Obree, in Papua ; and in Borneo, *D. piperita* is re-recorded by Stapf[25] above 3,000 feet. Alpine types of antarctic affinity overlap with those of undoubted arctic affinity in the Malayan Islands. On Kina Balu, in Borneo, occur the genera *Pratia*, *Gaultheria*, *Drimys*, *Coprosma* and *Nertera* ; these genera and some of their species extend from Borneo right across the sub-antarctic region. With them, however, are such genera as *Leptospermum* and *Leucopogon*, which are mainly Australian and do not extend beyond New Zealand ; genera, such as *Potentilla*, which are mainly boreal, and cosmopolitan types, such as *Drosera*, *Utricularia*, *Eriocaulon* and *Scirpus*. Du Rietz[26] records the mixing of boreal and New Zealand types in the high volcanoes Ardjoeno and Welirang, in Java.

The antarctic element is, therefore, an ancient one, as is indicated by its wide dispersal, its fusion with other elements in associations in different countries, and the fossil record. It must be regarded as essentially a flora of the southern hemisphere adapted to alpine and cool lowland conditions (*i.e.*, to present sub-antarctic conditions), and to be no more homogeneous than the palaeotropical element. The present isolation of its main concentration centres, and the infiltration of types of other geographical history, makes the antarctic element less easy to define with any exactness. On Bellenden Ker (N.Q.), for example, we have the Epacridaceous genus *Dracophyllum*, represented by *D. Sayeri*. Its family is usually looked on as typically Australian, but its territories extend, on the one hand to Malaysia and India, on the other to Polynesia, New Zealand and South America. There is an endemic genus, *Lebetanthus* (section *Prionoteae*) in Fuegia and Patagonia, but the only other genus of the section is in Tasmania. In the case of *Dracophyllum*, the closely related genera *Sphenotoma* and *Richea* are West Australian and Tasmanian respectively, and the lateral relationship suggests a vertical one. We find, however, that *Dracophyllum* is at present mainly concentrated in New Zealand where is has 28 species, as against five in New Caledonia and 10 in Australia and Tasmania. It is an Australian type which has been successful in New Zealand, and may be looked on as a Western Pacific member of the Antarctic community, but can only be called an antarctic type if we admit locally adapted types along with such typical and widespread genera as *Nothofagus*, *Colobanthus*, *Drimys*, etc., which are the backbone of the antarctic element. Just where the dividing line should be drawn is difficult to determine.

Though up to a certain point the antarctic element may be looked on as the local adaptation of the floras of the countries to which it is indigenous, endemism being more pronounced where the favourable areas are greatest, there runs through it a floristic relationship which denotes a former connection of its now separate parts. Applying the von Ihering method and using, as criteria, such obligate parasitic types as rusts and *Cyttaria*, the evidence for former land connection between South America, New Zealand and Australia seems conclusive.

The members of the genus *Puccinia* are obligate parasites. In his first catalogue of those found in New Zealand, Cunningham[27] deals with 72 species, of which 45 are indigenous; of these 23 are endemic, 19 occur in Australia, 15 in Tasmania, and six extend to North America and Europe. Cunningham's subsequent papers add to the introductions and to the endemic species of the genus, and other genera of Uredinales show somewhat similar type of distribution. Most of the species which are common to New Zealand and Australia, or to other southern hemisphere localities, are on the same or closely allied species, though they do not, in all cases, cover the entire geographical range of the host plants. *Puccinia unciniarum*, for example, found in Chile and New Zealand, is not recorded from Australia, though its New Zealand host, *Uncinia compacta*, is present. Assuming that the fungus is absent from Australia, and not merely overlooked, we have here the breaking up of an association. *Puccinia hydrocotyles* similarly is unrecorded from Australia, though widely spread through Europe, the Americas and New Zealand; the host genus *Hydrocotyle* is, however, well represented here both in number of species and number of individuals. *Cyttaria* is a genus of Ascomycetes, practically co-extensive with the southern beeches *Nothofagus*, *i.e.*, South America to New Zealand and Australia. The two Australian species of the fungus are restricted to the moister localities, and are absent from beeches growing in dry aspects. *C. gunnii*, in Tasmania, attacks *Nothofagus Cunninghamii*, an inhabitant of moist gullies, and a shelter-loving species. *N. Cunninghamii*, which grows in drier positions, has no associated species of *Cyttaria*, though of course dryness may not be the only reason. In the MacPherson Range, South Queensland, the recently described *C. septentrionalis*[28] attacks the beech *Nothofagus Moorei*, but only in the dampest parts of the forest. Large areas of beech forest, on Roberts Plateau, are not infested at all.

While we are dealing with the evidence afforded by parasites on the former continuity of the antarctic element, attention should be drawn to a paper by Du Rietz (*loc. cit.*) on the lichen flora of New Zealand. Antarctic regions are at present practically destitute of vascular plants, consequently the antarctic connection is usually regarded as a hypothesis, but from the point of view of the lichenologist it is a fact. *Usnea antarctica*, for example, closes the chain from New Zealand to Ecuador. The beeches of South America and Australia have a characteristic lichen flora in common, and in many cases showing no northern relationship at all.

Du Reitz traces the migration route of lichen types with bipolar distribution such as *Cetraria islandica* through the American cordilleras, and disagrees with Oliver's view[29] of a northern invasion in two independent circumpacific migration streams. Oliver's concept has been criticised ably by Skottsberg, Harrison and others, and it need only be added that the distribution of such parasites as *Cyttaria* provides additional evidence of antarctic radiation of important types.

The Australian Element.

The typical Australian element in the present flora of the continent exhibits a marked zonation from the flora of the arid interior to the wet sclerophyll forests and very restricted rain forests found around the margin of the continent where the rainfall is suitable. The great arid belt with an annual rainfall of less than ten inches divides eastern from western Australia, and the sclerophyllous forest of the south-west has lost contact with that of the east. Wallace[30] regarded the south-west as the remains of the continent on which the characteristic Australian flora was originally developed. Tate[31] divided the Australian flora into three groups—the autochthonian or south-western, the euronotian or south-eastern and north-eastern, and the eremian or desert flora. Tate considered the last type to be derived from the autochthonian and euronotian, with some oriental infiltration in Pliocene times. He suggested that the western Australian type might be regarded as of greater antiquity, hence the name, in view of the absence of primitive old world types such as *Quercus*, *Fagus*, *Panax*, *Litsaea*, etc., its highly specialised Australian types, and its long continued isolation from the rest of Australia. Though Tate's divisions have been considerably modified by Hedley, Spencer and others, the concept of the greater antiquity of the south-western flora re-appears time and time again in the literature on the subject. Harrison[32] admits that for animals, the antochthonian element is not exactly defined, but seems willing to accept the hypothesis that a recognisable ancient floral element is confined to the south-west. It is certainly recognisable but is not confined to the south-west. It reappears in eastern Australia in similar environments, and even along the tropical northern coast, though there with a strong admixture of palaeotropical types. The great characteristic genera of the south-west, *Grevillea*, *Hakea*, *Banksia*, *Eucalyptus*, *Acacia*, *Oxylobium*, *Daviesia*, *Tetratheca*, *Hibbertia*, etc., reappear in the east, often with a great gap in their distribution, and often the species are identical (*e.g.*, *Ricinocarpus pinifolius*). The dominant tree genus of the Australian element, *Eucalyptus*, with over 300 species, is represented in the Eocene in eastern Australia, including Tasmania, and its present distribution is mainly eastern and south-eastern. There is considerable evidence presented in a former paper[33] to show that this genus has retreated from regions formerly well watered but now arid, and that the present species represent a development of survivors of a period of extensive dying out in the centre of the continent. In the last glacial period we have definite evidence of the extinction of the bloodwood type in the south and of the re-invasion when warmer conditions returned, though the whole of the lost territory has not been re-peopled. Both aridity and temperature have, in the past, directed the destiny of the eucalypts. Along the coast of extra-tropical eastern Australia there are approximately 160 species, and on the average their geographical range is much wider than that of the 130 odd species of south-western Australia, from Sharks Bay to Eucla.

Western Australia shows very markedly, and not only in the distribution of eucalypts, the powerful confining action of its arid frontiers. Its well developed endemism is paralleled by that of the Cape province in South Africa. Thistleton-Dyer pictured a retreat of the Cape types into a cul-de-sac from which there was no escape. Bews' anonymous friend was right in pointing out that plants do not behave like a flock of sheep, but the fact remains that in Australia there has been such a retreat to the margins, and western Australia is now so hemmed in that its endemics have little chance of spreading far. Many of its endemic types are probably relics. A couple of examples of types almost endemic are *Gastrolobium*, with a tropical species, out of contact with all the south-western species, spreading across the north to Queensland ; *Lambertia* with one species in New South Wales, and six in western Australia. The danger of trusting to arithmetic in these matters of distribution is shown by the cosmopolitan genus *Drosera*, a genus particularly dependent on edaphic conditions. Of the 90 species, 62 are Australian and 45 of these are in Western Australia. Drosera plants are so common in Western Australia that there is no doubt that the suitable environment has encouraged the development of the genus there to a greater degree than in countries where it may be just as old. The peculiarities of the Western Australian environment are further shown in the great poverty of ferns in the flora ; there are less than 20, and these include such hardy types as the pan-Australian *Cheilanthes*. Rain forest is absent, though the Karri forests of the far south-west are very luxuriant and comparable with the best type of wet sclerophyllous forests in the east.

The admixture of palaeotropic types in the south-west is limited, as it is in the east in similar latitudes. Recognisable antarctic types cannot be indicated, and here it may be pointed out that the environmental conditions under which they are found in the eastern States—high mountains and suitable rainfall—are absent. In short, the flora of south-western Australia may be regarded as the purest collection of aboriginal plants in the Commonwealth which is spread over wide areas, but the evidence indicates that this is due to its isolation and the peculiar environment which excludes those other elements which enrich the mixed eastern floras.

In Queensland, as in other eastern States, environment influences the amount of admixture with these other elements—the palaeotropical, the antarctic and the cosmopolitan. The south Queensland wet sclerophyllous forests often contain palaeotropical types which are normally members of the rain forest ; this applies particularly to such epiphytes as are present. The drier types, such as the various types of *Eucalyptus* forests on the hills round Brisbane are relatively purer, and in the associations of the coastal sandy plains the genera are almost all characteristically Australian. In other words, the local changes in a small district parallel the changes noticed in different States when the floras, as a whole, are examined. The florula of the sandy country at Sunnybank (Brisbane) has much in common with the florula of King's Park, in Perth, but little in common with that of the rain forest area of the MacPherson Range.

To the north the admixture of palaeotropical types in the open forest becomes more and more marked. Here the wet sclerophyll forest is very strongly infiltrated with them. *Albizzia*, *Macaranga*, *Pandanus*, *Tephrosia*, etc., become increasingly important as fellow members with the Australian element in the open forests. In the Gulf country, Mr. Bick informs me that *Nepenthes* is an open forest type. *Erythrophloeum Laboucherii*, the Ironwood, in the dry country around Camooweal extends across Northern Australia, and has congeners as far as Sierra Leone. These are open forest plants in palaeotropical countries, though in many cases not restricted to open forests. Their association with Australian types persists beyond Australia, and the savannahs at the mouth of the Fly River, in New Guinea, have a distinct Australian physiognomy. Climatic conditions in eastern Malaysia are not, on the whole, suitable for the persistence of open forest types, and the Australian element is consequently not strongly represented over wide areas. This state of affairs, however, is found in North Queensland, in parts of the Cairns region, where open forest plays a minor part. *Eucalyptus alba* extends as far west as Flores. *E. clavigera*, *E. papuana*, and *E. tereticornis* are in New Guinea. Species of *Andropogon, Patersonia, Thysanotus, Clianthus, Acacia* (*A. confusa*, a phyllodineous species), *Stackhousia, Pimelea, Casuarina, Tristania* and *Leptospermum* extend to various extents, into Malaysia and the Asiatic mainland, but, in addition to climatic controls, have been influenced in distribution by the geographical vicissitudes of the archipelagic areas between Wallace's and Weber's Lines.

In Victoria the Australian element preponderates in the wet sclerophyll forest and rain forest. To the north palaeotropic types become increasingly important, as has been pointed out, until in the northern rivers of New South Wales they dominate the rain forests almost, but not quite, to the exclusion of Australian types. *Buckinghamia, Cardwellia* and *Hicksbeachia* are among the genera of Australian affinity restricted to rain forest; *Geijera, Grevillea* and *Codonocarpus* have open forest and rain forest members. These are only a few examples, but the total number is not great, and the individual range is often not wide, even in Australia, and Australian rain forest types are consequently not plentiful in Malaysia. *Tristania* is certainly successful, and *Eucalyptus naudiniana*, which grows on rain forest fringes, has a scattered distribution from New Guinea to Mindanao. The presence of the palaeotropic element in Australia does not imply an equal admixture of Australian types in Malaysia for two reasons. Both of these ultimately depend on climate. First, the Australian types must compete with palaeotropic open forest types in the open forests, and these are limited in area; and second, they are, with few exceptions, unfitted for competition under rain forest conditions.

SUMMARISED CONCLUSIONS.

Any study of the relationships of the Queensland flora must commence by the recognition of two facts revealed by the fossil record, the existence of angiospermous types at least as early as the Triassic, and the existence of well differentiated modern types, undoubtedly referable to living genera, in the early Tertiary. The leaf impressions from Eastern Australia are of types found in both open and rain forest, and of types of sub-antarctic palaeotropic and autochthonian affinity, so that already in Eocene or Miocene times the flora was one of considerable complexity. The present distribution of these types indicates that geological and climatic changes have modified considerably their original geographical distribution. A detailed examination of the main associations shows that the Queensland plant populations of to-day are strictly controlled by climatic and geographical factors. In general, types whose affinities are with those at present dominant in Malaysia occupy the warmer parts of the continent where rainfall exceeds about 35 inches. Types of sub-antarctic affinity, common in Tasmania, are found in Queensland, in the higher mountains, often, but not necessarily, in characteristic associations. The ecological conditions are, or have been, widespread over sufficiently continuous land masses, and both elements may be regarded as the ancient occupants of their own type of habitat in palaeotropic and sub-antarctic countries respectively.

The palaeotropic element in Queensland is part of the original widespread palaeotropic flora which, differentiated by geological and climatic isolation, has developed along somewhat different lines in Western Malaysia, Eastern Malaysia, North Queensland, South Queensland, Polynesia, and other centres. Here, as elsewhere, it has been enriched by the incorporation of certain plants not characteristic of palaeotropic communities generally, *e.g.*, *Grevillea.*

The sub-antarctic element is also portion of the great sub-antarctic flora, but here the area with ecological conditions suitable for its development is relatively small. We find, however, as with the palaeotropic element, a floristic backbone of types widespread from South America to Australia, some of them apparently South American, others apparently Australian, and yet others apparently Zelandic, but now widespread. With them, however, are interwoven local types in all the countries concerned, as must be expected in a widespread flora where homogeneity is impossible.

The autochthonous element is more localised in its distribution than the palaeotropic or the sub-antarctic. It is for the most part a flora of open formations and is not well adapted to cold conditions ; nor does it reach its best development in the tropics even where open formations are the natural type of vegetation. Such types as *Dracophyllum* and *Lomatia* have been successful in sub-antarctic countries, and such types as *Stackhousia* and *Pimelea* occupy suitable territory in Malaysia, but for the great majority circumscription by unsuitable territory has resulted in isolation and consequent marked localised development. It is a quantitative and not a qualitative distinction which has led to the designation of this type as the Australian element.

REFERENCES.

(1) Hooker, J. D., Introductory Essay, Flora of Tasmania, 1860.

(2) Willis, J. C., Age and Area. Cambridge, 1922 (also various papers in Annals of Botany, particularly vols. xxxi-xxxvii).

(3) Cockayne, L., Vegetation of New Zealand *in* Die Veg. der Erde, xiv. 2nd edition, 1928.

(4) Domin, K., Queensland's Plant Associations. Proc. Roy. Soc. Q., xxiii., 57-74, 1911.

(5) White, C. T., Queensland Vegetation *in* Handbook of Queensland, A.A.A.S. Meeting, Brisbane, 1930.

(6) Francis, W. D., Australian Rain Forest Trees, Brisbane, 1929.

(7) Francis, W. D., The Rain Forest of the Eungella Range. Proc. Roy. Soc. Q., xxxix, 107-114, 1927.

(8) Gibbs, L. S., The Phytogeography of Bellenden-Ker, Jour. Bot., lv., 297-301, 1917.

(9) McLean, R., Studies in the Ecology of Tropical Rain Forest, Journal of Ecology, vii., 5-54, 1919.

(10) Shreve, F., A Montane Rain Forest, 1914.

(11) Brown, W. H., Vegetation of Philippine Mountains, Manila, 1919.

(12) von Faber, F. C., The Physiology of the Mangrove. Treub Laboratory, Buitenzorg.

(13) Ramann, E., Bodenkunde, 1911 (cited by Lundegardh).

(14) Lundegardh, H., Environment and Plant Development, 330 pp., London, 1931.

(15) Longman, H. A., The Plants of Masthead Island. Proc. Roy. Soc., Q., xxv., 17-23, 1913.

(16) Whitehouse, F. W., Lecture on Problems in Queensland Palaeobotany. Proc. Roy. Soc. Q., xliii., p xiv., 1931.

(17) Thomas, H. H., The Caytoniales, a new group of Angiospermous plants from the Jurassic rocks of Yorkshire. Phil. Trans. Roy. Soc., Ser. B., 299-363, 1925.

(18) Wieland, G. R., The Antiquity of Angiosperms. Proc. Internat. Cong. Pl., Sc., I., 429-456, 1926.

(19) Chapman, F., A Sketch of the Geological History of Australian Plants: the Cainozoic Flora, Vict. Nat., xxxvii., 115-119, 127-132, 8 plates, 1921.

(20) Arthur, J. C., The Plant Rusts, New York, 1929.

(21) Merrill, E. D., Distribution of the Dipterocarpaceae; Philippine Jour. Science, xxiii., 1-32, 1923.

(22) Gibbs, L. S., A contribution to the Phytogeography and Flora of the Arfak Mountains, 226 pp., London, 1917.

(23) Skottsberg, C., Remarks on the relative independency of Pacific flora. Proc. Third Panpacific Science Congress, I., 914-920, 1926.

(24) Campbell, D. H., The Australasian element in the Hawaiian flora. Proc. Third Panpacific Sci. Cong., I., 938-946, 1926.

(25) Stapf, O., On the flora of Mount Kinabalu in North Borneo. Trans. Linn. Soc., Lond. (2nd series, Bot.), IV., 69-263 (20 plates), 1894.

(26) Du Rietz, G. Einar, The discovery of an arctic element in the lichen flora of New Zealand and its plantgeographical consequences, Rept. A.A.A.S., xix., 628-635, Hobart, 1928.

(27) Cunningham, G. H., The Uredinales or Rust Fungi of New Zealand. T.N.Z.I., lv., 1-58, 392-396, 1924.

(28) Herbert, D. A., Cyttaria septentrionalis, a new Fungus attacking Nothofagus Moorei in Queensland and New South Wales. Proc. Roy. Soc. Q., xli., 158-161, 1930.

(29) Oliver, W. R. B., Biogeographical relations of the New Zealand region. Jour. Linn. Soc. (Bot.), lxvii. (313), 99-140, 1925.

(30) Wallace, A. R., Island Life, 3rd edition, 1911.

(31) Tate, R., On the influence of physiographic changes in the distribution of life in Australia. Rept. A.A.A.S., I., 312-335, 1887.

(32) Harrison, L., The composition and origins of the Australian fauna, with special reference to the Wegener hypothesis. Rept. A.A.A.S., xviii., 332-396, Perth, 1926 (1928).

(33) Herbert, D. A., The major factors in the present distribution of the genus Eucalyptus. Proc. Roy. Soc. Q., xl., 165-193, 1929.

The Production of Protein by Inorganic Material: Evidence Suggestive of the Generation of Life.

By W. D. Francis.

Plates I and II.

(*Read before the Royal Society of Queensland, 27th June*, 1932).

CONTENTS.

I.—INTRODUCTION.

In 1926 a paper[4] by the writer on the relationship of iron to the origin of life was published in these Proceedings. In the same year a German translation of this paper was published in *Botanisches Archiv* by Prof. Carl Mez of Konigsberg University.

The experimental work outlined in the present paper was undertaken to test the validity of the theories which were put forward in a suggestive spirit in the previous paper[4]. Before describing the experiments, some theoretical considerations bearing on the origin of life will be very briefly discussed.

In my previous paper[4] I maintained throughout the view that life may originate in the present as it did in the past. It is quite clear from the paper that I did not restrict the theories to happenings in the past.

Whatever individual scientists may think about life's origin there is no shadow of doubt that the earth at present is capable of supporting life on a grand scale. This is equally evident whether we contemplate the large human populations of the cool temperate regions as in the cities of Northern Europe, or the populations concentrated in the extensive and crowded cities in the torrid climate of tropical India. The dense rain forests of tropical regions, teeming with diverse species, are ample indications of the earth's potentialities for the maintenance of vegetable life in its highest and lowest forms. These considerations predispose one to believe that the world may yet be capable of generating life.

Natural phenomena are more often the outcome of law and order than of chaos and accident. Natural processes are much more frequently continuous than detached. So that the supposition that life arose at one period of time almost as a coincidence or accident may be quite readily regarded as much less feasible than the view that it is a continuous process functioning in the present as well as in the past.

In concluding this section of the paper attention is drawn to the remarks of Professor Schafer[11], in his Presidential Address to the British Association for the Advancement of Science at Dundee in 1912:

> The process of evolution is universal. . . . . . If living matter has been evolved from lifeless in the past, we are justified in accepting the conclusion that its evolution is possible in the present and in the future. Indeed, we are not only justified in accepting this conclusion, we are forced to accept it. When or where such change from non-living to living matter may first have occurred, when or where it may have continued, when or where it may still be occurring, are problems as difficult as they are interesting, but we have no right to assume that they are insoluble.

II.—PRELIMINARY OUTLINE OF THE EXPERIMENTS.

Throughout the experiments a solution of the same chemical composition was used. The solution has been employed by bacteriologists in cultivating bacteria, especially iron bacteria such as *Spirophyllum ferrugineum.* R. Lieske[5] gives the composition of it. According to Cholodney[1] Lieske used this solution with the addition of metallic iron in his successful culture work on *Spirophyllum.* I had also used it three years ago in an endeavour to cultivate *Leptothrix ochracea* in an inorganic medium. The solution is composed of :—

Ammonium sulphate	1.5	grams.
Potassium chloride	0.05	,,
Magnesium sulphate	0.05	,,
Potassium monohydrogen phosphate	0.05	,,
Calcium nitrate	0.01	,,
Distilled water	1	litre

It will be noticed that the solution contains all of the protein elements except carbon. Provision for the supply of this element is made by lowering into the solution metallic iron in such a way that part of the iron is exposed to the air and the other part immersed in the solution. The purpose of this arrangement is to allow of the absorption of the carbon dioxide of the air by the iron as it undergoes corrosion.

The experiments were carried out in two series. The first series was of a preliminary character. It will be referred to as series A. The second or series B is more extensive and critical.

In both series the solution was placed in glass containers and the orifices plugged with cotton wool to prevent infection from the air. The containers with the solution were sterilised by steaming for one half hour on three successive days. The iron was sterilised by heating to redness in the flame of a spirit lamp and then placed in position in the glass container, taking care that the upper part of the iron was exposed and the lower part immersed in the solution. The heating of the iron caused it to be coated with a bluish black film of oxides of iron. The iron was placed in position after sterilisation of the solution, and mostly while the solution was still hot or warm. The containers were then left at room temperatures for periods varying from 7 to 14 days, unless otherwise stated. When the time allotted had elapsed, the cotton wool plug was removed and the film or incrustation of ferruginous material on the iron at the surface of the solution was transferred to cover glasses and dried over a spirit lamp. This process is carried out with a platinum loop which is sterilised by heating to redness. These cover glass preparations are similar to the "dry film" preparations of bacteriologists. The cover glasses are then placed on a glass slide in distilled water and examined with the microscope. In this way protein bodies of microscopic size were found in the material adhering to the iron at the surface of the solution. The protein bodies occur in the finely divided ferruginous material which is composed largely of ferric hydrate. In all of the instances in which a careful examination was made, minute patches and granules of ferric hydrate were included in the protein bodies. Before drying, which forms part of the preparation of the cover glass samples, the ferruginous material is composed of a mixture of coarse and fine suspensions with the solution as the continuous phase. Many of the smaller particles approach in size the upper limits of the particles of typical colloidal solutions.

The protein bodies are almost colourless. They remain dark when examined under the crossed nicols of the polarising apparatus and are, therefore, not doubly refracting. They are mostly strongly contrasted with the brown and yellow colours of the ferric hydrate which constitutes most of the material of the cover glasses.

III.—EXPERIMENTS SERIES A.

In this series the solution was composed of reagents obtained from the Agricultural Chemist's Laboratory. Although obtained from there about three years ago most of them were taken from bottles containing Merck's guaranteed reagents. The distilled water used to dissolve the reagents was also obtained from the laboratory of the Agricultural Chemist. The experiments were carried out in ordinary 5 inch test tubes. They were plugged with cotton wool after the solution was placed in them. In each case a fine steel sewing needle was lowered by means of brass wire into the solution so that it was immersed for about one half its length in the solution. The protein bodies in this series gave positive reactions to the following microchemical tests: Million's reagent, Xanthoproteic reaction, Raspail's test, Iodine in potassium iodide. They were insoluable in absolute alcohol, nitric, sulphuric and hydrochloric acid, one part concentrated to one part of water. With 3·5 per cent. solution of caustic potash they swelled to almost twice their original size. Two protein bodies were measured before and after treatment with 3·5 per cent. caustic potash with the following results: before treatment the first measured 25.9 $\times$ 18.5 μ, and the second also measured 25.9 $\times$ 18.5 μ; after treatment the first measured 38.1 $\times$ 31.5 μ, and the second 51.8 $\times$ 33.3 μ. In describing the reactions of the protein bodies found in the experiments of Series B details of the microchemical reactions will be given.

Although the experiments of this series are somewhat homely, they probably resemble more closely conditions in nature than do those of Series B. The steel needle in composition may resemble native forms of iron more closely than the purer iron wires used in the experiments in Series B.

IV.—EXPERIMENTS SERIES B.

Although the chemical composition of the solution used in this series of experiments was similar to that of Series A, redistilled water was used and the reagents were weighed out from previously unopened bottles. E. Merck's pure chemicals were used exclusively. A special form of test tube was designed and manufactured. With the ordinary cylindrical test tubes plugged at the orifice with cotton wool there is a slight possibility of an inorganic solution contained in the tube becoming contaminated with organic matter from the cotton wool during sterilisation. Steam arising from the solution may be condensed on the glass in contact with the cotton wool, and drain back into the solution. To avoid this possibility test tubes bent downwards at an acute angle at the top were used instead of the straight test tubes. When these special tubes are plugged with cotton wool any steam coming into contact with the cotton wool and condensing there would not find its way back into the solution. E. Merck's iron wire was used in all of these experiments. The glassware coming into contact with the solution, such as the bent tubes, cover glasses and slides, after a preliminary rinsing with water, were cleaned with sulphuric acid and potassium bichromate, rinsed with water several times, rinsed with a dilute solution of caustic potash, rinsed several times with distilled water and then with redistilled water. After being cleansed in this manner the cover glasses and slides were placed in Petri dishes and allowed to dry before being used.

In the first experiment of this series to be described iron wire of 0.2mm. diameter was inserted into the solution after sterilisation of the solution and the wire, as already outlined in the experiments of Series A. The bent tube was then placed in a light-proof cardboard box, which was wrapped in a camera focussing cloth, and left for 14 days. The purpose of this experiment was to ascertain whether light affected the generation of the protein bodies. Approximately eleven cover glasses of the ferruginous material from the iron wire were prepared in the manner already described. The protein bodies were found in the material of all these cover glasses.

The results of microchemical tests, which were applied to the material adhering to these cover glasses, are given below :—

1. Xanthoproteic reaction. It was found that the best results were obtained with concentrated nitric acid when diluted with an equal volume of water as the evolution of gas bubbles which interfere with observation was much less in evidence.

2. Millon's reaction. With Millon's reagent a rose red to pink colour is given. The reaction is accelerated by gradual warming.

3 Raspail's reaction. A concentrated solution of cane sugar with the addition of concentrated sulphuric acid gives a violet colour.

4. Biuret reaction. The reaction, as modified by Low and Bokorny, was used. The cover-glass preparation was placed in a 0.2 per cent solution of caustic potash for half an hour, washed, then placed in a 10 per cent. solution of copper sulphate for half an hour, washed and mounted in a 2 per cent. solution of caustic potash. The larger protein bodies were coloured faintly red.

5. Aldehyde reaction. The cover-glass preparation was placed in a 1 per cent. solution of vanillin in alcohol for 24 hours and then mounted in sulphuric acid (one part concentrated to one part water) to which a few drops of a solution of ferric sulphate were added. After careful warming the protein bodies were coloured blue to violet. In the larger bodies the colour was seen to be in patches.

6. Potassium ferrocyanide reaction. A cover-glass preparation was acted upon for an hour by a solution containing one volume of 10 per cent. aqueous solution of potassium ferrocyanide, one volume distilled water, and one volume of a solution of two parts of acetic anhydride in one part water ; 60 per cent. alcohol was drawn under the cover glass until the alcohol had lost its acid reaction and no blue colour was given with a solution of ferric chloride. The protein bodies were coloured blue before the addition of a ferric chloride solution which completes this reaction. The blue colour, however, was slightly intensified by the addition of the ferric chloride. There are evidently sufficient ferric compounds on the cover glass to complete the reaction without the addition of ferric chloride.

7. Iodine reaction. On treatment with a solution containing 1 per cent. of resublimed iodine and 5 per cent. potassium iodide, the protein bodies became bright yellowish brown.

8. Picric acid reaction. A concentrated solution of picric acid coloured the protein bodies bright yellow.

9. Caustic potash reaction. On treatment with a 3 per cent. solution of caustic potash the protein bodies swelled. Two of the bodies which were kept under observation were measured before and after addition of the caustic potash. Before being acted upon they measured $29.6 \times 14.8\ \mu$ and $25.9 \times 9.25\ \mu$; after swelling took place, they measured $40.7 \times 22.2\ \mu$ and $33.3 \times 25.9\ \mu$ respectively.

10. Insolubility tests. The protein bodies were found to be insoluble in absolute alcohol and in nitric, sulphuric and hydrochloric acids containing 1 part concentrated acid in 1 part water.

All of the microchemical tests outlined above gave positive reactions for protein. In carrying out these tests I have frequently consulted the works of Molisch[7], Schneider-Zimmerman[12], Czapek[2], and Meyer[6]. Emich[3] in the section of his book dealing with protein reactions especially refers to the above indicated works of Molisch and Schneider-Zimmerman; and these authors on some points refer to Meyer, who gives many details about the microchemical reactions of protein, especially protein crystals in the cells of organisms.

According to Czapek[2] (p. 36) Millon's reaction and the Xanthoproteic reaction are due to the tyrosin groups in the protein molecule. Czapek[2] (p. 42) also quotes Cole to the effect that Raspail's reaction depends upon the splitting of tryptophane from protein. Meyer[6] (p. 63) states that the aldehyde reaction is only shown by protein bodies containing a skatol group.

The action of aniline dyes is also an indication of the protein composition of the bodies. Czapek[2] mentions that the numerous aniline dyes of histology are, for the most part, tests for protein. Methylene blue and gentian violet both stain the bodies to varying degrees. The extent to which these basic aniline dyes colour the bodies is most probably affected by the amount of iron present in the bodies. I have noticed when staining iron bacteria that the presence of ferric hydrate to any observable extent prevents the staining of the bacterial protoplasm. A similar experience occurred with the preparations containing the protein bodies. Those bodies with a faint yellow impregnation of ferric hydrate only stained very feebly or scarcely at all with methylene blue. In making permanent preparations, cover glasses with the ferruginous material containing the protein bodies are stained with Ziehl Nielsen's carbol-fuchsin. This stain imparts to the protein bodies a deep cherry red colour. I chose it because experience in the past in staining the protoplasm of iron bacteria indicated that this stain is much more permanent than many of the others employed in histological work. The photomicrographs of the protein bodies illustrating this paper are from preparations stained with carbol-fuchsin.

In the second experiment of this series a fine glass tube was passed through the cotton wool plug of a bent tube containing the solution and a piece of Merck's iron wire 0.57mm. in diameter. At intervals of three days carbon dioxide from a Schroedter's apparatus was passed through the fine glass tube into the solution. The experiment was carried out in the diffused light of a room. At the end of 14 days the ferruginous material was removed from the wire, and cover-glass preparations made in the usual way. On examination it was found that protein bodies were present in all of the preparations, but were not so numerous as in the other experiments in which no carbon dioxide was artificially introduced into the system. Perhaps too much carbon dioxide was introduced. A very large amount of ferric hydrate was formed in the solution. In this experiment and all of the succeeding ones the iron wire used was taken from a previously unopened jar bearing Merck's label.

The third experiment of the series was carried out in an apparatus designed to exclude the carbon dioxide of the air from the solution with iron wire suspended in it. Mr. F. B. Smith suggested the experiment and indicated the suitability of soda-lime as a medium of extracting the carbon dioxide from the air passing into the apparatus. Two U tubes were used. One of these contained the soda-lime and the other the solution with the iron wire placed in it. The two U tubes were connected by a very short length of rubber tubing. The two unattached arms of the U tubes were plugged with cotton wool. The whole apparatus was sterilised by steaming for half an hour on three successive days. The air in the U tube with the solution and iron wire was drawn through the U tube with the soda-lime several times in order to remove any traces of carbon-dioxide from it. All of the stoppers of the apparatus, except the one which maintained the column of solution in position, were opened so that the air passing into the corroding iron passed through the soda-lime and was thus deprived of its carbon-dioxide. The apparatus was exposed to the diffused light of a room and opened up after 14 days. Five cover-glass preparations were made from the ferruginous material adhering to the wire at the surface of the solution. Of these the first three completed were free from protein bodies. The last two prepared were not distinguished from each other, and on one of them one protein body was found. Some days later the experiment was repeated with fresh material and new apparatus. In this experiment four cover-glass preparations were made. The first two cover-glass preparations to be taken from the iron wire and dried were found to be free of protein bodies. The last two were not distinguished as to sequence of completion, and one of these was found to contain two protein bodies. As the finding of protein-free cover-glass preparations made from the material adhering to the iron at the surface of the solution was unique in my experience, I ascribed it to the absence of carbon dioxide from the air in the U tube containing the oxidising iron. The only way I could account for the appearance of protein bodies in the last preparations made from the ferruginous material was by assuming that the carbon dioxide of the air became fixed and combined during the time which elapsed between the opening of the apparatus and the final drying of the last preparations. In both experiments the results were similar.

The experiment excluding carbon dioxide from the oxidising iron wire in the solution was carried out a third time. On this occasion the U tube containing the iron wire and solution was opened after the lapse of five days instead of 14 days. The method of sampling was also varied slightly. Instead of spreading the ferruginous material on all five cover glasses before drying, each cover glass was spread and dried before the next one was spread. The time elapsing between the opening of the U tube and the final drying of each cover-glass preparation was noted and is shown in brackets: No. 1 (4 minutes), No. 2 (9 minutes), No. 3 (16 minutes), No. 4 (25 minutes), No. 5 (41 minutes). The drying of No. 5 cover glass was purposely delayed. Nos. 1, 2, 3 and 4 were found to be free of protein bodies. Two delicate protein bodies were found on No. 5. The results of this experiment confirm those of the two preceding ones. The only appreciable difference in the first and last preparations made from the ferruginous material was in the absence of protein bodies from the first preparation. In all of the preparations it was evident that the ferruginous material was composed of particles of extremely varied sizes. It is quite clear that when the ferruginous material is lying undried on the cover glass, and even during the time subsequent to the removal of the stopper of the U tube, it is a medium containing a finely dispersed phase and therefore highly suitable for the development of surface reactions.

This experiment, which is based upon the exclusion of carbon dioxide, and which was carried out very carefully three times, indicates :

1. The protein bodies are not impurities.
2. The protein bodies are products of the assimilation of the carbon dioxide of the air.
3. The protein bodies can be generated within 41 minutes of the access of the carbon dioxide of the air to the product of the oxidation of the iron wire in the solution.

These conclusions at first seem incredible in the light of all previous knowledge. It is certain, however, that knowledge of natural processes is far from complete, and it is almost equally certain that fresh knowledge can at first appear to be almost unbelievable.

One other observation should be mentioned in connection with the question of the protein bodies being impurities. In the event of protein being in solution or suspension in the solution, it would betray its presence in the cover-glass preparations in the form of scum-like margins deposited as the solution contracts into a smaller volume while being dried. Even traces of protein in a solution will show in this manner, especially in a stained preparation. I have looked on the cover-glass preparations both stained and unstained for these indications of the presence of protein and have never found them. Before the material on the cover glass is dried the greatest part of it is composed of the solution, as this is necessary in order to transfer the ferruginous material in suspension. Had protein been present as an impurity, I expected to find it on the cover glasses with the ferruginous material formed when carbon dioxide was excluded.

The possibility of the protein bodies being derived from organisms is excluded by the results of the previously described experiments in which the carbon dioxide of the air is excluded and then allowed access for a short period of time to the ferruginous material. It is obvious that organisms could not develop and have their protein content metamorphosed into the irregular protein bodies within 41 minutes, which is the time elapsing between the first access of the carbon dioxide of the air to the ferruginous material and the drying of the material on the cover glass. In addition, it is to be noted that it would be scarcely possible for organisms to be present in such numbers and so consistently as to cause agglomerations of protein of the size of the protein bodies without the organisms leaving some indication of their presence. In the various experiments at least 60 cover-glass preparations of the ferruginous material were examined microscopically and in none of these was any indication of organisms found. There is, therefore, no evidence to suggest that the protein bodies are derived in any way from organisms.

V.—OTTO WARBURG'S WORK ON CELLULAR PHYSIOLOGY.

Some of the most notable contributions to the knowledge of the physiology of the cell in recent years have been made by Otto Warburg and his collaborators. In this section of the paper I have summarised some of the results of Warburg's work. It is highly significant that the general principles enunciated by Warburg evidently operate in my experiments, although his investigations were generally carried out with living cells or material derived from them.

In outlining experiments on the physical chemistry of cell respiration, Warburg[13] states that when the red blood corpuscles of birds are brought into a freezing mixture of -80° the cell membranes are torn and by thawing out a liquid is obtained in which the solid cell constituents are suspended. The experiment is so carried out that the cell respiration remains unaltered for some hours after the thawing out. By centrifuging two layers are obtained : an upper clear layer free of the solid cell constituents and a lower turbid one containing the solid cell constituents. When the respiration is measured in each layer it is found that only the lower turbid layer respires. The general respiration is connected with the solid cell constituents. In all cases so far in which a disruption of the cell is obtained without at the same time abolishing the respiration, similar observations have been made. The respiration of the unfertilised eggs of sea urchins and the respiration of the liver cells of higher animals are connected with solid particles, which are designated intracellular granules.

After studying the effects of narcotics on respiration, the oxidation of amino acids on blood charcoal and the effects of narcotics and prussic acid on the oxidation of the amino acids, Warburg concludes that cell respiration is a capillary-chemical process which takes place on the iron-containing surfaces of the solid cell constituents; that cell respiration is not thereby physically explained but reduced to phenomena of the non-living world; that narcotics retard respiration by covering the surfaces and thereby displacing the oxidisable material; that respiration is an iron catalysis; and that prussic acid retards respiration in that it converts the iron into a form unable to transfer the oxygen.

In the introduction to his work on the catalytic actions of living substance Warburg[15] (p. 10) states that from the characteristics of the respiration enzyme it is concluded that it is an iron-pyrrol combination in which the iron is connected with the pyrrol nitrogen as in haemoglobin.

In a paper dealing with his experiments on carbon dioxide assimilation Warburg[14] gives the results of his researches on the effects of light of varying intensity on *Chlorella*, a green alga. Two processes are concerned in assimilation: Blackman's reaction and a photochemical reaction. Blackman's reaction is an ordinary chemical reaction which is not affected by the illumination; it precedes or succeeds the photochemical reaction. The photochemical reaction is independent of the temperature and proportional to the absorbed illumination. In discussing the experiments Warburg states that the energy transmission in the photochemical reaction during carbon dioxide assimilation is a process which takes place on surfaces. This is indicated by the effect of narcotics. The stronger one of these substances becomes absorbed by assimilating cells, the stronger is the retardation of the energy transmission in the photochemcial reaction. Blackman's reaction is also a surface reaction as shown by its retardation by narcotics. Unlike the photochemcial reaction, Blackman's reaction is specifically retarded by prussic acid. From this retarding effect of prussic acid it is concluded that the Blackman reaction is a heavy-metal catalysis. If this is true, other substances which react with heavy metals should retard Blackman's reaction. In fact sulphuretted hydrogen in very small concentrations retards Blackman's reaction.

After reviewing the experimental data indicating that respiration and fermentation are reactions on surfaces and heavy-metal catalyses, Warburg[15] (p. 12) proceeds to generalise:

> Heavy-metal catalyses are also Blackman's reaction, which is a process participating in carbon dioxide assimilation, nitrate assimilation and hydrogen peroxide decomposition. For the enzymes of the reactions also form dissociating compounds with prussic acid and sulphuretted hydrogen. In addition these reactions are also surface reactions, so one recognises that the most fundamental catalytic actions of living substance are based upon the same principle. The metals and the manner of their combination may vary, the principle remains the same.

There is a very significant relationship between the conditions in my experiments and the fundamental principles enunciated by Warburg. In my experiments an extensive surface consisting of a minutely divided disperse phase results from the oxidation and hydration of the heavy metal iron. In this way the operation of Warburg's two principles of heavy-metal catalysis and reactions on surfaces is provided for simultaneously. The oxidising iron forms with the solution a system consisting of a disperse phase of varying degrees of division suspended in the solution. The coarse and fine particles provide surfaces comparable with those existing in living cells (see fig. 4). The photomicrographs (figs. 1, 2, 3, 5) show the protein bodies enclosing and in contact with granules of ferric hydrate, indicating the connection of the protein bodies with solid surfaces. In all of the protein bodies which I have carefully examined I have always found this intimate connection with granules of ferric hydrate. I have never found indications of protein in solution. From these facts it is inferred that the protein bodies are products of surface reactions. Of all the heavy metals functioning in organisms, iron is the most important. It is apparent from Warburg's work that he considers iron as the principal heavy metal in organisms. In his introduction to the work on the catalytic actions of living substance[15] (p. 7) he devotes several paragraphs to a statement of the iron content of living substance. His theory of respiration is based upon iron. The final paragraph of Warburg's introduction to the work mentioned above is headed "Catalysis in Chemical Technique", at least that is the English equivalent. As there are significant allusions to biological principles in it I shall reproduce the substance of it :

> The works reported upon here originated at a time in which chemical manufacture in the treatment of Haber, Bosch and Mittasch developed the methods of catalysis. They pass gradually from the platinum metals to the metals of the iron group ; and as it appears at present, the principal processes are iron catalyses on surfaces. "If one wishes," says Mittasch, "to compare the elements in relation to their catalytic value so shall one, when he has in view the inorganic manufacturing industry, award the prize to the metals of the iron group, especially to iron itself." So has chemistry found the way by which living nature has proceeded since the beginning.

VI.—CARBON DIOXIDE ASSIMILATION IN THE PROTEIN PRODUCING EXPERIMENTS.

The protein bodies appeared regularly in the ferruginous material formed on the iron when the carbon dioxide of the air had access to it. They were found to be absent from it just as regularly when the carbon dioxide was extracted from the air, and they appeared in the preparation when the untreated air had access to the ferruginous material for 41 minutes. All of the evidence indicates that the protein bodies are the products of carbon dioxide assimilation.

In the first experiment of series B the test tube containing the solution and iron wire was kept in darkness. As protein appeared in the preparation it is evident that the production of protein is not connected with photosynthesis. Evidently the process can be classed with the activities of the nitrate and nitrate bacteria. These organisms are able to assimilate the carbon dioxide of the air in darkness with the energy obtained from the oxidation of ammonia to nitrate and nitrate to nitrate. This type of organic activity is termed chemosynthetic assimilation. It is highly probable that the oxidation of the iron or of the lower oxides of iron provides the energy for the assimilation of the carbon dioxide of the air in my experiments. There is already a precedent for this hypothesis as it is now fairly generally accepted that the iron bacteria *Spirophyllum* and *Leptothrix* utilise the oxidation of iron and manganese salts as sources of energy (see Lieske[5], p. 285).

The experiment in which protein bodies appeared in a preparation, after its exposure to air for 41 minutes, indicates that the system which achieves this result is a very potent one. At the same time it must be remembered that the protein bodies were few in number and microscopic in size. Even so the reactions which resulted in the production of these delicate protein bodies must have taken place rapidly. The initial part of the process consisting of the absorption of carbon dioxide can be explained. Roscoe and Schorlemmer[10] state that ferrous hydroxide rapidly absorbs carbon dioxide. It is evidently the ferrous hydroxide of the system which begins the process by absorbing the carbon dioxide of the air. It is known that considerable quantities of ferrous hydroxide are formed during the rusting of iron[10] (p. 1270). The presence of ferrous hydroxide in the ferruginous material adhering to the iron wire during the experiments was indicated by the greenish colour.

The oxidation of the iron wire in the solution also takes place rapidly as I have observed specks of brown ferric hydrate on the surface of the wire within one half hour from the time of suspending the wire in the solution.

I have no idea as to what intermediate products are formed during the combinations leading to the eventual generation of protein. Apparently no starch was present in the preparations tested for protein with iodine as its presence would have been indicated by the familiar blue colour.

While I do not presume to explain the production of protein in the experiments, there are several facts which may throw some light on the process.

The fact that the elements carbon, hydrogen, oxygen, nitrogen, sulphur and phosphorus are in a state of combination in protein, indicates quite clearly that there are chemical affinities between them. I have already shown[4] (pp. 103-105) that iron exhibits chemical affinities for all of the protein elements and that the rust of commercial iron, under atmospheric conditions, contains a potential supply of all the common protein and carbohydrate elements in its content of water, carbonate, oxides, ammonia, sulphur and phosphorus. Because of the combining properties of iron in relationship to the protein elements I suggested that iron might have acted or may act as the assembling agent of the protein and carbohydrate elements or of the compounds containing them.

In view of the natural chemical affinities between the protein elements and the ability of iron to embody the compounds containing all of these elements into one medium containing extensive surfaces and material undergoing rapid oxidation the generation of protein is less difficult to understand.

As the elements in protein, especially the carbon, hydrogen and nitrogen, are in a highly reduced state, a considerable amount of reduction must take place during the production of protein. The reduction of nitrates can be inorganically effected by the ferrous hydroxide of the ferruginous material as Roscoe and Schorlammer[10] (p. 1266) state that that compound is a powerful reducing agent and reduces nitrates and nitrites to ammonia. The same authors[10] (p. 1234) also state in their discussion of the reactions in the blast furnace that metallic iron is oxidised when heated either in carbon dioxide or in carbon monoxide, free carbon being deposited in the latter case. It is possible that this relationship between iron and carbon with respect to oxygen may be a factor in the catalytic properties of iron in carbon dioxide assimilation. This possibility cannot be entirely discounted in view of the increasing significance which is being ascribed to systems with large surfaces. Wolfgang Ostwald[8] remarks :

> We are driven to conclude that all phenomena observable at ordinary surfaces increase enormously in intensity, and that they may even change qualitatively when we come to deal with dispersoids with their immense internal surfaces. There are also certain forms of energy that play an insignificant role in macroheterogenous systems but an enormous one in dispersoids.

It seems scarcely necessary to mention that the substance of living cells and the ferruginous material of my experiments are dispersoids.

Since writing the above statement with reference to the reactions in the blast furnace, I find that Rinne[9] in a very recent work makes observations on the same subject. He draws a comparison between the inorganic physico-chemical systems of the kind in the blast furnace with happenings in the organic world.

VII.—THE FERRUGINOUS MATERIAL OF THE EXPERIMENTS CONSIDERED IN RELATIONSHIP TO ORGANISM.

In the ferruginous material adhering to the surface of the iron in the solution some of the most fundamental properties of a living inorganically nourished cell are represented : (1) a system with a large surface consisting of a finely divided disperse phase in a nutrient medium ; (2) an energy-liberating system composed of material undergoing oxidation, which represents cell respiration ; (3) a system absorbing the carbon dioxide of the air. When protein is produced by this system and incorporated with it, another property of an inorganically nourished cell is added, since protein bodies and crystals are commonly found in cells. From the point of view of assimilation the ferruginous material with its protein producing ability is scarcely excelled by any living cell which has been studied physiologically. In view of these facts it is tentatively proposed to compare each one of the specks and patches of ferruginous material on the iron to an organism. These specks and patches are mostly visible to the unaided eye and vary considerably in size and shape. One of the most prominent features of an organism, which is absent from the specks and patches of ferruginous material, is specific form.

VIII.—THE MOST PRIMITIVE ORGANISMS.

One of the results of finding that protein is generated from inorganic material may be to invalidate the conclusions formed from many careful experiments carried out in the past. Even traces of iron in the nutrient solutions used for cultivating autotrophic (inorganically nourished) bacteria may be found to produce protein. The experimental production of protein from inorganic compounds under the conditions of my experiments indicates the probability of similar processes taking place in nature. The production in nature of highly complex organic compounds, such as protein, from inorganic materials may tend to minimise the importance of the difference between organically and inorganically nourished organisms of the lowest classes, such as bacteria. Although Lieske[5] is doubtful as to whether the iron bacteria *Spirophyllum* and *Leptothrix* are inorganically nourished, I am inclined to think that these organisms will prove, on further investigation, to be very primitive. Some of the other iron bacteria, which have not been investigated physiologically, may be more primitive than either *Spirophyllum* or *Leptothrix*. Over three years ago I carried out some investigations on *Leptothrix ochracea* and, as soon as time permits, I shall prepare the results of the work for publication. It might be mentioned here that I found iron in both the ferrous and ferric states in the protoplasm of the organism.

IX.—GENERATION OF LIFE ON THE EARTH.

The principal object of my work, both theoretical and experimental, was to endeavour to trace the course of natural processes in the primary stages of the evolution of organic material. The solution which was used is a nutrient solution designed for the cultivation of certain kinds of bacteria and algae. Obviously the solution must possess some degree of similarity to the natural conditions surrounding the organisms for which it is suitable. Otherwise the organisms would not grow in it.

It is not determinable from my experiments whether the presence of metallic iron is essential or whether the lower oxides of iron are capable of initiating the reactions leading to the production of protein.

Judging from the numerous discussions concerning the sources of energy of the iron bacteria, it is possible, or even probable, that ferrous hydroxide may be capable of effecting the primary steps which lead to the generation of protein. In its turn the production of protein is definitely indicative of processes associated with life.

Ferrous hydroxide resulting from the decomposition of ferrous compounds or other combinations of iron in the rocks and soils of the earth may be the starting point of the evolution of the organic from the inorganic. By ferrous hydroxide carbon dioxide in solution or suspension could be absorbed. The oxidation of other molecules of the same hydroxide may provide energy representing the respiration of living cells. The ferric hydrate resulting from this oxidation could supply the finely divided particles constituting a large surface, as in the writer's experiments. Nitrates or ammonium salts, sulphates and phosphates in solution in the natural waters could take part in the reactions. In this way protein may be formed in nature.

By microscopic observations made many years ago I am aware that the large surfaces provided by finely divided ferric hydrate are present in many rocks undergoing disintegration. The presence of this ferric hydrate is indicated macroscopically by the brown stain so often seen in rocks which are affected by weathering processes. The ferric hydrate is especially in evidence in the joints and cracks of rocks.

The experiment showing that the protein bodies are formed when the solution with the suspended iron wire was kept in darkness shows conclusively that the production of protein is independent of light. This experiment and the fact that the primitive nitrite and nitrate bacteria assimilate the carbon dioxide of the air in darkness suggest that this process, known as chemosynthesis, is more fundamental than the photosynthesis effected by green plants. In the vital processes functioning at the earth's surface, the energy of sunlight (photochemical energy) may displace, to some extent, the energy of mineral compounds in a reduced state, especially as mineral compounds are more highly oxidised towards the surface than lower down towards the unaltered rocks.

According to this view of the initiation of biological processes the immense stores of energy contained in unweathered rocks become liberated by oxidation and hydration during the process of disintegration and provide the energy for the development of the earliest forms of life. These stores of energy are located particularly in iron in the ferrous state in the rocks of the earth.

The primal forms of life are visualised as composed largely of mineral constituents, such as ferrous hydroxide. The ability of these precursors of organisms to generate highly complex compounds. such as protein, indicates their relationship to the organisms recognised by the biologist. It can be contended that these alleged early forms do not possess many of the characteristics of organisms, as for instance, the power of reproduction. As, however, they are derived directly from inorganic material, there is scarcely any necessity for the ability of reproduction. They are generated directly from the simple compounds of rocks, soils, water and the atmosphere. Their requirements and equipment are, therefore, not always identical with those of the organisms recognised by the scientist.

This sequence of events is in accordance with the great principle of evolution. Unquestionably there are speculative passages in the scheme outlined. On the other hand there are many facts as a basis to it.

X.—SUMMARY.

Iron, mostly in the form of wire, was suspended in a very dilute aqueous solution containing ammonium sulphate, potassium chloride, magnesium sulphate, potassium phosphate and calcium nitrate. After the lapse of several days the ferruginous material adhering to the iron wire on examination was found to contain protein bodies of microscopic size. The solution and the iron wire were separately sterilised. During the experiments the solution and the wire were protected from contamination. The experiments when carried out in an atmosphere freed of carbon dioxide by soda-lime, were found not to produce the protein bodies except after exposure of the ferruginous material to the untreated air for a period of 41 minutes. It is clearly indicated by the experiments that the protein results from the assimilation of the carbon dioxide of the air. The ferruginous material adhering to the iron wire in the solution consists of a complex system containing a large surface consisting of finely divided suspended particles, chiefly of ferric hydrate. This system, the association of the protein bodies with granules of ferric hydrate, and the absence of indications of protein in solution, indicate that the reactions leading to the production of protein takes place on surfaces.

The ferruginous material adhering to the surface of the iron wire possesses the following properties of a living, inorganically nourished cell: (1) a system with a large surface consisting of a finely divided disperse phase in a nutrient medium; (2) an energy-liberating system composed of material undergoing oxidation, which represents cell respiration; (3) a system absorbing and assimilating the carbon dioxide of the air and producing protein. In view of these facts it is tentatively proposed to compare each one of the specks and patches of ferruginous material on the iron to an organism.

In a discussion on the subject of the most primitive organisms it is suggested that the iron bacteria *Spirophyllum* and *Leptothrix* may rank among the lowest of known organisms.

Considering all of the evidence brought forward, a theory of the generation of life on the earth is proposed. It is suggested that life may be generated from mineral compounds in a reduced state in the rocks and soils of the earth. The oxidation of ferrous hydroxide, on account of the special properties of this hydroxide, is particularly mentioned as a possible starting point for the evolution of life. The process whereby organic compounds are produced in the absence of light by the ferruginous material of the experiments and by the nitrite and nitrate bacteria is considered to be more primitive than the photosynthesis of plant cells containing chlorophyll or a corresponding pigment.

ACKNOWLEDGMENTS.

The writer is deeply indebted to Mr. Frank B. Smith for advice on several technical chemical questions. It has already been stated that the experiments in which the carbon dioxide was extracted from the air were due to suggestions from Mr. Smith. However, it is due to him to mention that I accept full responsibility for the statements contained in this paper. A large number of the reagents used for the protein tests were generously supplied by the Agricultural Chemist. Mr. McKechnie, an analyst of the Agricultural Chemist's staff, kindly undertook to redistill the water which was used in experiments of series B.

REFERENCES.

1. Cholodny, N., Die Eisenbakterien (Pflanzenforschung, Heft 4), 95, 1926.
2. Czapek, F., Biochemie der Pflanzen, dritte Auflage, zweiter Band, 94, 1925.
3. Emich, F., Lehrbuch der Mikrochemie, zweite Auflage, 268, 1926.
4. Francis, W. D., A Contribution to the Theory of the Relationship of Iron to the Origin of Life. Proc. Roy. Soc. Queensland, 37 : 98-107, 1926. German translation by Carl Mez, Botanisches Archiv, 15 Band, Heft 5-6, 377, 1926.
5. Lieske, Rudolph, Kurzes Lehrbuch der allgemeinen Bakterienkunde, 325, 1926.
6. Meyer, A., Morphologische und physiologische Analyse der Zelle der Pflanzen und Tiere, erster Teil, 62, 1920.
7. Molisch, Hans, Mikrochemie der Pflanze, zweite Auflage, 311, 1921.
8. Ostwald, Wolfgang, Handbook of Colloid Chemistry, 2nd English Edition, translated by M. H. Fischer, 28, 1919.
9. Rinne, F., Grenzfragen des Lebens, 90, 1931.
10. Roscoe, H. E., and C. Schorlemmer, A Treatise on Chemistry, vol. II, part II, 1266, 1923.
11. Schafer, E. A., Presidential Address to British Association for the Advancement of Science, Dundee, 15-17, 1912.
12. Schneider, H., and A. Zimmerman, Botanische Mikrotechnik, 238, 1922.
13. Warburg, O., Physikalische Chemie der Zellatmung. Biochemische Zeitschrift, 119 Band, 134-166, 1921.
14. Warburg, O., Versuche uber die Assimilation der Kohlensaure. Biochemische Zeitschrift, 166 Band, 386-406, 1925.
    (This and the preceding paper are reprinted in Warburg's work cited in reference 15.)
15. Warburg, O., Uber die katalytischen Wirkungen der lebendigen Substanz, 10, 1928.

EXPLANATION OF PLATES.

All of the figures are from unretouched photographs.

Figures 1, 2, 3 and 4 were photographed with a 2mm. apochromat (n.a. 1.33) and periplanatic ocular × 15. Fig. 5 was photographed with a 4mm. apochromat (n.a. 0.90) and periplanatic ocular × 15.

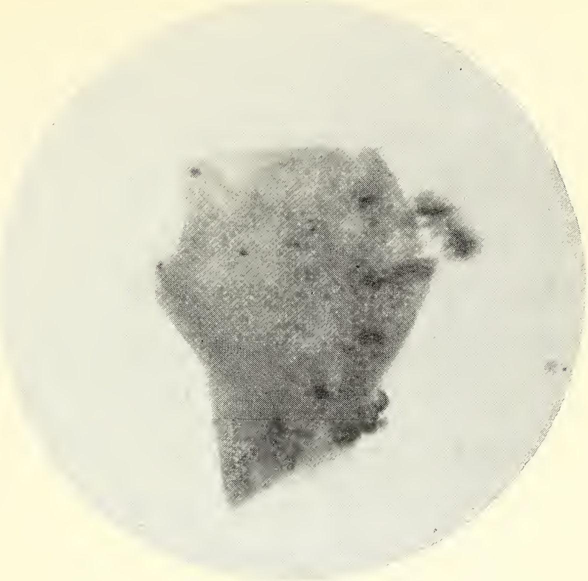
Plate I—Fig. 1. Photomicrograph of protein body. The darker patches and spots represent granules of ferric hydrate. Preparation from ferruginous material on Merck's .57mm. iron wire in the nutrient solution used in the experiments series B. The iron wire and solution were contained in a U tube with a U tube of soda-lime attached for 14 days and remained for another 10 days with the soda-lime U tube detached and with access of air. Preparation stained with Ziehl-Nielsen's carbol-fuchsin. × 1,200.

Plate I—Fig. 2. Photomicrograph showing two protein bodies (the two large bodies) on same slide as protein body depicted in fig. 1. The right-hand part of the lower protein body is out of focus. The upper protein body is in contact with granules of ferric hydrate on its upper right and right sides. Granules of the same material are imbedded in the upper protein body and in the left hand portion of the lower protein body. The ferric hydrate is shown as darker than the protein. × 1,200.

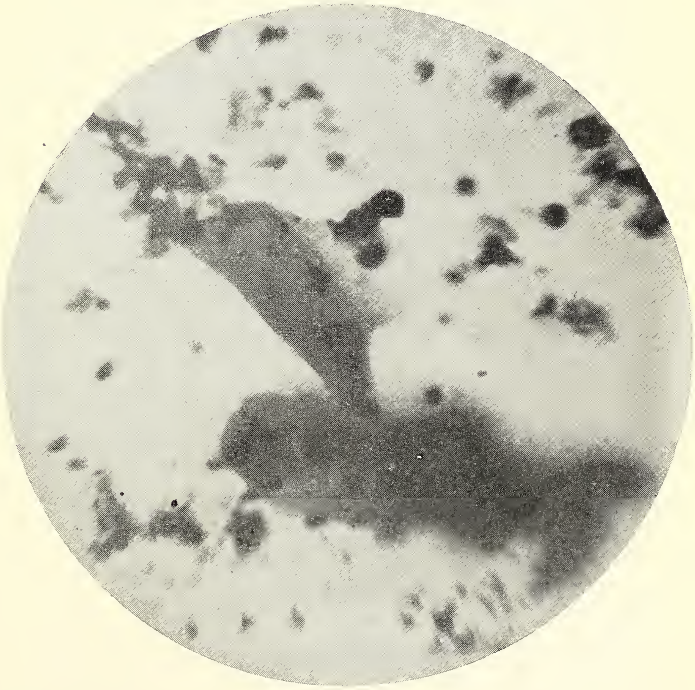
Plate II—Fig. 3. Photomicrographs of tenuous protein body in ferruginous material from Merck's .2mm. iron wire in nutritive solution used in experiments series B. The bent tube containing the wire and solution were kept in darkness for 14 days and then sampled. The protein is seen in a somewhat diffused condition enveloping exceedingly fine granules and coarser particles of ferric hydrate. The granules and particles of ferric hydrate are shown as darker than the protein. Preparation stained with Ziehl-Nielsen's carbol-fuchsin. × 1,200.

Plate II—Fig. 4. Photomicrograph showing the particles, principally of ferric hydrate, which form the disperse phase in the ferruginous material. The picture was taken from the same cover-glass preparation, parts of which are shown in figs. 1 and 2. Unstained. × 1,200.

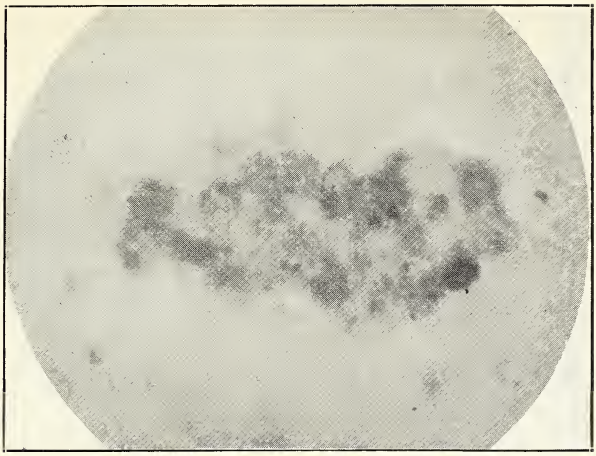
Plate II—Fig. 5. Photomicrograph of protein body in the same preparation, part of which is shown in fig. 3. Here again the darker patches represent particles of ferric hydrate. Stained with Ziehl-Nielsen's carbol-fuchsin. × 500.



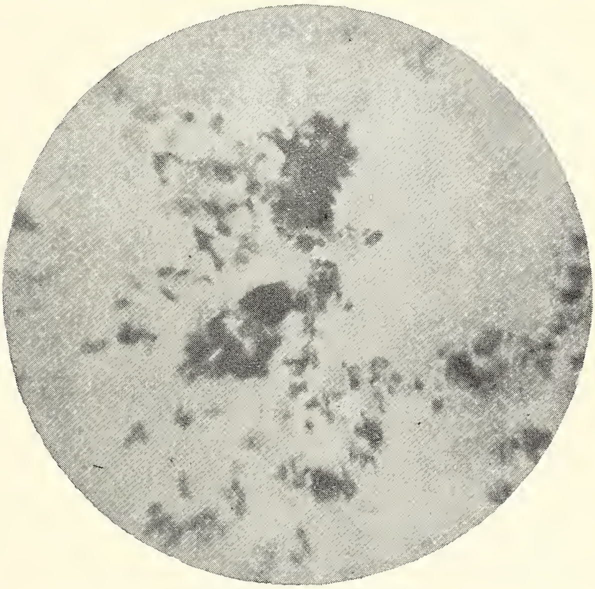
1. Protein body in ferruginous material. × 1200.



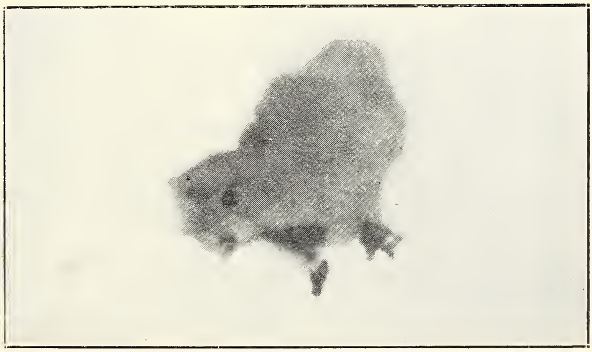
2. Two large protein bodies in ferruginous material. × 1200.



3. Tenuous protein body in ferruginous material. × 1200.



4. Microscopic structure of ferruginous material. × 1200.



5. Protein body in ferruginous material. × 500.

Notes on Australian Stratiomyiidae.

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(*Tabled before the Royal Society of Queensland, 27th June, 1932*).

The Australian Stratiomyiidae fall into five clearly definable subfamilies which may be readily distinguished by the characters in the key given below. Certain genera have been misallied in the past, and three are still somewhat ambiguous. Two of these, *Syndipnomyia* Kertesz, and *Ophiodesma* White, would be best allied with the subfamily Clitellarinae, whilst *Geranopus* White, may be placed with the Sarginae. The genera *Negritomyia* Bigot, *Elissoma* White, and *Peratomastix* Enderlein, join *Lagenosoma*, in the Hermetiinae, as these all form a homogeneous group. The genus *Hermetia* is represented by the introduced *H. illucens* Latrielle, and it is somewhat doubtful whether *H. pallidipes* Hill, is congeneric, but it belongs to the same subfamily, whilst *Pycnothorax* Kertesz, described with incomplete antennae, may come in here too.

Key to the subfamilies of the *Stratiomyiidae*.

1. Antennae with an extremely long apical segment. Abdomen with five to seven normal segments, but when the sixth and seventh are normal, they are usually capable of being telescoped within the fifth	*Hermetiinae*
Antennae with the apical segment otherwise formed ..	2
2. Abdomen with seven clearly defined segments, none of which are retracted	*Beridinae*
Abdomen with not more than five clearly defined segments, the others being modified to form part of the tubular ovipositor which is retracted, and similarly reduced on the male	3
3. Antennae normal, at most terminating in a thickened style, never with an arista	4
Antennae with a hair-like arista	5
4. Fourth median vein branching from the baso-median cell	*Stratiomyiinae*
Fourth median vein branching from the median cell ..	*Clitellarinae*
5. Median vein three branched..	*Sarginae*
Median vein two branched	*Paschygasterinae*

Subfamily Beridinae.

Genus *Actina* Meigen.

I recently gave a survey of the species of this genus and drew attention to the existence of an intermediate form. I have now added to my collection another species of this intermediate type; the pubescence on the eyes of the male being short and scattered. The metatarsus of the posterior leg of the male of this form is slightly swollen, and this character will distinguish it from that previously referred to. There is no difficulty in isolating the males of the species, but in the new one here described, some difficulty may be experienced in separating it from the female of *A. incisuralis* Macq. I still have some males before me that may belong to other species not yet diagnosed, but all the females known to me may be separated by the following key:—

Key to the females of species of *Actina*.

1. Wings marked with brown along part of the anterior border	2
Wings entirely hyaline	4
2. Eyes with short, scanty hairs. Legs, black. Large species with very long depressed yellow hairs on the dorsum of the thorax	*ocinis* Hardy
Eyes, bare. Legs, mainly yellow. Small species with short inconspicuous yellow hairs on the dorsum of the thorax	3
3. Apical segment of antennae about as long as the four segments preceding it	*silvicola* Hardy
Apical segment of antennae about as long as the two segments preceding it	*imperfecta* Hardy
4. Scutellar spines entirely metallic green	*costata* White
Scutellar spines with at least the apical half yellow ..	5
5. First antennal segment fully twice the length of the second	*nigricornis* Enderlein
First antennal segment only one and a half times the length of the second	6
6. Palpi and antennae yellow; the latter may be stained with black	*incisuralis* Macquart
Palpi and antennae black; at most the latter is stained with yellow	*brevihirta* n. sp

Actina brevihirta n. sp.

Male.—The eyes have scanty short pubescence and are well separated. The frons is bluish black with a silver-white tomentose spot just above each antenna; these spots may become confluent. The white also covers the whole face. The antennae are normal with the first segment twice the length of the second (the proportion is limited to this sex). The proboscis is yellow and the palpi and antennae are black; the latter may be stained with brown.

The thorax dorsally, is almost entirely bright metallic green, with rather long yellow pubescence; the six scutellar spines are yellow, and the humeral and postalar callus, though dark, may be lacking the metallic colour. The pleura is metallic, but much darker and with long, white hairs. The blue-black abdomen has both black and white hairs on it. The coxae, most of all the femora, the posterior tibiae, and all the tarsi except the posterior metatarsus are black, elsewhere yellow. The wings are hyaline. The male terminalia seem to differ distinctly from those of *A. incisuralis*, but they have not been studied in detail.

Female.—The hairs of the eye are not readily detected in this sex as they are very scattered. The eyes are much wider apart than those on *A. incisuralis*, but the antennal proportions are about the same. The pleura are of the same colour as the dorsal area of the thorax, and the abdomen has a light dorsal area covering at least three of the abdominal segments, while the ventral area is largely or entirely yellow-brown. The legs are entirely yellow except the tarsi which are more or less stained with black, and the apex of the posterior tibiae and tarsi may be more or less black. In other characters it agrees with the male.

Length.—5-6 mm.

Hab.—Queensland: Brisbane, 17 males, 4 females, May, 1932, all these were taken in the University grounds. Also 1 male, August; 1924, 1 male, October, 1925. Mt. Glorious, 2 males, 1 female, April, 1930.

New South Wales: Sydney, 1 male, April, 1928.

This species frequents grass and low vegetation, whereas other species known to me are associated with trees. The males were seen to dance in the air, and the females were sought for and found by sweeping low vegetation nearby.

Note.—Some remark is called for, in regard to the interpretation of the colour of the palpi. On the present species it is entirely black, and must not be confused with the case commonly met with in which the apex only is black. Enderlein gives the character of black for the Tasmanian *nigricornis*, the description of which reads very much like the present one. As far as I know, it is only the apical segment of the palpi that is black on *A. nigricornis*, as I do not know of this colour being otherwise represented on Tasmanian specimens; Enderlein described the female only. Another point of importance is present in the antennae. This is the first species described from the mainland on which the first segment is twice the length of the second. This character was hitherto limited to the Tasmanian specimens, but it is now found (on one sex only) on a Queensland species.

Subfamily Clitellarinae.

Genus *Ophiodesma* White.

Ophiodesma White, Proc. Lin. Soc. N.S. Wales, xli., 1916, 88; Hardy, Proc. Roy. Soc. Tasmania, 1920, 49.

Diapontiomyia Kertesz, Ann. Mus. Nat. Hung., xx., 1923, 116.

The above genera are based upon the southern species, the only one hitherto recognised, so there can be no doubt concerning the synonymy. The northern species has been known to me for some years but I have failed to discover its breeding ground. *O. flavipalpis* is to be met with along the outskirts of rather boggy land at Blackheath, New South Wales, and is scarce. Specimens from Victoria seem to have been taken on land that is perpetually damp.

Key to species of *Ophiodesma*.

Frons of female with the central area corregated, and a knob issuing from the median sulcus .. .. .. *flavipalpis* Macq.

Frons of female with the central area smooth, and there is no interruption of the median line .. .. .. *innodus n. sp.*

Ophiodesma flavipalpis Macquart.

Odontomyia flavipalpis Macquart, Dip. Exot. suppl. 4, 1849, 49.

Ophiodesma flavipalpis White, Proc. Lin. Soc. N.S. Wales, xli., 1916, 89.—Hardy, Proc. Roy. Soc. Tasmania, 1920, 50.

Diapontiomyia rufispina Kertesz, Ann. Nat., Hungary, xx., 1923, 118.

Both Macquart and Kertesz described this species from the male, which they associated with the Stratiomyiinae. White established the female and removed the genus to this position, nevertheless the appearance of the form is strikingly like that of *Odontomyia.*

Description.—On the female, the frons is over a quarter the width of the head (eye-frons-eye measurements are 15-11-15), and much of it is covered with a short pubescence ; a fairly large area is bare, showing corrugations, the ridges of which descend each side of a knob that protrudes through the median sulcus ; there are four of these ridges, and outside these the frons is densely punctured, each puncture bearing a hair. The sulcus through which the knob protrudes, extends down from the ocellar tubercle ending at a transverse suture where the corregations and the punctures also cease. The scutellum is semicircular, the spines being placed at each third of its apical border. The colour of the eyes, when alive, was not noted.

Hab.—New South Wales. The species is well represented in various collections, and the one from which the above description is taken is from Sydney, March, 1918. There is a male before me from the same locality, dated November, 1919. Sydney is the type locality given by Kertesz.

Ophiodesma innoda n. sp.

This species was originally confused with *O. flavipalpis*, from which it differs by having the frons distinctively different on the female.

Female.—The frons is under one quarter the width of the head (15-9-15) with a low bare flat carina on which the median line is distinguishable ; the protruding knob and the corrugations are missing. On each side of the carina the frons is densely punctured except for an interruption midway between the ocellar tubercle and the base of the antennae, where it is shining like the carina ; both the carina and the punctures stop at a transverse suture just above the antennae. The scutellum is less widely semicircular in comparison with that of the typical form, and the spines are much closer together, so that the distance between them is noticeably shorter than that from the spines to the thorax along the margin of the scutellum.

The species is like the typical one in many other respects, but besides differing in the above characters, the hairs of the thorax tend to form stripes, a character to be noted in both sexes, whilst the margin behind the eyes, seen from the lateral aspect, is not quite as broad, being reduced in conformity with the smaller head. When alive the eyes were green, with a spot above and below, purple in colour, and edged with red. Between these spots were five similarly coloured bars, two touching the posterior border of the eye, and two the anterior border.

Male.—This is very similar to the male of *O. flavipennis*, but there is a tendency for the scutellar spines to be closer together, but not to any very marked degree.

Hab.—Queensland ; Brisbane, one female (holotype), March, 1924, and one male (allotype), November, 1929.

Tribe Antissini.

Members of this tribe are to be distinguished by the presence of a short bristle-like spine at the apex of the intermediate tibiae. There are two genera placed here, both unknown to White, and I have been unable to trace them. *Antissa* was based on a Western Australian species by Walker, and it might be the same as *Antissella* White, whilst *Anacanthella* Macquart, from South Australia, might be *Lecomyia* White.

Genus *Lecomyia* White.

This genus is readily distinguished by the very broad abdomen, being about as broad as long. Of the typical form, *L. quinquecella* Macquart, only the male is known, so a key to the species cannot yet be given.

Lecomyia cyanea White.

White described the female only, from the Hawkesbury River, New South Wales. It has since been found in Queensland, where it occurs on tree-trunks, and is difficult to catch.

Male.—Eyes separated, and with dense white pubescence (on *quinquecella* Macquart, this pubescence is black). The frons is blue, the pubescence together with that at the summit, is black, except that some white hairs occur at about half its length, and again just above the antennae, and thence the white hairs occur down much of the face. The beard is white, and behind the head the hairs are black and white. The black palpi have mainly black hairs, but some white ones are to be detected. The thorax is very dark, practically black, but with violet reflections, and much of the pubescence on it is white, and forms a distinct pattern. The scutellum lies at an angle of about 30 degrees to a line drawn from the neck to the base of the scutellum ; it is fringed with long white hairs, and elsewhere on it, the pubescence is black. The abdomen is blue with violet reflections, the pubescence is mainly dark, but white hairs form two or four pairs of diagonally placed lateral bars. The coxae, femora and tibiae are mainly black, with much shorter white hairs ; the knees and tarsi are white. On the wings a band is more or less clearly defined, reaching right across from the costa, and is invariably indicated just behind the radio-median crossvein, even when the remainder is completely obsolete.

Hab.—Queensland ; Brisbane, September to November, 1923 and 1925. The allotype male and five paratype males are in my collection. Other paratypes are in various collections.

Lecomyia notha n. sp.

Male.—The eyes are densely pubescent, with long black hairs, and they are approximated from the ocellar tubercle to near the insertions of the antennae. The very small frons so formed, is metallic but very dark, and the same colour extends on to the face which widens out, being much wider than that of the species referred to above. The pubescence of the face and frons is mainly white, elsewhere on the head it is black. The antennae are brown, the segments 4 to 10 being shorter than normal, and some of these segments are difficult to detect ; all the segments together are shorter than the head. The black palpi have black hairs. The thorax is vivid blue, as are the scutellum and abdomen ; it has violet reflections and is covered with long black hairs which extend on to the scutellum. The scutellum has four pairs of short spines, all the same size, and there is a subapical depression bordering it for the entire length of its outer margin ; the last character is not to be detected on the other species. The uniformly distributed black and white pubescence of the vivid blue abdomen, is short and does not form a pattern. The legs are entirely black and the wings hyaline.

Female.—This differs from the male by having the eyes widely separated, the frons being metallic blue, but becoming black just above the antennae ; the black extends down the face and the area so covered bears white hairs. White hairs are traceable in the beard, on the palpi and down the centre of the frons. The palpi are black with a brown tip. The pubescence of the thorax is very short, and hairs reflect white when seen at an angle. The pubescence of the scutellum and abdomen is similar.

Hab.—Queensland ; Ormiston, near Cleveland, August, 1924. Three males and two females were found resting on twigs in a patch of bush beside the railway station. Brisbane, August, 1929, two males from twigs at Mt. Gravatt close to the township.

Genus *Antissella* White.

There is little to distinguish this genus from *Lecomyia,* but the spines are reduced to mere knobs along the border of the scutellum, and the abdomen is more or less longer than broad, also the general appearance is quite different. One species described from Tasmania, *A. parvidentata* Macquart, has also been taken in New South Wales, Barrignton Top (G. Goldfinch, December, 1921), and another species from Brisbane, described below, has the thorax covered with bright yellow depressed hairs.

Antissella angustifrons n. sp.

Female.—The frons is rather narrow, metallic, and with a carina strongly indicated ; white hairs occur at about the central third of the frons on each side of the carina, and again just above the antennae, from where they continue on the face. Behind the head the hair is also white. The eyes are minutely hairy and appear to be bare and the antennae are black. The dorsal surface of the thorax and scutellum is metallic green and densely covered with bright yellow depressed hairs that give the appearance of being golden. The metallic colour of the blue-black abdomen is scarcely discernible. The legs are yellow. Length : 5 mm.

Hab.—Queensland, Sunnybank, near Brisbane, October, 1927, one female taken on a window. Other specimens are in various collections but only this one is before me. The species appears to be distributed widely, and perhaps is more frequently to be found inland.

Subfamily Sarginae.

White recognised two genera in this subfamily, one of which he attributed to *Sargus*. Later Hill added another species that evidently comes into this subfamily but he apparently knew neither of White's generic conceptions, and the species he allied with *Sargus* is not congeneric with that of White, if his description is correct. Reference must also be made here to *Geranopus* White, which would seem to be anomalously placed by White in Clitelarinae, on wing venation, but shows affinities with this subfamily. I have seen White's type but was unable to place it satisfactorily. The two genera may be distinguished by *Sargus* being metallic blue without scutellar spines, and *Acanthasargus* being otherwise coloured and with scutellar spines ; in both, the arista is placed dorsally on the terminal segment which is either the sixth or perhaps the seventh segment. This character will distinguish the two genera from *Geranopus*, and from the species placed by Hill under *Sargus*. I do not know if the generic conception thus limited, is strictly applicable to *Sargus*, but it agrees fairly well with that genus as generally understood. White's species differs from the one here described by colouration, the abdomen being metallic brown with a golden tinge.

Sargus darius n. sp.

Female.—Metallic blue with voilet reflections. Frons is narrow and a third of its length, just above the antennae, is white. The anterior ocellus is three times further away from the posterior ones, than the posterior ones are from each other. The face is brown, and the proboscis white. The head is deeply excavated behind the eyes and black, the neck is long and dirty yellow brown. The yellow brown antennae have seven segments discernible, the arista being placed dorsally on the apical one. A few hairs are readily seen under the binocular on the arista. The antennae are inserted at about three-quarters the depth of the head and, seen in profile, the frons protrudes beyond the eye margin.

The thorax has a white humeral callus, and a white line running from it to the insertions of the wings. Below this line, a large brown triangular area occurs. There is also a large brown area covering the postalar callus and metapleura, and it extends in a line round the scutellum. The anterior and postalar coxae are more or less tinged black in parts, the posterior pair being mostly shining black, and the femora have a dark subapical patch. The tibiae are basally black, and the intermediate and posterior tarsi are mostly dark on the type, but this colour varies. In other respects the legs are yellow. Five abdominal segments are normal, the sixth and onwards form the tubular ovipositor, the apex of which is yellow, with metallic blue two-segmented lamellae.

Length.—9 to 7 mm.

Hab.—Queensland: holotype from Gt. Palm Island, May, 1925. There are four paratypes, Brisbane Botanical Gardens, March, 1926 (from a window, H. Tryon), Dunk Island, May, 1927 (A. J. Turner), and May, 1914 (R. Hamlyn Harris), Tamborine Mt. (W. Davidson). The three last are in the Queensland Museum. In the Deutsches Entomologisches Institut Berlin, there is another paratype from Kuranda, February, 1910.

Genus *Acanthasargus* White.

This genus differs from *Sargus* by having spines at the apex of the scutellum, and, in addition, the appearance is quite distinct.

Key to species of genus *Acanthasargus*.

1. Thorax and abdomen entirely black	2
Thorax and abdomen yellow in part	3
2. Scutellum and scutellar spines black	*pallustris* White
Scutellum with a yellow bar between yellow scutellar spines	*gracilis* White
3. Scutellum and spines entirely yellow; legs almost entirely yellow	*flavipes n. sp.*
Scutellum black, scutellar spines yellow; legs yellow, with sections of the femora and tibiae black ..	*varipes n. sp.*

Acanthasargus flavipes n. sp.

Female.—The frons, antennae, face and the whole of the post-ocular region are black, except for two yellow spots on the frons, situated one above each antenna and another pair of yellow spots occur on the flange, one behind the upper corner of each eye. The proboscis is yellow. The thorax is black, except that the humeral callus and the postalar callus are yellow; the same colour also extends along a strip of the pleura between the humeral callus and the wing insertions. The scutellum is yellow. The black abdomen has the dorsal surface laterally margined with yellow, the colour extends slightly so as to form lateral confluent spots on each segment. The coxae and the two apical segments of the tarsi are black, otherwise the legs are entirely yellow.

The male is similar except that the eyes are contiguous for most of their length, and the spots above the antennae are confluent whilst the flange behind the eyes is almost eliminated, and the yellow occurs there as a line.

Length.—5 mm.

Hab.—Queensland : Brisbane, May and September to November 1929 and 1930, two males and four females, all taken on windows in the University.

Acanthasargus varipes n. sp.

Female.—Head black, but with two large confluent yellow spots above the antennae, these forming a broad bar that reaches from eye to eye and are hardly divided in the centre ; in addition, the flange behind the eyes is yellow on the upper two thirds. The thorax has the humeral callus and the postalar callus yellow, the same colour extends along a strip of the pleura, from the humeral callus to the wing insertions. The scutellum is black, with the spines yellow or testaceous. The black abdomen has a pair of yellow lateral spots on three segments. The coxae are stained black, but the yellow is discernible in places. The fermora and tibiae have a black ring, broad on the former, situated at about half their length, otherwise these and the first two segments of the tarsi are yellow, and the other segments of the tarsi are stained black.

The male is similar, but the frons is very narrow, almost linear, but widens above the antennae to a triangular area which is yellow. The flange behind the eyes is broad, and like that of the female.

Length.—5 mm.

Hab.—Queensland : Brisbane, January, February, April, and from September to December, 1927 to 1930, two males and nine females. Some of these were taken on windows in the University, but others were gathered, either on vegetation on a piece of waste ground, or resting on leaves, in the University grounds and in the Botanical Gardens.

REFERENCES.

Full references, not given above for genera and species, will be ound in my catalogue in the *Proceedings of the Royal Society of Tasmania*, for the year 1920, pp. 33-64 ; and for the purposes of this paper add :—

KERTESZ.—Ann. Mus. Nat. Hungarici, xviii., 1921, 171 (Syndipnomyia) ; and xx., 1923, 124 (Pycnothorax).

HARDY.—Proc. Roy. Soc. Queensland, xliii., 1932, 51. (Actina).

A Revision of the Australian Species of the Coral Genera Spongophyllum E. & H. and Endophyllum E. & H. with a Note on Aphrophyllum Smith.

By O. A. JONES, M.Sc., (Cantab.), M.Sc. (Q.), F.G.S.

PLATES III. AND IV. and Two Text Figures.

(*Read before the Royal Society of Queensland*, 27th *June*, 1932).

Till recently some confusion existed as to the structure of the genotypes of both these genera. As a result some of the descriptions of the Australian species are not as full or as clear as is desirable. The writer has recently revised the genotypes (1929)* and the following work is based upon that paper. For some of the species more and better preserved topotypes have been obtained and the descriptions have been amplified or amended.

The writer wishes to thank Dr. R. S. Allan for placing his collection at his disposal ; Dr. Stanley Smith for a specimen of *Aphrophyllum hallense* ; Prof. Wanner of Bonn University for Eifel material, and Dr. Koliha of the Narodni Museum, Prague, for specimens of *Cyathophyllum manipulatum*.

The following records have been made :—

1888 *Endophyllum* (*spongophylloides*) Foerste, from the Upper Silurian† of Bowning. This species was referred to *Spongophyllum* by Chapman in 1925. See p. 52.

1889 *Lonsdaleia*? (*Spongophyllum*) *bipartita* Eth. fil. Examination of Foerste's material has shown this to be identical with the foregoing species. See p.52.

1898 *Endophyllum schluteri* Eth. fil., Middle Devonian, Isis River. See p. 59.

1899 *Spongophyllum giganteum* Eth. fil., Middle Devonian, Moore Creek. See p. 54.

1911 *Spongophyllum cyathophylloides* Eth. fil., Devonian, Clermont. See p. 55.

1911 *Spongophyllum* sp. Eth. fil., Silurian, Chillagoe. See p. 54.

1913 *Spongophyllum enorme* Eth. fil., Upper Silurian, Yass. See p. 61.

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* See bibliography p. 62.

† Silurian is used in the sense of Gothlandian, so that Upper Silurian = Wenlock and Ludlow.

1918 *Spongophyllum halysitoides* Eth. fil., Middle Devonian, Nemingha. See p. 56.

1918 *Spongophyllum* sp. Dun and Benson, Middle Devonian, Loomberah. See p. 57.

1920 *Endophyllum schluteri* var. *colligatum* Eth. fil., Middle Devonian, Moore Creek. See p. 59.

1920 *Aphrophyllum hallense* Smith, Carboniferous, near Bingara. See p. 60.

1924 *Spongophyllum* cf. *halysitoides* Eth. fil., Richards and Bryan, Devonian, Silverwood. See p. 56.

1925 *Spongophyllum stevensi* Chapman, Yeringian (—Upper Silurian), Lilydale. See p. 52.

1925 *Spongophyllum shearsbii* Chapman, Upper Silurian, Yass. See p. 51.

1928 F. W. Whitehouse recorded *Spongophyllum halysitoides* Eth. fil., in rolled Devonian pebbles from the Lower Limestone in the Carboniferous beds near Mt. Lion. See p. 57.

In 1922 W. N. Benson catalogued the Devonian species noted above, and added some new localities.

SPONGOPHYLLUM SHEARSBII CHAPMAN.

Plate III. ; Figures 1 and 2. Plate IV. ; Figure 1.

1925 *Spongophyllum shearsbii* ; F. Chapman, p. 113, pl. xiv., figs. 18a, b ; pl. xv., figs. 25, 26.

Holotype.—The specimen described and figured by Chapman (1925, p. 113-114, pl. xiv., figs. 18a, b ; pl. xv., figs. 25, 26), now in the National Museum, Melbourne ; Hatton's Corner, Yass ; Silurian.

Description.—Corallum compound, cerioid, reaching a diameter of 15 cms. or more. Corallites polygonal, variable in size, average diameter about 5 mm. Epitheca thick. Septa very variable in number, average 20-30.* Major septa arising from the epitheca, stout at their bases, but rapidly becoming thin, reaching or almost reaching the centre of the corallites. Minor septa very variable in development, sometimes arising directly from the epitheca, more often starting as spines and crests on the first or second cycle of dissepiments, in which case the dissociated peripheral ends appear as septal ridges on the epitheca. Dissepiments large, in two or three cycles, strongly curved, steeply inclined, almost vertical at the theca. Tabulate area narrow, about one-third the diameter of the corallites. Tabulae nearly all complete, about 2 per mm.

* The large corallite shown in Pl. III., figs. 1 and 2, has 60 septa.

Remarks.—The great variation in the number of septa is in part due to the variable development of the minor septa, but the number of septa also increases rapidly with the increase in size of the corallites.

S. shearsbii differs from the genotype in having much thicker walls, both major and minor septa, the former of which are stout basally and are always attached to the epitheca. Such differences are, perhaps, to be expected in an early form, and may give some indication of the characters of the ancestral stock.

At first glance this species is very like the Devonian *Cyathophyllum manipulatum* Pocta (1902, p. 103, pl. 64 ; pl. 103, fig. 3 ; pl. 104, figs. 6, 7 ; pl. 112, figs. 1-3) from Bohemia. Examination of thin sections of the latter has shown it to differ in several respects ; its corallites are slightly larger and septa more numerous, and it has a narrow stereozone extending about 1 mm. inside the epitheca. Apart from the stereozone in *C. manipulatum* the longitudinal sections are very similar.

Locality.—Bowspring Limestone, Hatton's Corner, Yass, N.S.W.

Age.—Upper Silurian.

SPONGOPHYLLUM STEVENSI Chapman.

1925 *Spongophyllum stevensi* F. Chapman, p. 113, pl. xiv., figs. 17a, b ; pl. xv., figs. 24, 27.

Holotype.—The specimen described and figured by Chapman (1925, p. 113 ; pl. xiv., figs. 17a, b ; pl. xv., figs. 24, 27). Now in the National Museum, Melbourne. Cave Hill, Lilydale. Silurian.

Remarks.—This species was founded on a single corallum from Lilydale, and the writer has not obtained any further specimens. According to Chapman the epitheca is even thicker than in *S. shearsbii*. The important difference from the latter is that the major septa extend only about half way to the centre.

Locality.—Cave Hill, Lilydale, Victoria.

Age.—Upper Silurian (Yeringian).

SPONGOPHYLLUM SPONGOPHYLLOIDES (Foerste).

Plate III. ; Figures 3, 4.

1888 *Endophyllum* (*spongophylloides*) A. F. Foerste, pp. 131-2, pl. xiii., figs. 16-17.

1889 *Lonsdaleia*? (*Spongophyllum*) *bipartita* R. Etheridge, junr., pp. 22-26 ; pl. III., figs. 1-5.

1925 *Spongophyllum bipartita* (Eth. fil.) F. Chapman, pp. 114-5.

Holotype.—The specimen figured by A. F. Foerste, 1888, pl. xiii., figs. 16, 17, now in the British Museum (Natural History).

Description.—Corallum massive, forming large, probably hemispherical masses, with a "thin and pellicle like (basal) epitheca, bearing broad longitudinal subangular ribblets, and distant secretion ridges."* Corallites variable in size both in the same specimen and from specimen to specimen, 10 to 16 mm. in diameter. Epitheca well developed but thin, bearing pronounced septal ridges.† Septa thin; very variable in development, some younger corallites having very few indeed. Major septa 18-20, often meeting at the middle of the corallites, but seldom reaching the epitheca, usually ending as crests on the dissepiments. Minor septa poorly developed, sometimes absent or represented only by ridges on the epitheca; when fully developed, equal in number to the major.‡ Dissepimental area wide. Dissepiments large, forming several series of steeply inclined, curved plates, supplemented by a considerable number of smaller plates. Tabulate area very narrow, 1/4 to 1/5 of the diameter of the corallites; tabulae thin, mostly complete, fairly numerous, 10 or 12 in a space of 3 mm.

Remarks.—The writer has had the opportunity of examining Foerste's own material, now at the British Museum, and there is no doubt of the identity of *S. bipartita* with the coral which Foerste called "*Endophyllum spongophylloides.*" Neither Foerste's description nor his figure is accurate, which led to Chapman (1925, p. 115) regarding them as distinct species.

This species differs from the genotype, *S. sedgwicki* § in several respects. In *S. spongophylloides* the corallites are nearly twice as large and the septa, tabulae and dissepiments are more numerous. There can, however, be no doubt concerning its reference to *Spongophyllum*—the septa being weak, the dissepiments large and the tabulate area narrow.

Etheridge thought he detected the presence of a rudimentary columnella, and so doubtfully referred it to the genus *Lonsdaleia*, but the writer, dealing with a considerable quantity of excellently preserved material, has found no trace of one.

This species is similar to *S. inficetum* Pocta (1902, p. 153, pl. 102, fig. 1), but the latter has smaller corallites—5 to 7 mm. in diameter, and the septa, which cannot be divided into major and minor are 30 to 34 in number. *S. inficetum* is from stage E^2 of the Bohemian deposits, which, according to Kayser (1923, p. 130), is near the top of the Upper Silurian.

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* The basal epitheca is not preserved on any of the specimens which the writer has examined; the above remark is quoted from Etheridge (1889, p. 24).

† The septal ridges are very marked in tranverse sections of well preserved specimens, but are not always noticeable in poorly preserved examples. They are not shown in Etheridge's figure.

‡ Etheridge (loc. cit., p. 24) states that the septa are all major—"careful examination having failed to detect the presence of intermediate and smaller radii." Some of the specimens in the writer's collection show no minor septa; this is due to poor preservation, which was probably the case with Etheridge's material.

§ See Edwards and Haime, 1853, p. 242, pl. lvi., figs. 2—2e; O.A. Jones, 1929, p. 88.

Localities.—Bowspring Limestone, Hatton's Corner, Yass; Barrandella Limestone, Hatton's Corner, Yass; Derrengullen Creek, Yass; Limestone Creek, Yass; Humewood Lead Mine, near Yass (Etheridge); Bowning, N.S.W. (Foerste).

Age.—Upper Silurian.

SPONGOPHYLLUM sp.

1911 *Spongophyllum* sp. R. Etheridge, jun., p. 8, pl. B., figs. 3, 4.

Remarks.—Etheridge's material was very poorly preserved and as no further specimens have been obtained, a new name is not justified. It probably does represent a new species which is most nearly related to *S. spongophylloides.* It is distinguished from the latter by its few and very weak septa, and the smaller size of its corallites.

Locality.—Chillagoe, Queensland.

Age.—Upper Silurian.

SPONGOPHYLLUM GIGANTEUM Eth. fil.

1899 *Spongophyllum giganteum* R. Etheridge, jun., pp. 158-9, pl. xx., figs. 1-3; pl. xxxviii., fig. 3.

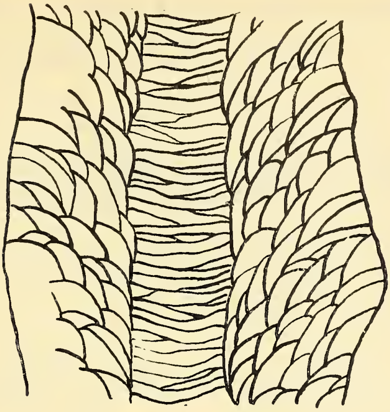
1922 *Spongophyllum giganteum* Eth. fil.; W. N. Benson, p. 66.

Lectotype (here chosen).—The specimen figured by Etheridge, 1899, pl. xx., fig. 2; it is preserved in the Australian Museum—registered number F. 4294. Other specimens figured by Etheridge—pl. xxxviii., fig. 3 (F. 4315), pl. xx., fig. 1 (F. 4293)—are also in the Australian Museum. The original of pl. xx., fig. 3, cannot be traced.

Description.—Corallum compound, cerioid. Corallites prismatic, polygonal, large—20 mm. or more in diameter. Epitheca well developed, moderately thin. Septa, very variable in development, 40 to 50 in number, all of about the same length, extending nearly to the centre, but only occasionally reaching the cpitheca, usually breaking up into crests on the peripheral dissepiments. Dissepiments large, steeply inclined, becoming nearly vertical to form a well marked theca at their junction with the tabulae. Tabulate area narrow, about one-third of the diameter of the corallite. Tabulae very numerous, complete and incomplete, concave upwards, ending abruptly at the theca.

Remarks.—Etheridge stated that the tabulae are rarely complete; their apparent incompleteness is due to their crowded nature and the difficulty in obtaining a longitudinal section in which they are not broken up by the septa.

This species differs from the genotype in being much larger, having nearly three times as many septa, and more numerous tabulae. The weak septa, narrow intrathecal area, well marked theca, and large dissepiments at once place it in this genus.



TEXT FIGURE 1.

Diagram of longitudinal section of a specimen of *S. giganteum*, from Moore Creek. × 5. The dissepiments are in part obscured.

Of the Australian species it is most like *S. spongophylloides* (Foerste), but it has more septa and is larger.

Locality.—Moore Creek Limestone, Moore Creek, near Tamworth, N.S.W.

Age.—Middle Devonian.

SPONGOPHYLLUM CYATHOPHYLLOIDES ETH. FIL.

1911 *Spongophyllum cyathophylloides* R. Etheridge, jun., pp. 7, 8; pl. A., fig. 3; pl. C.

1922 *Spongophyllum cyathophylloides* Eth. fil.; W. N. Benson, p. 66.

Lectotype (here chosen).—The specimen figured by Etheridge, 1911, pl. A, fig. 3; pl. C, fig. 2. The specimen (four pieces) is in the Australian Museum—registered numbers F. 9494-7. The other figured specimen—pl. C, fig. 1, is also in the Australian Museum—registered numbers F. 9717-8.

Remarks.—No new material of this species has been examined and Etheridge's description and figures are quite adequate. The epithecal walls are the thickest of any of the Australian species. As in the genotype the septa sometimes reach the epitheca, but usually do not; they are more numerous than in the latter; also the dissepiments are more numerous, but the narrow tabulate area is a feature common to both.

Locality.—Clermont, Queensland.

Age.—Devonian.

SPONGOPHYLLM HALYSITOIDES Eth fil.

1918 *Spongophyllum halysitoides* R. Etheridge, jun., p. 49, pl. vii.

1922 *Spongophyllum halysitoides* Eth. fil.; W. N. Benson, p. 67.

1924 *Spongophyllum* cf. *halysitoides* Eth. fil.; H. C. Richards and W. H. Bryan, pp. 97, 98-99, pl. xvii., figs. 1, 2.

Holotype.—The specimen described and figured by Etheridge, 1918, p. 49, pl. vii., figs. 1-3; Road near Beedles' Farm, Moonbi, County Inglis, N.S.W. Middle Devonian.

Description.—Corallum compound, cerioid. Corallites polygonal, variable in size, diameter 4 to 6 mm. Epitheca well defined, moderately thin, bearing marked septal ridges.*

Septa absent or represented by a few short lamellae or crests about the theca. Dissepiments very large, forming a single series of steeply inclined convex plates, supplemented by a few smaller plates. Tabulate area very narrow, about one-fourth of the diameter of the corallite. Tabulae complete, horizontal, four or five in a space of 3 mm., ending abruptly against the vertical dissepiments, thus forming a well marked theca.

Remarks.—For some reason Etheridge quite misinterpreted the structure of this coral. It is clear that when he described, in longitudinal section, a tabulate zone with "egg shaped vesicles" surrounded by a narrow zone of complete horizontal tabulae, he described two corallites as if they were one,† the large convex dissepiments of the two corallites giving his zone of egg shaped vesicles.

Text Figure 2.

Diagram of longitudinal section of a specimen of *S. halysitoides*, from Silverwood. × 4.

The longitudinal section is strikingly like that of the genotype in its marked theca, large dissepiments and narrow tabulate area, with few and complete tabulae. The almost complete absence of septa at once separates it from the latter, and in this respect it

* The thick, short, septal ridges give rise to that appearance in transverse section which Etheridge described as like a "string of minute shuttle-like figures, swelling and contracting alternately," and from which he derived the trivial name.

† In the thin section from which his figure was taken (pl. vii., fig. 3) the two centre corallites have parted, causing the destruction of the wall, and this may have led to his overlooking the fact that they are two corallites.

approaches more closely to *S. kunthi* Schluter (1881, pp. 96-99, pl. xii., figs. 1, 2), which, in its development of septa, lies between the genotype and the species under discussion.

The writer has examined the specimen from rolled Devonian pebbles in the Carboniferous at Mt. Lion which Dr. Whitehouse (1928) recorded as *S. halysitoides.* This coral is about four times as large as *S. halysitoides,* but otherwise is very similar to it. The only specimen is very crystalline, and more material is needed before a definite conclusion as to its relationships can be reached.

It may be noted that this species has been recorded from two of Benson's Devonian provinces (see Benson, 1922), viz.: the Eastern (Nemingha Limestone, Lower Middle Devonian) and the North Eastern (Upper Middle Devonian)—if Dr. Whitehouse's identification be accepted—and also from Silverwood, which area Richards and Bryan (1924, pp. 59, 98-99) regarded as intermediate between the above two provinces, but more closely related to the former.

Localities.—Road near Beedles' Farm, Moonbi, Co. Inglis, N.S.W. (Nemingha Limestone, Lower Middle Devonian); Limestone Siding, near Silverwood; Lomas North, near Silverwood; (Lower? Middle Devonian).

? *SPONGOPHYLLUM* sp.

1918 *Spongophyllum sp. nov.*, W. S. Dun and W. N. Benson, pp. 377-8, pl. xxxiv., figs. 2, 3; text fig. 5 on page 378.

1922 *Spongophyllum sp.*, W. S. Dun; W. N. Benson, p. 67.

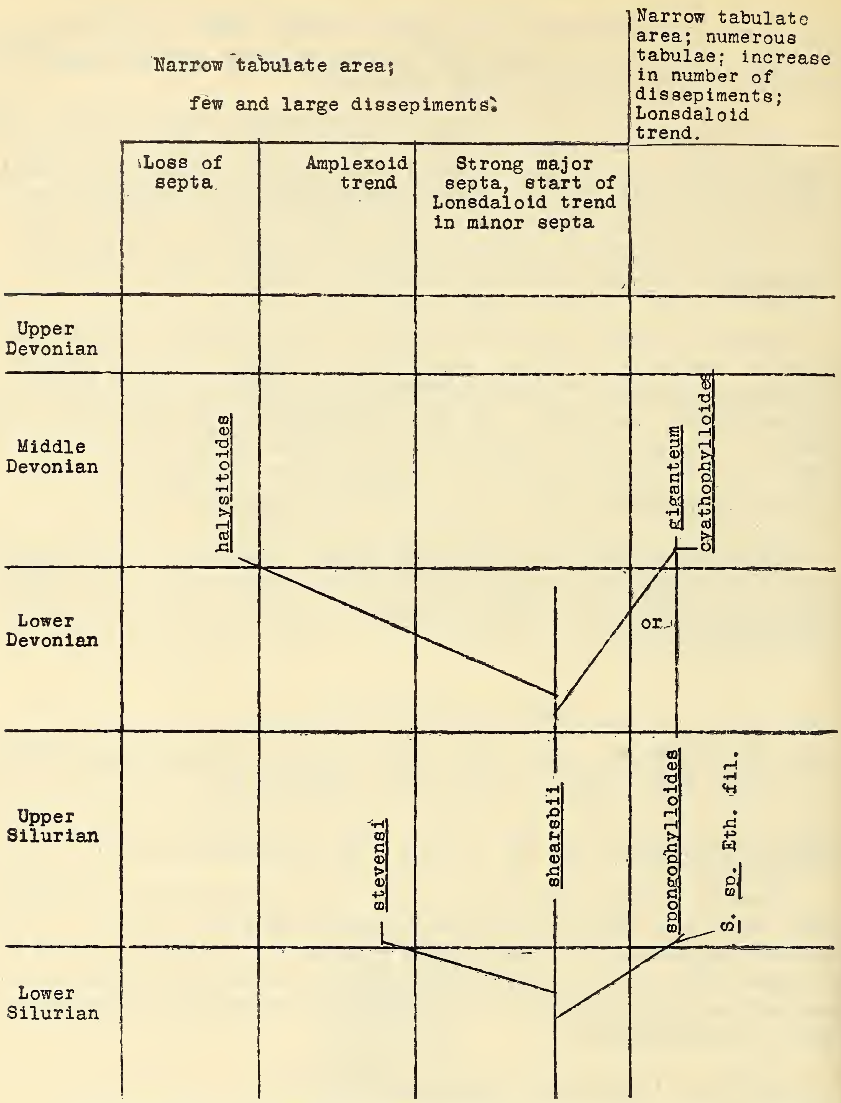
Remarks.—The writer has not been able to examine the material which Dun and Benson described as Spongophyllum sp. nov. The material appears to have been badly preserved and the figs. 2 and 3, pl. xxxiv., are obscure. From the text fig. 5 (a drawing of the transverse section) the form appears more likely to be related to *Endophyllum* than to *Spongophyllum.*

Locality.—Loomberah Limestone, N.S.W.

Age.—Middle Devonian.

SUMMARY OF THE CHARACTERS AND RELATIONSHIPS OF THE AUSTRALIAN SPECIES OF *SPONGOPHYLLUM.*

These species fall into three well defined groups—(1) *S. shearsb i* and *S. stevensi*; (2) *S. spongophylloides*, *S. sp.* Eth. fil., *S. giganteum*, and *S cyathophylloides*; (3) *S. halysitoides.* The first group may be again divided on the presence or absence of the *amplexoid* trend. The following table (p. 58) sets out these groups with their distinguishing characters and also serves to indicate a possible evolution of the species. It must be stressed, however, that, owing to the gap between the Upper Silurian and the Middle Devonian, the evolutionary scheme is extremely hypothetical.



S. halysitoides approaches most closely to the genotype, but differs in the absence of septa. *S. shearsbii* and *S. stevensi* are very like the genotype in longitudinal sections but transverse sections show them to possess strong septa and epitheca ; but this perhaps is not surprising in forms earlier in age than the genotype. The *S. spongophylloides*, *S. giganteum* group shows a more complex structure ; the septa are more numerous and are differentiated into major and minor ; dissepiments are more numerous but still large ; and tabulae are more numerous and sometimes incomplete.

Probably the ancestral form was a species with strong epitheca and septa, few and large dissepiments and a narrow tabulate area. Development perhaps proceeded along two main lines—(1) loss of septa by retreat both from the centre (*S. stevensi*) and from the walls (*S. halysitoides*) ; (2) increase of all the coral tissue except the septa which retreated from the walls (*S. spongophylloides*, *S. giganteum* group).

ENDOPHYLLUM SCHLUTERI Etheridge fil.

1898 *Endophyllum schluteri*, R. Etheridge, jun., pp. 43-46, pls. IV., V.

1922 *Endophyllum schluteri*, Eth. fil. ; W. N. Benson, p. 67.

Lectotype (here selected).—The specimen from which the slides (M. 233 (2)) figured by Etheridge, 1898, pl. V., figs. 1, 2, were cut. Now in the collection of the Geological Survey of New South Wales.

Remarks.—The writer has examined the material described by Etheridge, 1898. Etheridge's figures as well as this material show clearly that this species is closely related to the *Endophyllum bowerbanki* end of the *bowerbanki-abditum* series (see O. A. Jones, 1929, p. 85) ; his description may be supplemented in a few points. The major septa are very strong at the base, but rapidly become very thin and somewhat flexuous. As in *E. bowerbanki* E. and H., the minor septa are very short, and both major and minor septa break up peripherally into a vertical series of crests resting on the successive dissepimental platforms. There are two series of tabulae, a central flat series and an outer series inclined downwards to the well marked theca, very similar to those in the lectotype, (see Etheridge, 1898, pl. V., fig 4). The species agrees also in size with *E. bowerbanki*, but the dissepiments are even larger and much thicker, numbers uniting to form thick floor like expansions, with thinner ones in between. There are about 28 major septa in *E. schluteri* and 30 to 35 in *E. bowerbanki*.

Localities.—Isis River, Parish of Crawney, Co. Brisbane, N.S.W. (M. Devonian) ; Moore Creek, near Tamworth, N.S.W. (M. Devonian).

ENDOPHYLLUM SCHLUTERI Eth fil. var *COLLIGATUM* Eth. fil.

1920 *Endophyllum schluteri* Eth. fil, var. *colligatum*, R. Etheridge, jun. p. 55, pl. xiii ; pl. xiv., fig. 1.

1922 *Endophyllum schluteri* Eth. fil, var. *colligatum*, Eth. fil. ; W. N. Benson, p. 67.

Lectotype.—The author has not been able to trace the specimens figured by Etheridge, but has examined some of his material. Specimen F. 9228 (2 sections cut) is here chosen tentatively as lectotype.

Remarks.—Etheridge's description of this variety is not very clear, but his figures show it to be a form corresponding to about the middle part of the *bowerbanki-abditum* series. Thus, in parts, it is cerioid or sub-phaceloid instead of astraeoid, and a weak epitheca is then developed. The septa frequently reach the epitheca and are not modified peripherally to as great an extent as in *E. schluteri*. The corallites and intrathecal areas are about the same size in the species and the variety.* In the astraeoid parts of the coralla the structure is indistinguishable from that of the species.

* Etheridge, p. 55, stated that the corallites in the variety are larger, but he compared the diameter of the corallites of the variety with the diameter of the intrathecal areas of the species.

Locality.—Moore Creek, near Tamworth, N.S.W. (Upper Middle Devonian).

ENDOPHYLLUM sp.

This form collected by Mr. L. C. Ball from Kroombit Creek, about 50 miles south south-west of Gladstone, differs from both the previous forms. The material is very poorly preserved—too poorly to warrant a trivial name or to give figures.

The most marked difference between this and the other Australian forms is that the former possesses a definite epitheca which appears to be somewhat thickened by stereoplasm. The form is, therefore, related to the *E. abditum* end of the *E. abditum-E. bowerbanki* series.* The corallum is cerioid or sub-phaceoid; the corallites are about 12 mm. in diameter; the septa, which are confined to the intrathecal area, are of two orders. The major vary greatly in length, sometimes reaching almost to the centre, sometimes but a short distance into the intrathecal area; the minor are one-third to half the length of the major. The tabulae are divided into two series and are crowded as in the genotype. The dissepiments are so crushed and broken in the available material that their disposition cannot be determined.

Locality.—Kroombit Creek, 50 miles s.s.w. of Gladstone.

Age.—Devonian.

APHROPHYLLUM HALLENSE Smith.

1920 *Aphrophyllum hallense* S. Smith, p. 53, pl. 11, figs. 1-5.

Remarks.—Dr. Stanley Smith noted (p. 55) the close resemblance in transverse section, of *A. hallense* and *Endophyllum abditum* Edwards and Haime (1851, p. 394; 1853, p. 233, pl. liii., fig. 6). See also Jones (1929, p. 87, pl. x., figs. 3, 4). Examination of longitudinal sections of *E. abditum* has brought to light further characters in common. As in *Endophyllum* the tabulae of *Aphrophyllum* are divided into two series—an inner flat or slightly arched series the members of which are frequently incomplete and an outer series which curve sharply down to the theca in *Aphrophyllum* but sharply down and then up again to the theca in *Endophyllum*. Further, the dissepiments in both are very large and steeply inclined.

The points of agreement of the two genera may be summarised as follows:—

(1) The septa frequently do not reach the epitheca.

(2) The dissepiments are large and steeply inclined.

(3) The tabulae are in two series.

* See O. A. Jones, 1929, p. 85.

Now these are the generic characters of *Endophyllum*, but it is perhaps inadvisable to merge the two genera at present, as they are probably an example of heterogeneous homeomorphy.

Locality.—Carboniferous Rocks, Parish of Hall, 16 miles south of Bingara, N.S.W.

CRINOPHYLLUM gen. nov.*

Genotype.—Spongophyllum enorme R. Etheridge, jun. (1913, p. 35, pls. IV.-VII.). Escarpment north east of Boonoo Ponds Creek, Hatton's Corner, Yass River, near Yass ; Upper Silurian.

Diagnosis.—Cerioid rugose corals with septa developed only as crests on the dissepiments and tabulae. Tabulate area moderately wide. Dissepiments very large and rather flat, forming, at their junction with the tabulae, a well marked theca.

Remarks.—In vertical sections the genus shows some likeness to *Ketophyllum* Wedekind (1927, Taf. 15). The latter is, however, a simple coral, has smaller dissepiments and a stronger development of septa.

The genus differs from *Spongophyllum* E. and H. in having less well developed septa, much flatter dissepiments and a wider tabulate area.

CRINOPHYLLUM ENORME (Eth. fil.).

Plate IV. Figures 2 and 3.†

1913 *Spongophyllum enorme* R. Etheridge, jun., pp. 35-37, pls. iv., vii.

Description.—Corallum compound, cerioid, forming very large spreading masses. Corallites polygonal, very large, 2 to 4 cms. in diameter. Calices funnel shaped, moderately deep, somewhat flattened at the peripheries, flat bottomed. Septa numerous but very weak, developed only as crests on the dissepiments, passing a short distance into the tabulate area ; variable in strength and number from corallite to corallite. Dissepiments very large, rather flat at the periphery, curving sharply down till almost vertical at the theca, supplemented by a few smaller curved plates at the periphery. Tabulate area moderately wide. Tabulae numerous, complete and incomplete, flat in the centre, sometimes curving up and passing imperceptibly into the dissepiments, more often ending abruptly against them.

Remarks.—Etheridge stated (p. 35) that the tabulae "pass insensibly into the general body of smaller vesicles forming the peripheral mass of each corallite" ; but both in his figure (pl. vii., fig. 1) which, it should be noted, is upside down, and in the sections examined by the writer, they more often end abruptly against the almost vertical dissepiments, thus forming a very marked theca.

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* *Κρῖνον* = a lily.

† For good figures of externals and further photomicrographs, see Etheridge, oc. cit., pls. iv-vii.

In very weathered specimens the corallites frequently break along the large dissepiments giving a series of invaginated cups.

Localities.—Etheridge's material was from the Boonoo Ponds Limestone, Boonoo Ponds Creek, Hatton's Corner, Yass. The writer has obtained material from the equivalent Bowspring Limestone, Hatton's Corner, Yass.

Age.—Upper Silurian.

BIBLIOGRAPHY.

Benson, W. N., 1922.—Material for the study of the Devonia · Palaeontology of Australia. Rec. Gol. Surv. N.S.W., Vol. x., pt. 2, pp. 83 2(4, pls. xiii, xiv., xiv a.

Chapman, F., 1925.—New or Little Known Fossils in the National Museum. Pt. xxviii., Some Silurian Rugose Corals. Proc. Roy. Soc. Victoria, vol. xxxvi (n.s.), pt. 1, pp. 104-118, pls. xii-xv., May, 1925.

Dun, W. S. and Benson, W. N., 1918.—In Benson, W. N., The Geology and Petrology of the Great Serpentine Belt of N.S.W., pt. vii. The Geology of the Loomberah District and a portion of the Goonoo Goonoo Estate. Proc. Linn. Soc. N.S.W., Vol. xlii., pt. 2, July, 1918, pp. 375-382, text figs. 3-5, pls. xxxiv-xxviii.

Edwards, H. M. and Haime, J., 1851.—Pol. Foss. Terr. Pal. Arch. Mus. d'Hist. Nat., Tome V.

Edwards, H. M., and Haime, J., 1853.—A Monograph of British Fossil Corals, pt. iv., Corals from the Devonian Formation. Palaeontographical Society.

Etheridge, R. Junr., 1889.—On the Occurrence of a Coral, intermediate in its structure between the Genera *Lonsdaleia* and *Spongophyllum* in the Upper (?) Palaeozoic Rocks of N.S.W. Rec. Geol. Surv. N.S.W., Vol. 1, pt. 1, No. iv., pp. 22-26, pl. ii., figs. 1-5.

——————, 1898.—On the Occurrence of the Genus *Endophyllum*, E. and H. (emend. Schluter) in the Lower Palaeozoic Rocks of N.S.W. Rec. Geol. Surv. N.S.W., Vol. vi., pt. 1, pp. 43-46, pls. iv., v.

——————, 1899.—On the Corals of the Tamworth District. . . . . Rec. Geol. Surv. N.S.W., Vol. vi, pt. III., July, 1899, pp. 151-182, pls. xvi-xxxviii.

——————, 1911.—The Lower Palaeozoic Corals of Chillagoe and Clermont. Queensland Geol. Surv., pub. No. 231, pp. 1-8, pls. A-D.

——————, 1913.—A very remarkable species of *Spongophyllum* from the Upper Silurian Rocks of N.S.W. Rec. Aust. Mus., Vol. X., No. 3, pp. 35-37, pls. IV-VII.

——————, 1918.—Two Remarkable Corals from the Devonian of N.S.W. . . . . Rec. Aust. Mus., Vol. xii., No. 4, April, 1918, pp. 49-51, pls. vii-ix.

——————, 1920.—Further additions to the Coral Fauna of the Devonian and Silurian of N.S.W. Rec. Geol. Surv. N.S.W., Vol. ix., pt. 2, pp. 55-63, pls. xiii-xv.

Foerste, A. F., 1888.—Notes on Palaeozoic Fossils. Bull. Sci. Lab. Denison Univ., Vol. III., pt. II., pp. 117-136, pl. xiii.

Jones, O. A., 1929.—On the Coral Genera *Endophyllum*, Edwards and Haime, and *Spongophyllum*, Edwards and Haime. Geol. Mag., Vol. lxvi., No. 776, Feb., 1929, pp. 84-91, pl. x.

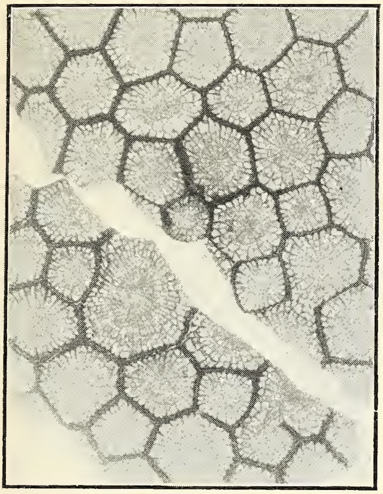

Fig. 1.

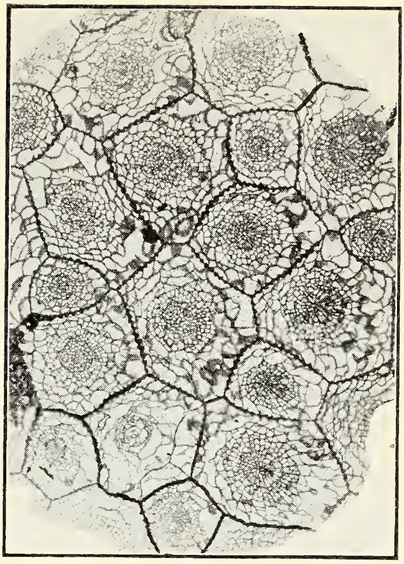

Fig. 3.

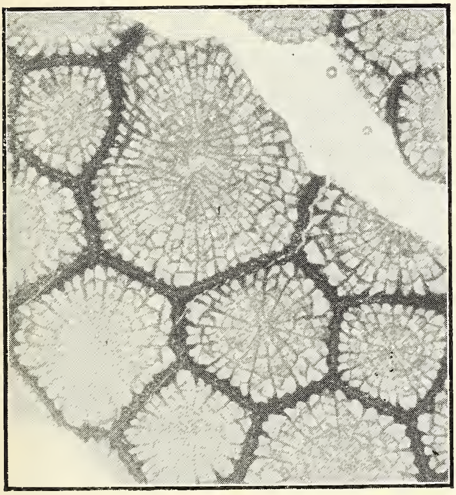

Fig. 2.

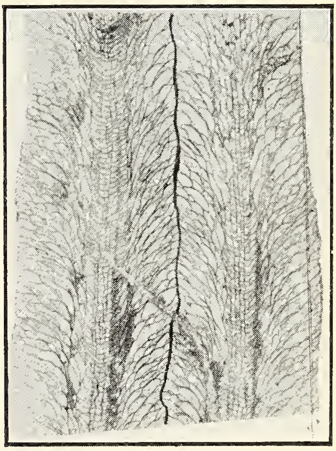

Fig. 4.

Spongophyllum shearsbii Chapman.

Fig. 1.—Transverse section of a specimen from the Bowspring Limestone, Hatton's Corner, Yass. × 2.

Fig. 2.—Portion of the same section. × 4. The lonsdaloid trend in the minor septa is well displayed in the large corallite.

Spongophyllum spongophylloides (Foerste).

Fig. 3.—Transverse section of a specimen from Limestone Creek, Yass. × 2.

Fig. 4.—Longitudinal section of a specimen from the Barrandella Limestone, Hatton's Corner, Yass. × 2.

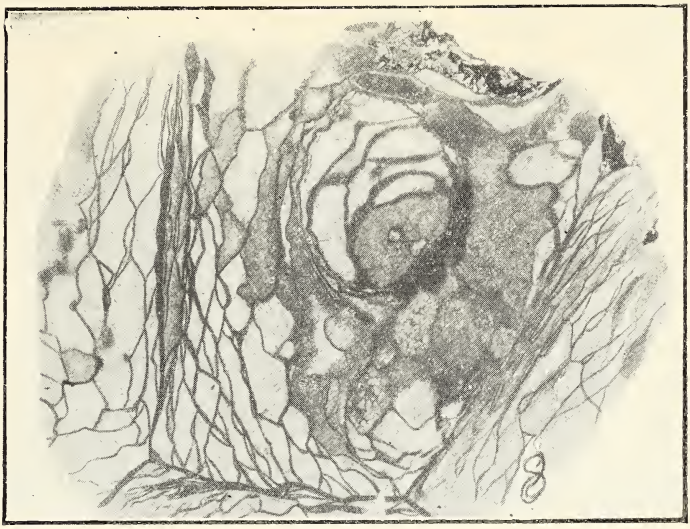

Fig. 2.

Fig. 3.

Fig. 1.

Spongophyllum shearsbii Chapman.

Fig. 1.—Longitudinal section of the same specimen as pl. III. figs. 1, 2. × 2.

Crinophyllum enorme (Eth. fil.).

Fig. 2.—Transverse section of a specimen from the Bowspring Limestone, Hatton's Corner, Yass. × 2.

Fig. 3.—Longitudinal section of the same. × 2.

KAYSER, E., 1923.—Lehrbuch der Geologischen Formationskunde, zwei Bande, 1 Bd., 8 vo., Stuttgart.

POCTA, P., 1902.—in Barrande, J., Systeme Silurien du Centre de la Boheme. 1st part, vol. viii., Tome 11, Prague.

RICHARDS, H. C. AND BRYAN, W. H., 1924.—The Geology of the Silverwood-Lucky Valley area. Proc. Roy. Soc. Queensland, Vol. xxxvi., No. 6, pp. 44-108, pls. vii-xx.

SCHLUTER, C., 1881.—Ueber einige Anthozoen des Devon. Zeits. d. deut. geol. Gesell., Bd. 33, pp. 75-108, pls. vi.-xiii.

SMITH, S., 1920.—On *Aphrophyllum hallense* gen. et sp. nov. and *Lithostrotion*, from the neighbourhood of Bingara, N.S.W. Jour. an Proc. Roy. Soc. N.S.W., Vol. LIV., pp. 51-65, pls. ii.-v.

WEDEKIND, R., 1927.—Die Zoantharia Rugosa von Gotland. . . Sveriges Geol. Undersokning, ser. Ca., No. 19, Avhanlingar och uppsatser i 4 : 0.

WHITEHOUSE, F. W., 1928.—Abstract Proc. Roy. Soc. Queensland, Vol. xxxix, p. xi.

Preliminary Note on the Geology of Mount Barney

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(*Read before the Royal Society of Queensland, 25th July*, 1932).

I. INTRODUCTION.

The following note is the result of a recent visit to Mount Barney made with the express purpose of investigating the possible occurrence of late Palaeozoic strata within the area.

In the year 1911 there appeared the following paragraph in a paper by Wearne and Woolnough* dealing with the geology of West Moreton :

" An inlier of Permo-Carboniferous rocks is to be found immediately to the north west of Mount Barney, a high double peaked mountain, which is situated about six miles to the north-north-west of Mount Lindesay. These rocks have been previously considered as of Trias-Jura age, but the discovery of a definite specimen of *Fenestella fossula* Lonsd., submitted to Mr. W. S. Dun for indentification places them in the Permo-Carboniferous. This is the first record of Permo-Carboniferous fossils in the West Moreton District."

Later in the same paper† there appears the statement " Mount Barney the culminating peak of southern Queensland, 4,625 feet high, is also composed of rhyolite, intruded by basalt dykes." Wearne and Woolnough considered this rhyolite to be of Tertiary age.

In another paper published in the same year Wearne‡ stated that Mount Barney " was found to consist of rhyolite intruded by basalt and dolerite," but added that " The age of the volcanic eruptions was found to be Trias-Jura contemporaneous with the uppermost portion of the Walloon stage of the Ipswich coal-measures."

In 1915 Richards§ after considering all the relevant evidence concluded that he was " unable to accept the evidence for a Trias-Jura age " but was " firmly of the opinion that these rocks have all been extruded during the Cainozoic era." Of the Mount Barney area

* Proc. Roy. Soc. N.S.W., Vol. XLV., p. 142.

† Op. cit., p. 147.

‡ A.A.A.S., 1911, p. 194.

§ Proc. Roy. Soc. Qld., Vol. XXVII., p. 131.

in particular the same author states :* " Large masses of rhyolitic rocks which seem to represent plugs associated with central vents occur at Mount Lindesay, Mount Barney . . . . " and again " On the Upper Logan River between Mounts Lindesay and Barney, there are rhyolitic dykes intruding the Walloon sandstones and shales, and at the Yellow Pinch reserve, just to the east of Mount Barney, there is a rhyolitic dyke about 15 feet wide, which has severely baked the intruded sandstones and shales. Heat metamorphism of the intruded coal measures seems to have been more pronounced in connection with the Mount Barney mass than in any other locality examined."

In 1916 Walkom† recorded " the occurrence of *Fenestella* and *Polypora* (?) in a boulder about eight inches in diameter in a conglomerate of Cainozoic age near Richmond Gap." Referring to the specimen of *Fenestella* collected by Wearne near Mount Barney (some 16 or 17 miles away) Walkom wrote : " Mr. Wearne has informed me that he collected the specimen when time did not permit him to make any further investigations as to its source, and he agrees with me that it was probably another such occurrence as the one now recorded."

In 1923 Morton‡ made a geological reconnaissance of the Upper Logan and Albert River watersheds which included a hurried traverse up the Logan River. The map accompanying the report shows Mount Barney as part of a mass of " high precipitous ranges mainly rhyolite " and assigned to the Tertiary era. This mass is shown as bounded on the east by members of the " Upper Jurassic Walloon Series " dipping to the east at angles which vary from 30 degrees to 40 degrees.

II. INVESTIGATIONS IN THE FIELD.

The first step in our field investigations was a thorough examination of the pebbles in the bed of the Upper Logan River about one mile downstream from the locality known as the Yellow Pinch. This search soon revealed boulders of a dark fine-grained quartzite containing crinoid stems and bryozoa.

Proceeding upstream an examination was made of the pebbles at the mouth of the tributary streams (at this time dry water courses) which drain the eastern part of the Mount Barney mass. The first stream course to be examined (a short tributary joining the river in the north-eastern part of Portion 127 V.) contained no boulders with marine fossils, but only sandstone and other pebbles lithologically similar to the undoubted Mesozoic sediments found farther to the east. A little further up the Logan Valley a larger and longer water course enters the river. (This is unfortunately not shown on the land map). The pebbles at the mouth of this creek were found to contain a greater proportion of fossiliferous marine sediments than those of the Logan River itself, although mixed with these were pebbles of grits and sandstones of a Mesozoic appearance and two apparently different varieties of rhyolite. It was decided to proceed up the dry creek bed

* Op. cit., p. 132.

† Proc. Roy. Soc. Qld., Vol. XXVIII., p. 101.

‡ Qld. Govt. Min. Jrnl., p. 244.

which was found to run in an easterly direction through Portion 127 V roughly parallel to and a little to the north of the surveyed road shown in that portion. This westerly traverse revealed at first nothing but grits and sandstones of a Mesozoic aspect, nearly horizontal or dipping towards the west. After about half-a-mile, greenish brown sandstones were encountered striking N.N.E. and dipping westerly at 60°. A sudden change in strike separated these beds from sandstones and mudstones containing indeterminate plant remains and striking N.N.W. with a steep dip to the west. This 45° change in the strike of steeply dipping beds within a few yards strongly suggested an important fault at this point.

The beds containing the indeterminate plant remains were conformably succeeded by a very compact bar of rhyolite which forms a waterfall some 15-20 feet in height at this point.

This appears to be either an interbedded flow or a sill as the junction with the associated mudstones is very sharp and no cutting across the bedding is noted. The margin of this fine grained rhyolite is fluidal.

There is a sharp difference in appearance between this conformable rhyolite and the micrographic rhyolite which forms the main mass of Mount Barney*.

As the creek bed was followed up still further to the west, the sediments which succeeded the rhyolite became more and more compact. The strike of the sediments which were now almost vertical in position was N.N.W. and any dip the strata had was very steeply inclined easterly.

The fossil remains of bryozoans were found associated with these indurated sediments.

Intercalated with these sediments was another but much smaller mass of rhyolite.

Continuing in a westerly direction from these fossiliferous beds towards the summit of Mt. Barney, massive, fine-grained, felspathic grits were encountered. These rocks, which usually are so massive that it was impossible to make any definite observations of dip and strike, extend westwards for about three-quarters of a mile and to a height of 2,000 feet above sea-level. Near this point a thin, interbedded conglomerate was found with pebbles of a pink granite.

Here these older sediments are intruded by the mass of the Mt. Barney micrographic rhyolite which extends, with practically no variation in the hand specimens, to the summit of the mountain. This igneous mass, which weathers into rounded boulders in a way resembling a granite, has occasionally a rude columnar structure. It is intruded by a dolerite dyke, about 7 feet wide, that weathers away to

* Examination under the microscope, however, shows a rather surprising resemblance between the two in that the groundmass in each case is granophyric.

form the very prominent gorge that is one of the outstanding features of the eastern side of the mountain mass. This is closely comparable and probably continuous with the similar feature described by Wearne on the western side.

In addition to this main mass of micrographic rhyolite an outlier was observed on the ridge in the south-east of portion 127 V., resting on the upturned edges of the marine fossiliferous shales.

This rock has already been described by Richards* in the following terms : " This forms the main plug of Mount Barney and it is somewhat different from the other rhyolites, as it is much coarser. It is greyish white in colour and in patches is stained brown by the limonite resulting from the altered magnetite in the rock. This rock contains phenocrysts of felspar, a good deal of which is possibly anorthoclase, and quartz, the felspar being the more abundant. In many cases the felspars are subidiomorphic, whereas the quartz is allotriomorphic. The groundmass consists of a micrographic intergrowth of quartz and orthoclase, which is developed to a great perfection. The intergrowth forms a framework around the phenocryst which in some cases has been embayed. Frequently one sees the intergrowth radiating off from a particular point or line and there is apparently no nucleus of felspar or quartz. Distributed through the rock are abundant small granules of magnetite which are frequently being altered into limonite. Minute grains of apatite and zircon occur as inclusions in the phenocrysts. Specific gravity 2.50. Name : *Micrographic Rhyolite.*"

A second traverse was made up the valley of the Logan River for a mile or so on either side of the Yellow Pinch in Reserve 191. This showed an interesting series of exposures strictly comparable with those recorded above. The first point of interest is just above the ford where the surveyed bridle track crosses the Logan River. Here the Mesozoic sandstones, showing marked current bedding and containing much fossil wood and interbedded carbonaceous mudstones, dip 15° to 20° in a N.E. direction.

From this point the dip of the sandstones and mudstones becomes gradually but rapidly steeper as one goes upstream until the sandstones and carbonaceous shales become quite vertical and abundant evidence of faulting is seen. On the right bank of the river at this point, which is opposite the central southern part of portion 164, there is a big cliff section exposed by comparatively recent landslides. Recent river gravels and boulder beds some 100 feet above the present stream course have been faulted probably as a result of recent movement along the old fault line. Immediately to the west of the fault rhyolite is met striking N.N.E. and dipping 80°–85° to the east. The width of outcrop of the rhyolite is of the order of 200 feet and is similar to the finer grained rhyolite associated with the older sediments in portion 127 V.

The stratigraphical sequence to the west of the rhyolite in the Logan River valley is precisely the same as in the creek course in portion 127 V. including the presence of the second smaller rhyolite mass. But in

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* Op. cit., p. 136.

addition to the bryozoans there were found in this traverse brownish sandstones containing abundant brachiopods and other marine organisms.

The traverse was continued up the Logan River to a creek bed between portions 201 and 202.

In this creek course the marine sediments were followed west for a half mile and the same N.N.E. strike with steep dip (80° to 85°) in an easterly direction was recorded. Here the marine sediments are more calcareous than noted elsewhere and, while great masses of secondary coarsely crystalline calcite are abundant, much of the sedimentary material consists of a dark, somewhat foetid limestone.

An examination of the right bank of the Logan River as it passes the Yellow Pinch revealed that it was made up of a steep cliff of rhyolite continuous with and on the line of strike of the larger of the two masses met with in both the earlier traverses.

In the southern portion of the Yellow Pinch reserve a very strong fault was observed, the fault line striking in a N.N.E. direction. At this point typical Mesozoic shales and sandstones have been very much disturbed and dip vertically. This fault is almost certainly continuous with the two important faults noticed in the earlier traverses. The three faults if joined form an almost straight line running in a general direction somewhat east of north and with a very slight concavity directed towards Mount Barney.

III. THE AGE OF THE SEDIMENTS.

Two series of sedimentary rocks are present in the area—an older, highly inclined series that has yielded marine fossils, and a younger series, in general with relatively gentle dips, that contains fossil wood and is part of the widespread Lower Mesozoic beds of this part of Queensland.

In the older series the marine fossils have been found in the middle portion of the section at two localities, each of them immediately west of the main mass of the interbedded rhyolite and with comparable strikes and dips. Thus they most probably represent the same zone. This fauna contains *Polypora smithi* Eth. fil., *Aviculopecten* cf. *ptychotis* McCoy, crinoid stems and undescribed species of *Fenestella*, *Pustula*, "*Spirifer*," *Spiriferina*, *Dielasma* and *Pleurotomaria*. This is the fauna of the upper portion of the Rockhampton Series (the Neerkol Series of Reid) in the Stanwell and Neerkol area of central Queensland. Very few elements of this fauna have yet been described; but the same species of *Polypora*, *Fenestella*, *Pustula*, "*Spirifer*" and *Spiriferina* that occur in the beds at Mount Barney are present in the very similar sediments of the Stanwell–Neerkol area.

In Central Queensland these beds lie above the *Amygdalophyllum* Limestone, a wide-spread although intermittent horizon in Eastern Australia that has a fauna of the *Dibunophyllum* (D_2) Zone of the European succession. The overlying *Pustula* beds with which these

Mount Barney beds are to be correlated represent apparently the very top of the Lower Carboniferous. No representatives of the *Amygdalophyllum* Limestone were found in this preliminary survey of the Mount Barney area.

Marine Carboniferous fossils have been found in Queensland also in the hinterland of Gladstone (Mt. Grim), at Cania, Canindah, Mundubbera and Texas. Only at Cania and Canindah, however, do we know of such faunas that would appear to be later than the *Amygdalophyllum* Limestones ; but neither of these faunas is closely to be compared with the forms from the Mount Barney beds.

Fossils are abundant in the Burindi Series of New South Wales ; but, as far as one can gather from published records, very few species have yet been described from the beds above the *Amygdalophyllum* Limestone. No close comparison of the Mount Barney fossils can be made with any of the known Carboniferous faunas of New South Wales.

Thus the only fauna that can definitely be correlated with this assemblage is the suite from the beds immediately above the *Amygdalophyllum* Limestone in Central Queensland ; but, fortunately, a very close comparison indeed can be made with these two faunas.

The two specimens containing fenestellids that previously were described from this area—the one by Wearne and Woolnough and the other by Walkom—have not been traced, so that no further observations are possible on these forms. It seems probable that they may have been derived ultimately from these or similar beds in the area.

In attempting to correlate the section of these older beds as a whole one difficulty arises. These beds are nearly vertical ; but the dips that are recorded are all definitely to the east—which would suggest that the sequence would be, in descending order :—

Compact mudstones with imperfect plant remains ;
    (Larger Conformable Rhyolite)

Sediments without fossils ;
    (Lesser Conformable Rhyolite)

Compact mudstones with marine fossils ;

Massive grits.

However, in such an area of intrusion and faulting with the beds so nearly vertical, it is not impossible that the sequence may be in the reverse order. If the sequence as given is correct, then it would be logical to suggest that the massive grits are equivalent to the rather similar grits in the lower portion of the Rockhampton Series.

No observations were made that place definitely the horizon of the Mesozoic sediments. Fossil wood occurs in these beds, but usually in a bad state of preservation.

IV. GENERAL CONCLUSIONS.

An inlier of marine sediments of Carboniferous age occurs on the south-eastern flanks of Mount Barney in south-eastern Queensland.

The fact that Mr. R. A. Wearne obtained *Fenestella* from the North Western flank of the mountain suggests a considerable extension of the mass in that direction.

The occurrence is in the nature of a horst being separated from the freshwater sediments of the Walloon Series of Jurassic age by a strongly marked fault.

Associated with the fault but within the older series is a large massive sill of rhyolitic nature standing almost vertically. Petrologically this sill and a smaller parallel one are similar to the mass forming the upper portion of Mount Barney and to dykes which penetrate and metamorphose the Walloon sediments, especially in the development of micrographic and granophyric structures.

Note on the Stratigraphical Significance of Monilopora Nicholsoni.

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(*Tabled before the Royal Society of Queensland, 29th August*, 1932).

I. INTRODUCTION.

In several of those classificatory schemes that have been advanced in recent years in an endeavour to correlate the various late Palaeozoic series of Australia, the coral *Monilopora nicholsoni* has played an essential part. It is very important, therefore, that the validity of its use for this purpose be critically examined.

The stratigraphical value of *M. nicholsoni* like that of all other zone fossils will depend upon three things:

1. The precise knowledge of the stratigraphical position of the type ; 2. The strictly accurate diagnosis of all those specimens assigned to the species ; and 3. The stratigraphical range of the species as shown by the relative positions of all specimens that can be confidently referred to the type.

It is the purpose of this note to show that :

1. The stratigraphical position of *M. nicholsoni* where first described in West Australia is not known with certainty.
2. The fossil corals in Eastern Australia referred to *M. nicholsoni* embrace several distinct forms none of which may be specifically identical with the type.
3. That the comprehensive group formed of those Eastern Australian fossils assigned to *M. nicholsoni* covers such a great vertical range that the stratigraphical value of the group as such is negligible.

II. GENERAL.

Monilopora nicholsoni was first described by Etheridge from Mount Marmion in North West Australia.[1,2] This remained the only record of the genus for Australia until 1924 when Richards and Bryan[3] described and figured a closely comparable form from the Condamine River in southernmost Queensland. In the same publication these authors drew attention to certain corals from Boorook, New South

Wales, seen in the Australian Museum, which closely resembled some of the Condamine Block material, and to the similar coral from Kempsey which Dun had described as "a stout variety of *Cladochonus tenuicollis*."[4] Following this publication fossil corals more or less closely resembling *M. nicholsoni* were discovered both as unnamed or wrongly named specimens in old collections and as a result of active collecting in the field in many parts of Queensland, and near Drake in New South Wales.

III. RANGE OF *MONILOPORA NICHOLSONI sensu stricto.*

The genus *Monilopora*, like the closely related genus *Cladochonus*, and like the frequently associated genus *Trachypora*, is generally regarded as essentially Carboniferous. Consequently, and in view of the accompanying fossils Etheridge placed the type of *Monilopora nicholsoni* from Mount Marmion in the Carboniferous. Whitehouse[5] pointed out that the so-called "*Gastrioceras jacksoni*" which occurred over a thousand feet below *Monilopora nicholsoni* was a "Paralegoceras" and indicated a high Upper Carboniferous age. Sir Edgeworth David[6] cited Dighton Thomas' opinion to the same effect, but in an appendix to his recently published summary of the Geology of Australia David[7] quoted the opinion of Dr. Arthur K. Miller that "*Gastrioceras jacksoni* is not a *Paralegoceras* but a *Metalegoceras* and a definitely Permian genus."

IV. RANGE OF *MONILOPORA NICHOLSONI sensu lato.*

Let us turn now to Eastern Australia. The beds of the Condamine Block of Richards and Bryan were correlated with the Upper Marine of the Hunter River largely on account of the abundant development of *Trachypora wilkinsoni*, the authors remarking that "The presence of such typically Carboniferous genera as *Cladochonus* and *Monilopora* . . . . . is somewhat surprising."[8]

Whitehouse[9] in 1926 and again in 1928[10] regarded all the Australian examples of *Monilopora* known at the time as restricted to a horizon equivalent to the base of the Middle Bowen Series on the one hand and the Greta Coal Measures on the other.

David[11] in turn disagreed with Whitehouse and to quote his own words "stresses the point that the characteristic Carboniferous corals *Monilopora* and *Cladochonus* occur in some profusion in Queensland on certain Permo-Carboniferous horizons, always Sub-Greta." David consequently places what he terms the "main Monilopora horizon" as 500 feet below the base of the "main Eurydesma cordatum horizon" which places it towards the bottom of the Lower Marine Series of the Kamilaroi System.

In the same year David and Sussmilch[12] restated this position and added the statement: "Thus by means of these two fossils (*Monilopora nicholsoni* and *Eurydesma cordatum*), both of which are characteristic and of restricted range, the Kamilaroi strata of Western Australia can be correlated with those of Queensland and northern New South Wales . . . ."

As late as 1932 David[13] still regards *Monilopora* as restricted to one horizon which he places near the base of the Kamilaroi System.

In the work of J. H. Reid in 1930 on the Upper Palaeozoic Succession in Queensland[14], we find yet another interpretation of the stratigraphical position of *M. nicholsoni*. That author placed all those localities in which *Monilopora* or *Trachypora* had been discovered in Queensland (including those previously assigned to the Middle Bowen by R. L. Jack or Whitehouse or himself) as pre-Middle Bowen (pre-Greta) but, while he placed some occurrences within the Lower Bowen Series, others were moved farther down into his Gympie Formation which Reid regarded as definitely pre-Permo-Carboniferous. Of the latter (Gympie) group he writes "*Trachypora wilkinsoni* and *Monilopora* appear characteristic of what are probably the later stages of the Upper Carboniferous transition," while concerning the fossils of the Lower Bowen he states "*Trachypora wilkinsoni* and *Monilopora nicholsoni* definitely ascend to approximately mid-horizons in the Lower Bowen Series."

Reid's position has been further modified as the result of recent work in the Springsure district. In a recent paper on "The Dilly Stage of the Lower Bowen"[15] he records that "Neither of the Lower Bowen Corals, *Monilopora* and *Trachypora*, has been found in the Dilly Stage. They have, however, been recorded in association in the Coral Stage (with *Conularia*) at an interval of possibly 900 feet below the Dilly Stage. They have also recently been found by the writer in the Middle Bowen marine stage above the Serocold Stage, but *Trachypora* is exceedingly rare therein while *Monilopora* is abundant." Reid adds "It will now be difficult to maintain that the coral known as *Monilopora nicholsoni* from the Queensland basin is restricted to the Carboniferous. . . ."

Thus we see that fossils more or less closely resembling the West Australian *Monilopora nicholsoni* have been placed by different workers in horizons regarded by them as equivalent to (1) Upper Marine, (2) Greta, (3) Lower Marine, (4) Pre-Kamilaroi. That the disparity does not represent solely differences of opinion as to the age of one horizon is shown by the fact that in the Springsure area Reid has collected *Monilopora* from horizons separated by over 2,000 feet of strata, the so-called *Eurydesma cordatum* horizon lying about mid-way between.

The practice of selecting certain of the localities in which these corals are obtained and grouping them as the "main *Monilopora* horizon" and assigning to the latter a definitely restricted range does not in the writer's opinion meet the difficulty but, on the other hand, introduces a dangerous method. One might just as reasonably refer all those localities in Queensland where *Trachypora wilkinsoni* occurs abundantly to the Upper Marine of the Hunter River section when an entirely different scheme of correlation would be obtained.

V. DIAGNOSIS OF *M. NICHOLSONI.*

The question now arises as to which, if any, of the forms from Eastern Australia can be confidently assigned to Etheridge's species *M. nicholsoni* from Mount Marmion ?

This is essentially a question for the palaeontologist, but the writer is convinced after personally collecting in the field from a number of different localities in Queensland and New South Wales, examining Museum specimens from other localities, and studying the descriptions and figures that have been published, that the name *Monilopora nicholsoni* is at present loosely used to cover quite a number of perfectly distinct forms.

In the Condamine area alone there are present: (1) the form referred by Richards and Bryan to "(?) *Monilopora nicholsoni*"; (2) a very stout but otherwise somewhat similar form; (3) a form referred by Richards and Bryan to *Cladochonus tenuicollos* but which Whitehouse[16] thinks should also have been referred to the genus *Monilopora*; and (4) a form which Richards and Bryan could not refer definitely to either *Monilopora* or *Cladochonus*.

In a paper published by Girty[17] in 1925, "On the Genera *Cladochonus* and *Monilipora*" [sic] it was argued that "*Cladochonus* and *Monilipora* are really the same genus, not only because they have by description essentially the same characters, but also because they probably have the same genotype." (It is quite clear from the context that Girty's "*Monilipora*" refers to *Monilopora*, the name for the genus as erected by Nicholson and Etheridge.[18]) Girty's paper opens with two statements especially significant here: "The genera *Cladochonus*, *Monilipora* and *Aulopora* all occur, or at least have been cited as occurring, in the Carboniferous strata of North America. To identify corals of this group even generically, is usually quite difficult . . . ." Of what value then are the specific determinations of *M. nicholsoni*, many of them made in the field?

VI. CONCLUSIONS.

Palaeontological research in the genera *Monilopora* and *Cladochonus* is urgently needed in Australia. The systematic study of these corals may well lead to the definition of a number of species or varieties that will be useful for stratigraphical work in the future. At present, however, the genus *Monilopora* appears to be of little value for the purpose of precise correlation of our late Palaeozoic strata.

REFERENCES.

1. Bull. Geol. Sur. W. Aus., No. 58, 1914, p. 14.
2. Trans. Roy. Geog. Soc. S. Aus., 1916-1917, p. 3, Pl. xxxix, figs. 2 and 3.
3. Proc. Roy. Soc. Qld., Vol. XXXVI., 1924, p. 102, Pl. xviii, figs. 5 and 6.
4. Records Geol. Sur. N.S.W., Vol. V., p. 181.
5. A.A.A.S., 1928, p. 76.
6. A.A.A.S., 1930, p. 66.
7. Explanatory Notes of Geological Map of Australia, Addenda et Corrigenda.
8. Op. cit., pp. 67 and 102.
9. A.A.A.S., 1926, p. 282.
10. A.A.A.S., 1928, p. 76.
11. A.A.A.S., 1930, p. 64.
12. Bull. Geol. Soc. Amer., Vol. 42, p. 515.
13. Explanatory Notes, p. 61.
14. Qld. Geol. Sur. Pub. No. 278, pp. 62 and 69.
15. Proc. Roy. Soc. Qld., Vol. XLIII., 1931, p. 59 and p. 64.
16. Verbal communication.
17. Jour. of Geol., Vol. 33, 1925, p. 19.
18. Geol. Mag., 1879, p. 293.

The Australian Species of Macroteleia and Prosapegus (Scelionidae) Hymenoptera

By Alan P. Dodd.

(*Tabled before the Royal Society of Queensland*, 31*st October*, 1932).

This contribution revises and re-describes the Australian species of the above genera, and adds nine new species in *Prosapegus* Kieffer. The members of these two segregates are mostly long slender insects, in which the first abdominal segment is not distinctly narrowed or sub-petiolate ; the parapsidal furrows are complete ; the marginal vein is often longer and is never much shorter than the stigmal vein, and the postmarginal vein is well developed.

The genera are closely related, differing in propodeal characters as follows :

Propodeum in the female with a raised median area or process, variable in form, triangular, narrow-oblong, or rectangular, which is bidentate at apex ; the teeth may be broad, divided to their base, and even completely separated, or they may be replaced by two approximate longitudinal carinae that are joined except at the apex ; in the male the process is often reduced to a pair of strongly-raised median carinae ; lateral carinae of propodeum strong and complete, and, at least in the male, projecting at the posterior margin .. .. *Prosapegus*

Propodeum without a raised median area, process, carinae or teeth, the lateral carinae delicate and not projecting at the posterior margin .. .. *Macroteleia*

Another distinguishing character is the apex of the male abdomen which is unarmed in *Macroteleia* but bears two teeth or spines in *Prosapegus*.

Romilius duris Walker (*Scelio duris* Walker, 1839), founded on a male from Tasmania, should be placed in one of these two genera ; the bispinose apex of the abdomen suggests *Prosapegus*, but an examination of the propodeum of the type is required for confirmation.

Macroteleia Westwood.

Proc. Zool. Soc. London, iii., 1835, p. 70.

A world-wide genus containing about forty described species. This revision recognises four Australian species. The following group of congeneric species, originally referred by me to *Macroteleia*, is more nearly allied to *Baryconus* Forster, and may be included in a broad interpretation of the limits of the latter genus :—*M. varicornis* Dodd, *M. australica* Dodd, *M. tricolor* Dodd, *M. unicolor* Dodd, *M. setosa* Dodd, *M. minima* Dodd, *M. polita* Dodd, *M. inornata* Dodd, *M. infuscata* Dodd, and *M. simillima* Dodd.

Key to the Australian Species of Macroteleia.

1. Female propodeum excavated, the abdomen with a basal process ; head and scutum smooth ; male antennae with funicle 2 longer than 1 .. .. *cornuta*

	Female propodeum not excavated, the abdomen without a basal process; head and scutum densely punctate; male antennae with funicle 2 shorter than 1	2
2.	Major colour bright orange	*apicalis*
	Head, thorax and abdomen black	3
3.	Postmarginal vein twice as long as the marginal; female abdomen $2\frac{1}{2}$-3 times as long as head and thorax	*magna*
	Marginal and postmarginal veins subequal; female abdomen a little less than twice as long as head and thorax	*torresia*

Macroteleia cornuta Dodd.

Trans. Royal Soc. South Aust., xxxvii, 1913, p. 178.

Female.—Length, 4.30 mm. Black, the tegulae brown; legs, including the coxae, golden-yellow; first five antennal joints suffused with yellow.

Head polished, smooth and without sculpture except for a very few scattered punctures, a line of fine punctures on either side of frons against the eyes, and a row of punctures against the occipital margin, each puncture bearing a fine short hair; lower frons lightly depressed medially. Antennal scape moderately long and stout; pedicel $2\frac{1}{2}$ times as long as its greatest width; funicle 1 and 2 elongate, narrower than the pedicel, 1 as long as the pedicel, 2 slightly longer than 1, 3 two-thirds as long as 2, 4 two-thirds as long as 3, somewhat longer than wide; club compact, rather stout, joints 1-5 each twice as wide as long, 1 rather small, 3 slightly the widest. Thorax almost twice as long as its greatest width; pronotum narrowly visible on the sides, punctate; scutum almost as long as its greatest width, its anterior margin narrowly rounded, the median lobe declivous anteriorly, the surface smooth with very scattered small punctures bearing fine white hairs; parapsidal furrows distinct, complete, not foveate or punctate; scutellum smooth with a few small punctures and fine hairs, with a line of foveae against the anterior and posterior margins, the latter faintly concave; metanotum showing as a transverse faintly concave line; propodeum moderately long, deeply excavated to its base to receive the abdominal process, the excavation bounded laterally by the delicate lateral carinae outside which the surface is finely punctate and pubescent, and there is a fringe of white hairs arising on either side of the excavation at its base. Posterior coxae slender, their tibiae very long, twice as long as the femora, the tarsi slightly longer than the tibiae, their basal joint twice as long a 2 - 5 united. Forewings extending to base of fourth abdominal segment; sub-hyaline; marginal vein a little longer than the stigmal which is very oblique, its apex curved; postmarginal vein twice as long as the marginal; basal and median veins not marked. Abdomen two and one-third times as long as the head and thorax united, its greatest width somewhat narrower than that of the thorax; a little narrowed at base but not sub-petiolate, gradually tapering to apex from segment 3; segments 1-3 not carinate laterally; 1 one-half longer than its posterior width, at base with a slender oblique horn projecting forward into the propodeum as far as the metanotum; 2 one-half longer than 1; 3 a little longer than 2, two-thirds longer than wide; 4 as long as 2; 5 one-fourth shorter than 4; 6 not compressed, scarcely longer than 5, three times as long as its basal width; 1 rather strongly striate, its horn smooth; 2-4 more finely striate and with fine punctures between; 5 and 6 with finer sculpture; lateral margins of 2-5 smooth; dorsum of 2-4 with scattered fine hairs, the pubescence longer and denser on 5 and 6 and along lateral margins.

Male.—Length, 3.50 mm. Scutellum straight posteriorly; metanotum tranverse but not linear, its posterior margin straight; propodeum raised and flat medially, sloping laterally, its posterior margin concave and gently carinate, its surface rugose-punctate medially, finely punctate outside the lateral carinae. Abdomen hardly twice as long as the head and thorax united, widest at the posterior margin of segment 4; anterior margin of 1 convex; 3 no longer than 2; 4 somewhat shorter than 3; 5 two-thirds as long as 4, three-fourths as long as its basal width; 6 one-half as long as 5, no longer than its posterior width; 7 short, one-half as long as 6, broadly truncate or faintly convex at apex; 1-3 with several strong striae; 4 and 5 finely striate and punctate; 6 and 7 punctate and coriaceous. Antennal scape reddish-yellow, the pedicel dusky, the flagellum black; funicle 1 one-half longer than the pedicel, fully twice as long as wide, 2 one-half longer than 1, 3 as long as 2, 4-9 gradually shortening, 9 as long as 1.

Habitat.—North Queensland; Cairns district, one pair.

Holotype in the South Australian Museum, I. 1,445.

Very distinct from the other species in the long abdominal process and excavated propodeum in the female, the smooth head and scutum, and the differences in antennal segmentation in both sexes.

Macroteleia apicalis Dodd.

Proc. Royal Soc. Queensland, xxvi, 1914, p. 99.

Female.—Length, 4.25 mm. Bright brownish-yellow or orange, the eyes and ocelli black; vertex of head and apical segment of abdomen dusky-black; segments 1 and 5 of abdomen dark brown; legs golden-yellow; first six antennal joints yellow, the club black.

Head shaped as in *M. magna* except that the vertex behind the ocelli slopes precipitiously to the occipital margin; cheeks, frons and vertex with numerous rather small punctures bearing fine pale pubescence, the punctures dense but not confluent towards the occiput; frontal impression shallow, smooth medially; mandibles rather small, tridentate. Antennal scape moderately long; pedicel slender, almost three times as long as its greatest width; funicle 1 as long as the pedicel and a little narrower; 2 two-thirds as long as 1, twice as long as its greatest width; 3 somewhat longer than wide; 4 wider than long; club 6-jointed, joint 1 a little wider than long, 2-5 each twice as wide as long. Thorax almost twice as long as its greatest width; pronotum narrowly visible, densely punctate; scutum as long as wide, with numerous setigerous punctures; parapsidal furrows complete, punctate; scutellum with scattered fine punctures bearing fine pale hairs; metanotum very transverse, foveate, at meson projecting shortly and narrowly into the propodeum; propodeum narrowly and completely divided at meson, its posterior border gently concave and not margined, finely punctate laterally, finely punctate and striate medially, the lateral carinae fine and hardly distinguishable. Forewings reaching almost to apex of segment 4 of abdomen; faintly stained; venation thick and distinct; marginal vein one-half longer than the stigmal which is rather short and scarcely oblique, the postmarginal twice as long as the marginal. Abdomen two and one-third times as long as the head and thorax united, somewhat narrower than the thorax; segments 1-3 carinate laterally; 1 somewhat raised at base, its anterior margin convex and fitting close to the propodeum; 1 a little longer than its posterior width; 2 one-half longer than 1; 3 a little longer than 2, one-half longer than wide; 4 as long as 2; 5 somewhat shorter than 4; 6 slightly longer than 3, strongly compressed dorso-ventrally and narrowly acuminate; wholly finely longitudinally striate and with obscure punctures between; dorsum of 2-4 with fine short pubescence, 5 and 6 and sides of abdomen with longer conspicuous pubescence.

Male.—Unknown.

Habitat.—North Queensland; Herbert River, the holotype female in March, A. P. Dodd.

Holotype in the South Australian Museum, I. 11,013.

Agrees very closely in structure and sculpture with *M. magna* except that the vertex of the head is more precipitous posteriorly.

MACROTELEIA MAGNA Dodd.

Trans. Royal Soc. South Aust., xxxvii, 1913, p. 149.

M. angusta Dodd, ibidem, p. 150.

Female.—Length, 5.50 mm. Black (in spirit specimens often showing brownish), the tegulae yellow; legs, including the coxae, golden-yellow; antennal scape clear yellow, the pedicel and funicle joints somewhat dusky, the club black.

Head from dorsal aspect sub-quadrate, one-third wider than long, the vertex sloping gently to the occipital margin which is gently concave and not carinate; from lateral aspect the vertex and upper frons are rounded, the lower two-thirds of the frons being almost at right angles, so that the head is as long as high and the mouth is situated at the posterior extremity; lower frons depressed above the antennae; eyes moderately large, bare; ocelli well apart, the lateral pair against the eyes; vertex and frons finely coriaceous and with numerous scattered rather small punctures which are dense toward the occiput and on the lower frons except for the smooth median line; cheeks broad, finely coriaceous and rather densely punctate; head with a noticeable pubescence of fine white hairs; mandibles rather small, tridentate, the middle tooth small. Antennal scape long and slender; pedicel slender, almost three times as long as its greatest width; funicle 1 hardly shorter than the pedicel, 2 two-thirds as long as 1, 3 somewhat shorter than 2, a little longer than wide, 4 as wide as long; club compact, rather slender, 6-jointed, joint 1 largest, as long as wide, 2-5 plainly wider than long. Thorax three-fourths longer than its greatest width; pronotum, scutum and scutellum with a conspicuous pubescence of white fine hairs; pronotum narrowly visible, densely punctate; scutum as long as its greatest width, its anterior margin rather sharply rounded, almost flat, with numerous punctures which are dense anteriorly on the median lobe, the parapsides finely coriaceous also; parapsidal furrows complete, punctate; scutellum with numerous punctures, its posterior margin foveate and almost straight; metanotum very short, transverse, foveate, not raised or prominent, at meson with a short projection into the propodeum; propodeum moderately long, sloping laterally, its posterior border gently concave and not margined, the posterior angles not prominent, the lateral carinae delicate and straight, without a median process or carinae but somewhat raised and narrowly divided to its base, punctate and pubescent. Forewings extending to base of fourth abdominal segment; sub-hyaline; venation thick, deep yellow; marginal vein one-half longer than the stigmal vein which is rather short, slightly curved, not very oblique; postmarginal vein twice as long as the marginal; basal and median veins not indicated. Posterior coxae long, not much shorter than the rather stout femora, the tibiae long and slender, the tarsi slightly longer than their tibiae, their basal joint shorter than 2-5 united. Abdomen $2\frac{1}{2}$ to three times as long as the head and thorax united; somewhat narrower than the thorax; almost as wide at base as its greatest width, its anterior margin somewhat convex and fitting close to the propodeum; segments 1-3 carinate laterally; 1 not raised at base, a little longer than its posterior width; 2 one-half longer than 1, as long as 4; 3 one-half longer than wide, somewhat longer than 2; 5 shorter than 4; 6 as long as 3, strongly compressed dorso-ventrally; 1-5 finely longitudinally striate and with subobsolete punctures between the striae, the punctures more pronounced on 5; 6 punctate on its dorsal ridge, striate laterally; 2-4 with fine short pubescence which is longer on 5 and 6.

Male.—Length, 5.25 mm. Metanotum not projecting at meson; posterior margin of propodeum almost straight. Abdomen two to two and one-third times as long as the head and thorax united; fitting close to the propodeum but the anterior margin is straight; segment 6 two-thirds as long as 5, not compressed; 7 two-thirds as long as 6, as long as its greatest width, pointed at apex; pubescence of abdomen longer and denser than in the female. Antennal scape yellow, the pedicel and funicle joints suffused with yellow or brown, less so apically; pedicel fully twice as long as its greatest width; funicle 1, as long as the pedicel, 3 somewhat shorter than 1, 2 a little shorter than 3; 4-9 subequal, each slightly longer than wide.

Habitat.—Queensland; Cairns district (type); Brisbane; Mt. Tambourine; a small series.

Holotype in the South Australian Museum, I. 1,389.

M. angusta Dodd appears to be merely a small male, 3.50 mm. of this species.

Macroteleia torresia Dodd.

Trans. Royal Soc. South Aust., xxxvii, 1913, p. 150.

Macroteleia perkinsiana Dodd, Trans. Ent. Soc. London, 1919, p. 327.

Female.—Length, 3.40 mm. Black; legs reddish-yellow, the coxae usually fuscous; antennal scape yellow, the pedicel and funicle joints fuscous, the club black.

Head shaped as in *magna*; frons and vertex between the ocelli with numerous small punctures which are dense and subconfluent between the ocelli and the occiput and on the cheeks; a smooth area on lower frons medially; pubescence fine and pale. Antennal scape slender; pedicel long and slender; funicle 1 narrower and shorter than the pedicel, $2\frac{1}{2}$ times as long as its greatest width; 2 one-half as long as 1, slightly longer than wide; 3 slightly wider than long; 4 transverse; club 6-jointed, joint 1 longest but wider than long, 2-5 each twice as wide as long. Thorax two-thirds longer than its greatest width; pronotum, scutum, and scutellum with fine whitish pubescence; pronotum narrowly visible, densely punctate; scutum almost as long as its greatest width, its anterior margin rather broadly rounded, with moderately dense small punctures which are confluent on the median lobe anteriorly; parapsidal furrows complete, punctate, not very conspicuous; scutellum with small scattered punctures; metanotum very transverse, not prominent, foveate, its posterior margin straight; propodeum moderately long, raised medially, sloping laterally, the posterior border gently concave and not margined, the median line apparently not divided ; surface of propodeum finely punctate and, except laterally, longitudinally striate, the lateral carinae very delicate and hardly distinguished from the striae. Forewings extending to apex of fourth abdominal segment ; sub-hyaline ; venation thick, deep brown ; marginal and postmarginal veins subequal, each twice as long as the stigmal vein which is rather short, not very oblique, straight ; basal and median veins faintly marked. Legs much as in *magna.* Abdomen a little less than twice as long as the head and thorax united, a little narrower than the thorax ; slightly narrowed at base, narrowly acuminate at apex, its basal margin lightly convex and fitting close to the posterior margin of the propodeum ; segments 1-3 carinate laterally ; 1 as long as its posterior width ; 2 one-half longer than 1 ; 3 slightly longer than 2, scarcely longer than wide ; 4 as long as 2 ; 5 two-thirds as long as 4 ; 6 as long as 3, strongly compressed dorso-ventrally ; 1-4 finely longitudinally striate and with sub-obsolete punctures between the striae ; 5 very finely striate and with fine punctures between ; 6 punctate on its dorsal ridge, finely striate laterally ; 2-4 with very fine short pubescence, 5 and 6 and sides of abdomen with longer conspicuous pubescence.

Male.—Length, 3-3.30 mm. Basal margin of abdomen straight and free from the propodeum ; abdomen more pubescent than in the female ; segment 6 broad, not compressed, two-thirds as long as 5 ; 7 acutely triangular, much shorter than 6 ; punctures distinct on 5-7. Antennal scape yellow, the pedicel and basal funicle joints suffused yellowish ; pedicel twice as long as its greatest width ; funicle 1 slightly shorter than the pedicel, 3 somewhat shorter than 1, one-third longer than wide, 2 a little shorter than 3, as wide as long, 4-9 subequal, each as wide as long.

Habitat. — Queensland ; Thursday Island ; Pentland ; Proserpine , Westwood ; Wowan ; Bundaberg ; Mt. Tambourine ; Chinchilla ; five males, five females, in November-April.

Holotype and *Allotype* in the South Australian Museum, I. 1,390.

A widely-distributed although not common species ; the type locality is Proserpine. A smaller species than *M. magna,* the abdomen shorter in relation to the head and thorax, and the postmarginal vein not longer than the marginal. *M. perkinsiana* Dodd, erected on two females from Bundaberg, is a true synonym.

Prosapegus Kieffer.

Ann. Soc. Sci. Brussels, xxxii, 1908, pp. 121, 147.

Apegus Ashmead (not Forster), Bull. U.S. National Museum, xlv, 1893, p. 226.

Cacellus Dodd (not Ashmead), Trans. Royal Soc. South Australia, xxxix, 1915, p. 445; ibidem, xl, 1916, p. 23-24 ; Archiv fur Naturg. Berlin, lxxx, 1915. *Macroteleia* (part) Dodd (not Westwood), Proc. Royal Soc. Qld. xxvi, 1914, p. 100 ; Archiv fur Naturg. Berlin, lxxx, 1915 ; Trans. Royal Soc. South Australia, xxxix, 1915, p. 444. *Alloteleia* Kieffer, Broteria, xv, 1917, p. 59.

This genus was erected by Kieffer for *Apegus elongatus* Ashmead. The female of this insect has not been described ; yet in all his works Kieffer has assumed that the female antennae are without a terminal club.

Several years ago, Mr. A. B. Gahan of the U.S. Bureau of Entomology kindly compared specimens of *Cacellus giganteus* Dodd and *C. propinquus* Dodd with the type of *elongatus*, and furnished me with valuable notes from which it appears evident that the Australian species are congeneric with the North American insect. I had already made this suggestion (Trans. Ent. Soc. London, 1919, p. 321).

Mr. Gahan states that the head of *elongatus* is more quadrate than in *giganteus* and *propinquus*, but this is true of at least one Australian species. Further, he gives the following characters of *elongatus*, some of which are always present in the Australian species : Propodeum with two high carinae which converge but do not meet posteriorly ; dorsum of abdomen with a median carina on segment 2 and lateral carinae on segments 1-3.

Alloteleia appendiculata Kieffer, founded on a male from the Philippine Islands, is undoubtedly congeneric with the Australian species, a fact which is established from an examination of the description of this, the genotype and only described species.

Thus *Prosapegus* should contain one species from North America, one from the Philippine Islands, three from New Guinea (*P. violaceus* Dodd, *P. atrellus* Dodd, and *P. metatarsalis* Dodd), and one from Fiji (*P. glorianus* Dodd), while in this paper fifteen species are recognised from Australia. The species vary in size from moderately large to very large ; *P. violaceus* from New Guinea is one of the largest known Scelionids, and *P. giganteus* and *P. insignis* are the largest members of the family from Australia. They are slender *Macroteleia*-like forms with the exception of *P. validus* which is a stouter insect with a general resemblance to species of *Oxyscelio* Kieffer and *Hoploteleia* Ashmead.

Most of the Australian species are closely related, and are distinguished by small structural and sculptural differences.

Key to the Australian Species of Prosapegus Kieffer.

1.	Females	2
	Males	16
2.	Propodeal process triangular with one median carina ; size very large	*giganteus*
	Propodeal process with two median carinae or none, or divided into two teeth	3
3.	Segments 2-4 of abdomen strongly sparsely striate, the punctures between rather indefinite ; teeth of propodeum small, well-separated	*nigriscapus*
	Segments 2-4 densely punctate, sometimes with more or less distinct, but fine, striae	4
4.	Teeth of propodeum widely separated	*discissus*
	Teeth of propodeum joined or at least close together at base ..	5
5.	Pubescence of abdominal segments 5-6 scattered	*insignis*
	Pubescence of segments 5-6 dense	6
6.	Abdomen shorter, one-fourth longer than the head and thorax ; funicle 1 no longer than the pedicel	*validus*
	Abdomen longer, at least one-half longer than the head and thorax ; funicle 1 plainly longer than the pedicel	7
7.	Punctures of median lobe of scutum becoming small and indefinite posteriorly ; thorax and abdomen more or less brownish ..	*fuscicorpus*
	Punctures of median lobe not small and indefinite posteriorly ; thorax and abdomen wholly black	8
8.	Punctures of median lobe sparse on posterior half ; propodeum on either side with a long straight carina inside the lateral carina which it joins posteriorly ; coxae dark	*infusus*

Punctures of median lobe even in density; propodeum without the inner carina, or if present it is short and joins the posterior margin well inside the lateral carina; coxae red or yellow .. 9

9. Propodeal process broad, narrowly divided, the teeth broad; abdomen more slender apically, segment 5 plainly longer than its basal width, 6 at least twice as long as its basal width .. *extensus*

Propodeal process either narrow or broadly divided almost to its base; abdomen less slender apically, segment 5 never longer than its basal width, 6 less than twice as long as its basal width 10

10. Anterior margin of abdomen straight, not projecting forward into the propodeum 11

Anterior margin of abdomen not straight, projecting forward into the propodeum 14

11. Punctures of median lobe of scutum larger, well separated .. *illustris*

Punctures of median lobe smaller, confluent or sub-confluent .. 12

12. Apex of abdomen convex 13

Apex of abdomen concave and bispinose .. .. *augustus*

13. Lateral carinae of propodeum curved; abdomen two-thirds longer than the head and thorax, segment 2 one-half longer than 1, 6 longer than its basal width .. .. *regalis*

Lateral carinae of propodeum straight; abdomen one-half longer than the head and thorax, segment 2 one-fourth longer than 1, 6 no longer than its basal width.. .. .. *distinctus*

14. Abdomen with a convex ridge medially, segments 1-3 without a lateral carina .. .. *fissilis*

Abdomen without a convex ridge medially, segments 1-3 with a lateral carina 15

15. Abdomen one-half longer than the head and thorax; teeth of propodeal process narrowly separated .. .. *solitus*

Abdomen twice as long as the head and thorax; teeth of process well separated .. .. *accultus*

16. Propodeal process triangular with one median carina; size very large .. .. *giganteus*

Propodeal process with two median carinae or none; size smaller, except in *insiginis* 17

17. Abdomen very sparsely striate .. .. *nigriscapus*

Abdomen densely punctate, or if striate the striae are numerous.. 18

18. Propodeum with a long carina between the median process and the lateral carina, joining the latter posteriorly .. .. .. *infusus*

Propodeum either without a carina between the median process or carina and the lateral carina, or with a short carina that joins the posterior margin well inside the lateral carina 19

19. Propodeal process broad with two stout teeth 20

Propodeal process either narrow, with two approximate teeth or carinae, or reduced to a pair of carinae 21

20. Abdomen scarcely narrower than the thorax, segment 3 wider than long .. .. *insignis*

Abdomen distinctly narrower than the thorax, segment 3 longer than wide .. .. *extensus*

21. Punctures of median lobe of scutum small and scattered posteriorly 22

Punctures of median lobe large and numerous posteriorly .. 23

22. Median carinae of propodeum parallel and close together; postmarginal vein $2\frac{1}{2}$ times as long as the marginal .. .. *fuscicorpus*

Median carinae of propodeum wide apart at base; postmarginal vein one-half longer than the marginal .. .. *discissus*

23. Propodeal process in the form of a long narrow bicarinate tooth that projects well beyond the posterior margin medially .. 24

Propodeal process reduced to a pair of raised carinae that hardly project beyond the posterior margin medially 25

24. Carinae of propodeal process approximate for their entire length, a strong carina present on either side; punctures of scutum larger .. .. *illustris*

Carinae of process divergent towards base; no strong carina on either side; punctures of scutum smaller .. .. .. *solitus*

25. Propodeum long medially, the median carinae sub-parallel .. 26

Propodeum rather short medially, the median carinae converging posteriorly 27

26. Segments 2 and 3 of abdomen slightly longer than wide; basal joint of posterior tarsi longer than 2-5 united .. .. .. *fissilis*

Segments 2 and 3 much longer than wide; basal joint of posterior tarsi a little shorter than 2-5 united .. .. *augustus*
27. Posterior margin of propodeum gently concave between the lateral carinae .. .. *regalis*
Posterior margin of propodeum deeply concave between the lateral carinae 28
28. Abdomen three-fourths longer than the head and thorax, six times as long as its greatest width, segments 1-4 each plainly longer than its posterior width .. .. *accultus*
Abdomen one-half longer than the head and thorax, not more than four times as long as its greatest width, segments 1-4 each no longer than its posterior width .. .. *distinctus*

Prosapegus giganteus Dodd.

Cacellus giganteus Dodd, Archiv. fur Naturg., Berlin, lxxx, 1915.

Female.—Length, 7.50 mm. Black; legs, including the coxae, golden-yellow; tegulae, mandibles, and antennal scape deep red or black.

Head from dorsal aspect twice as wide as long, the vertex sloping sharply from immediately behind the lateral ocelli to the occiput which is gently concave; ocelli very large, separated from each other by their diameter, the lateral pair narrowly separated from the eyes which are large and bare; frons with large, rather scattered punctures, denser ventrally, each bearing a fine hair; frontal impression shallow, broad and smooth; vertex behind the ocelli highly polished, rather densely pubescent, with indefinite confluent punctures forming longitudinal grooves separated by blunt striae or indefinite carinae, or with definite large punctures arranged in longitudinal rows; cheeks rather narrow, with scattered punctures; mandibles broad, tridentate, the teeth blunt. Antennal scape long and slender; pedicel twice as long as its greatest width; funicle 1 elongated, twice as long as the pedicel, one-half as long as the scape; 2 slightly more than one-half as long as 1; 3 as wide as long; 4 somewhat widened, wider than long; club compact, joint 1 a little wider than long, 2-5 each twice as wide as long. Thorax one-half longer than its greatest width; pronotum with longitudinal grooves bearing indefinite punctures; median lobe of scutum with large rather dense punctures, shortly smooth against the declivous anterior margin, the lateral lobes with shallower punctures; parapsidal furrows deep, a little curved, indefinitely punctate; scutellum with scattered punctures; pronotum, scutum and scutellum shining, with a pubescence of scattered long fine hairs; propodeum long, not greatly shorter medially than laterally, finely pubescent outside the lateral carinae, which are strong, straight, and close to the base of the median process, the posterior margin gently concave but with a strong projection at the junction of the lateral carinae; a strong carina runs sharply oblique on either side from about one-half the length of the median process to join the lateral carina at the posterior margin; median process smooth, flat, triangular, not projecting beyond the posterior margin, slightly longer than its basal width, strongly carinate laterally and with a median carina which terminates before the apex, the lateral carinae oblique but shortly parallel posteriorly and raised to form from lateral aspect a pair of rounded teeth. Forewings reaching to apex of fifth abdominal segment; deeply smoky; venation thick, blackish; marginal vein as long as the stigmal, the postmarginal slightly longer than the marginal; radial, basal, and median veins represented by thick brown lines, M3+4 and Cu1 by pale brown lines. Posterior tarsi as long as their tibiae, their basal joint as long as 2-5 united. Abdomen two-thirds longer than the head and thorax, its greatest width at base of segment 3 two-thirds that of the thorax ; segment 1 three-fourths as long as its posterior width, as long as its basal width, its anterior margin straight ; 2 almost twice as long as 1 ; 3 as long as 2, as long as wide ; 4 a little shorter than 3, slightly longer than its posterior width ; 5 somewhat shorter than 4 ; 6 a little shorter than 5, as long as its basal width, terminating in an acute point or spine ; 1 not raised nor projecting forward at base ; 2-5 with a strong median carina ; 1-4 with a strong lateral carina ; 1 strongly striate, smooth between the striae, showing faint punctures laterally ; 2-4 strongly confluently punctate with a longitudinal arrangement and showing traces of striae ; 5 more shallowly punctate ; 6 shallowly fine punctate, finely coriaceous apically ; 1-4 dorsally with short pubescence, which is longer and denser on 5 and 6 and along the lateral margins.

Male.—Segment 2 of abdomen about three-fifths longer than 1, a little shorter than 3, slightly longer than 4 ; 6 slightly more than one-half as long as 5, a little shorter than its basal width ; 7 short, transverse, its posterior margin broadly concave and armed with a stout acute tooth or spine at either angle. Antennae black, the scape and apex of pedicel either dull red or black ; scape moderately short ; pedicel short, not greatly longer than wide ; funicle 1 one-half as long as the scape, twice as long as the pedicel ; 2 and 3 subequal, each two-thirds as long as 1 ; 4-9 subequal, each slightly shorter than 3 and two-thirds longer than wide.

Habitat.—North Queensland ; Cairns district, four females, four males in January-April, A. P. Dodd.

Holotype in the South Australian Museum.

The largest representative of the family known from Australia. The triangular propodeal process with its single median carina will distinguish it from the other Australian species. *P. atrellus* Dodd from Dutch New Guinea is a close relation of *giganteus.*

Prosapegus nigriscapus Dodd.

Macroteleia nigriscapa Dodd, Archiv. fur Naturg., Berlin, lxxx, 1915. *Macroteleia paucipunctata* Dodd, Trans. Royal Soc. South Aust., xxxix, 1915, p. 444.

Female.—Length,—3.00 mm. Black, the tegulae red ; legs, including the coxae, golden-yellow ; antennal scape and the funicle joints yellow, the pedicel fuscous, the club black.

Head from dorsal aspect almost twice as wide as long ; vertex moderately long, sloping shortly and sharply to the occipital border which is gently concave and not margined ; ocelli moderately large, the lateral pair touching the eyes, separated from the anterior ocellus by twice their diameter and from each other by a somewhat greater distance ; upper frons and vertex between the ocelli smooth with numerous scattered moderately small punctures ; behind the ocelli the punctures are larger and there is a transverse row of confluent punctures against the occiput ; frontal impression broad and shallow ; cheeks with numerous punctures. Antennal scape moderately long and slender ; pedicel slender, $2\frac{1}{2}$ times as long as its greatest width ; funicle 1 slightly longer than the pedicel, 2 somewhat shorter than 1, 3 shorter than 2, one-half longer than wide, 4 as wide as long ; club compact, joint 1 a little wider than long, 2-5 each twice a wide as long. Thorax one-half longer than its greatest width; pronotum very narrowly visible, densely punctate and pubescent; scutum somewhat shorter than its greatest width, shortly declivous anteriorly, smooth with very fine scattered punctures, the anterior half of the median lobe with dense punctures of moderate size; parapsidal furrows foveate, broad, not widening posteriorly where they are separated by twice their own width; scutellum with a few minute punctures; pubescence of scutum and scutellum of long fine white hairs; metanotum very short, unarmed; propodeum long laterally, extremely short medially, the posterior margin very deeply concave from the lateral angles, the lateral carinae short; medially the posterior margin bears a fringe of white hairs, and on either side at base there is a sub-erect tooth bearing long hairs. Legs slender; posterior tarsi no longer than their tibiae, their basal joints as long as 2-5 united. Forewings reaching apex of fifth abdominal segment; faintly yellowish; venation thick, yellow; marginal vein somewhat longer than the stigmal, which is a little curved and not very oblique, the postmarginal one-third longer than the marginal; basal and median veins represented by faint yellow lines. Abdomen twice as long as the head and thorax united, one-third narrower than the thorax; segment 1 as long as its posterior width, at base with a raised prominence that projects forward into the propodeum; 2 one-half longer than 1; 3 a little longer than 2, one-third longer than wide; 4 slightly shorter than 2; 5 three-fourths as long as 4; 6 as long as 5, almost twice as long as its greatest width, sharply pointed at apex; 1 with a strong lateral carina which is weaker on 2, faint on 3; 1 striate, its prominence smooth; 2-5 rather finely, somewhat irregularly longitudinally striate, and with shallow punctures between the striae, 6 smooth with obscure punctures at base, coriaceous apically; pubescence scattered, but longer and denser on lateral margins and on segments 4-6.

Male.—Length, 2.75-3.00 mm. Propodeum moderately long medially, its posterior margin gently concave, the lateral carinae long; pubescent medially and armed on either side with a strong raised carina ending posteriorly in an erect triangular tooth, the carinae well apart and converging a little posteriorly. Abdomen somewhat narrower than in the female, gradually tapering to apex from segment 2; segment 1 raised, flat and tri-carinate medially; 3 one-half longer than wide; 6 somewhat shorter than 5; 7 one-half as long as 6, deeply concave and sharply bidentate at apex; striation more regular than in the female, very sparse, there being about eight striae in a transverse count, the punctures very obscure; 6 almost smooth; 2-4 with a median stria or carina. Antennae black, the scape fuscous; pedicel one-half longer than wide; funicle 1 longer than the pedicel, twice as long as wide, 2 and 3 each slightly shorter than 1, 4-9 sub-equal, each slightly longer than wide.

Habitat.—North Queensland; Cairns district, one female, three males in May-January, A. P. Dodd.

Holotype in the South Australian Museum, I. 11,067.

The original descriptions of *nigriscapus* and *paucipunctatus* were based on male specimens. A small slender species with the propodeal teeth in the female small and well-separated, in which respect it resembles *discissus*. It differs from *discissus* in the short lateral carinae of the female propodeum, the less slender thorax, the less quadrate head, and the more distinct striation of the abdomen, while the male may be recognised by the very slender sparsely striate abdomen.

Prosapegus discissus n. sp.

Female.—Length, 3.75 mm. Black, the tegulae red; legs, including the coxae, bright reddish-yellow; antennal scape reddish yellow, the pedicel and funicle joints suffused with red.

Head from dorsal aspect sub-quadrate, one-half wider than long; vertex rather long, sloping gently to the posterior border which is somewhat concave and not margined; eyes large, not very wide apart; ocelli moderately large, equidistant apart, the lateral pair almost touching the eyes; vertex, frons and cheeks with moderate-sized dense punctures and somewhat coriaceous; between the ocelli the surface is smooth except for short wrinkles; frontal impression rather deep, circular, not sharply defined, faintly sculptured, separated from the eyes by two or three rows of punctures; above the antennal insertion there is a median carina for some distance; pubescence fine, short, rather dense. Antennal scape moderately long and slender; pedicel slender, three times as long as it greatest width; funicle 1 not or scarcely longer than the pedicel, 2 much shorter, one-half longer than wide, 3 a little longer than wide, 4 slightly widened, as wide as long; club slender, 6-jointed, joint 1 very slightly the longest, 1-5 each plainly wider than long. Thorax rather slender, almost twice as long as its greatest width; pronotum narrowly visible on the sides, densely punctate and pubescent; scutum as long as its greatest width, somewhat declivous against the anterior margin of the median lobe; parapsidal furrows complete, foveate, widening and approaching close together posteriorly where they are separated by not much more than their own width; median lobe of scutum with dense moderately small punctures on the anterior half, with scattered punctures on the posterior half, and fine reticulation against the parapsidal furrows; lateral lobes with fine impressed reticulation and scattered small punctures; scutellum smooth with scattered punctures; pubescence of scutum and scutellum of fine white hairs; metanotum very short, unarmed, not prominent; propodeum moderately long, completely and rather broadly divided at its base medially, where it is armed on either side with a triangular sub-erect punctate and pubescent tooth, the lateral carinae strong and straight, the surface within the lateral carinae finely punctate, outside the lateral carinae finely punctate and pubescent, the posterior margin within the lateral carinae deeply concave to its base medially. Legs slender; posterior tarsi no longer than their tibiae, their basal joint as long as 2-5 united. Forewings reaching apex of fourth abdominal segment; lightly infuscate; venation deep brown; marginal vein a little longer than the stigmal which is long, oblique, somewhat curved, the postmarginal almost twice as long as the marginal; basal and median veins represented by thick pale lines. Abdomen slender, twice as long as the head and thorax united, one-sixth narrower than the thorax, its dorsal surface flat; segments 1-3 with a strong lateral carina which fails on 4; 1 slightly wider posteriorly than basally, as long as its basal width, at base with a blunt prominence that projects forward into the propodeum; 2 two-thirds longer than 1; 3 a little longer than 2, a little longer than wide; 4 slightly shorter than 2; 5 somewhat shorter than 4; 6 as long as 5, one-half longer than its basal width, its apex sharply convex and almost pointed ; 1 longitudinally striate medially, smooth between the striae, densely punctate laterally ; 2 and 3 confluently punctate and rather finely indefinitely striate ; 4 with shallow punctures and finer more definite striae ; 5 with shallow indefinite punctures, becoming coriaceous laterally and posteriorly ; 6 densely coriaceous ; dorsum of segments 1-4 with fine inconspicuous pubescence ; 5 and 6 dorsally and lateral margins of abdomen with dense long pubescence.

Male.—Coxae dusky-brown. Propodeum not divided to its base medially where it is moderately short with two rather widely-separated strongly raised and somewhat pubescent median carinae which converge somewhat posteriorly, the surface depressed and punctate between the median carinae, smooth between the median and lateral carinae, the posterior border margined and somewhat concave between the lateral carinae. Segment 1 of abdomen somewhat raised and flat medially at base but not produced forward ; 6 one-half as long as 5 and as its basal width ; 7 very short, transverse, truncate at apex and armed on either side with a moderately long acute spine ; 2 and 3 with the fine striae more definite, the punctures less definite. Antennae black, the scape golden-yellow ; funicle 1 a little longer than the pedicel, fully twice as long as wide ; 2 a little shorter than 1 or 3 ; 3 slightly shorter than 1 ; 4-9 subequal, each one-half longer than wide and somewhat shorter than 3.

Habitat.—Queensland ; Brisbane, one female (holotype) and one male (allotype) in December and January, A. P. Dodd ; Mt. Tambourine, two females in March, A. P. Dodd ; Beenleigh, one female in December, A. A. Girault ; Westwood, three males in February-November, A. P. Dodd. New South Wales ; Hawkesbury River, one female, four males in January-March, A. P. Dodd.

Holotype and *Allotype* in the Queensland Museum.

Paratypes in the author's collection.

The female may be distinguished by the more quadrate head and the completely divided propodeum with its well-separated teeth ; while the male may be recognised by the fact that the abdomen is definitely striate as well as punctate.

Prosapegus insignis n. sp.

Female.—Length, 4.5-7.0 mm. Black ; tegulae red ; legs, including the coxae, bright red, the tarsi faintly dusky or almost black ; antennal scape bright or dusky red, the pedicel and funicle 1 and 2 sometimes reddish.

Head from dorsal aspect $2\frac{1}{2}$ times as wide as long, more transverse than usual, the eyes wider apart ; sloping from just behind the lateral ocelli to the occipital margin ; ocelli very large, the lateral pair separated from the eyes by one-half their own diameter and from each other by fully twice their diameter ; frons, vertex and cheeks with large confluent or sub-confluent punctures which are arranged transversely behind the line of the lateral ocelli ; frontal impression moderately shallow, separated from the eyes by three or four rows of punctures, smooth ; pubescence of long fine hairs ; mandibles stout, tridentate, the outer teeth blunt, the inner tooth very small. Antennal scape moderately long and slender ; pedicel fully twice as long as its greatest width ; funicle 1 elongate, three-fourths longer than the pedicel, one-half as long as the scape ; 2 abruptly shorter, one-half longer than wide ; 4 as wide as long ; club slender, joint 1 as long as wide, 2-5 each a little wider than long. Thorax one-third longer than its greatest width ; pronotum confluently punctate ; scutum and scutellum highly polished ; median lobe of scutum with a flat or sub-depressed area anteriorly which bears rather dense punctures, the rest of the median lobe and the lateral lobes with large scattered punctures, the abruptly declivous anterior margin of the median lobe with smaller confluent punctures ; parapsidal furrows foveate, widening posteriorly ; scutellum with large scattered punctures ; pubescence of scutum and scutellum of long fine hairs ; propodeum shorter, flatter, and broader than usual, the lateral carinae close to the median process, the posterior margin uniformly gently concave except for the projecting lateral carinae, the surface outside these carinae broad and with dense white pubescence ; median process of propodeum densely coarsely punctate and with scattered long hairs, large, very broad at base, not as long as its basal width, projecting shortly over the abdominal hump, broad at apex and shortly concave, the two teeth short, truncate or blunt. Forewings extending to apex of fourth abdominal segment ; rather deeply embrowned ; venation blackisk ; marginal vein somewhat shorter than the stigmal, the postmarginal a little longer than the stigmal ; basal and median veins represented by thick light brown lines ; radial vein indicated by a long darker brown line forming an elongate false radial cell which is almost closed ; veins M 3 + 4 and Cu 1 (Tillyardian notation) indicated by long light brown lines. Posterior tarsi about one-fifth shorter than their tibiae, their basal joint slightly longer than 2-5 united. Abdomen two-thirds longer or almost twice as long as the head and thorax united ; gradually tapering to apex, its lateral outline gently convex, broadest at apex of segment 2 ; its greatest width almost as great as that of the thorax, the dorsal surface flat ; segments 1-4 strongly carinate laterally ; 1 no longer than its basal width, two-thirds as long as its posterior width, at base medially with a broad prominence which projects forward slightly into the propodeum ; 2 one-half longer than 1 ; 3 as long as 2, three-fourths as long as wide ; 4 a little shorter than 3, as long as its posterior width ; 5 a little shorter than 4 ; 6 slightly shorter than 5, as long as or one-half longer than its basal width, the sub-apical plate sharply convex ; 1-3 strongly confluently punctate with a longitudinal arrangement, 1 with also irregular strong striae except laterally ; 4 with shallower punctures and irregular longitudinal striae ; on 5 and 6 the punctures are shallow and indefinite, and the striae are stronger and sparser, although sometimes absent on 6 ; 1-4 without pubescence dorsally, with long fine pubescence below the lateral carinae ; 5 and 6 with scattered long fine hairs ; 2 with a median carina which may show faintly on 3-5.

Male.—Segment 4 of abdomen three-fourths as long as its posterior width ; 5 one-fourth shorter than 4 ; 6 one-half as long as 5, one-half as long as its posterior width ; 7 very short, at apex broadly concave and with a short acute spine on either side ; 1 somewhat raised but flat at base, its anterior margin straight ; punctures and pubescence on apical segments more pronounced, the striation less definite than in the female. Propodeal process narrower than in the female, the teeth closer together. Antennae black, the scape red or almost wholly black ; scape rather short ; pedicel small, hardly longer than wide ; funicle 1 elongate, fully one-half as long as the scape; 2-9 sub-moniliform; 2 and 3 sub-equal, each a little more than one-half as long as 1; 4-9 sub-equal, each slightly shorter than 3, and somewhat longer than wide.

Habitat.—Queensland; Jericho, one female in March; Gogango, eight females, four males in March; Biggenden, one male in January; Chinchilla, five females, two males in February-March; Dulacca, one male in March. New South Wales: Moree, one female in April. All collected by the author.

Holotype and *Allotype* in the Queensland Museum; *Paratypes* in the author's collection.

A fine species with large punctures and rather broad abdomen, which in the female bears very sparse pubescence on the dorsal segments. It appears to have a wide range in Central and Southern Queensland and North-West New South Wales, frequenting the brigalow (*Acacia*) and belar (*Casuarina*) scrubs of the sub-coastal and interior districts. The size is variable, and to a lesser degree is the colour of the antennae and tarsi. In the series from Gogango, collected on the one day, are found the smallest examples, varying from 4.5 to 5.5 mm., except one male which measures 6.5 mm. The Jericho female measures 5 mm., while the Chinchilla specimens vary from 6 to 7 mm. In the smaller examples the abdomen is shorter in relation to the head and thorax, and the apical segments in the female are shorter in relation to their width. The antennal scape is usually red, but is black in one Chinchilla female and in the males from Dulacca and Biggenden. The tarsi vary from almost clear red to black. The size of the propodeal teeth vary in the male and may be divergent although more often close together. The holotype and allotype have been selected from Chinchilla specimens.

Prosapegus validus n. sp.

Female.—Length, 3.80 mm. Black, the tegulae red; legs, including the coxae, bright red; antennal scape red, the next three joints suffused with red, the remainder black.

Head rather more transverse than usual and sloping more gently to the occipital margin which is gently concave; vertex, frons and cheeks rather strongly sub-confluently punctate and somewhat coriaceous, with a pubescence of fine white hairs; frontal impression broad, shallow, separated from the eyes by two rows of punctures, smooth but with oblique striae ventrally; mandibles bidentate, the teeth short, stout and blunt. Antennal scape moderately long and stout; pedicel twice as long as its greatest width; funicle 1 no longer than the pedicel, 2 as wide as long, 3 and 4 wider than long, 4 a little widened; club slender, joints 2-5 each much wider than long, 1 slightly longer. Thorax one-fourth longer than its greatest width; parapsidal furrows deep, foveate, widening posteriorly; median lobe of scutum with moderately large punctures, confluent anteriorly, separated posteriorly, the lateral lobes with scattered shallower punctures and fine impressed reticulation; scutellum with scattered punctures; pubescence of scutum and scutellum of fine white hairs; propodeum moderately long laterally, short medially, punctate, weakly pubescent outside the irregular rather weak lateral carinae, the posterior margin moderately deeply concave but not carinate between the lateral carinae; propodeal process short, pubescent, broadly triangular, not projecting beyond the posterior margin, divided for some distance from apex, the two teeth short, blunt, separated. Posterior tarsi no longer than their tibiae, their basal joint slightly longer than 2-5 united. Forewings reaching almost to apex of fifth abdominal segment; lightly stained brownish; venation thick, blackish; marginal vein two-thirds as long as the stigmal, the post-marginal twice as long as the marginal; basal, median and radial veins faintly marked. Abdomen one-fourth longer than the head and thorax united, slightly narrower than the thorax, $2\frac{1}{2}$ times as long as its greatest width, widest at base of segment 3, tapering to apex, its outline regularly ovate; segments 1-4 strongly carinate laterally, 2 with a median carina; 1 rather short, two-thirds as long as its basal width, one-half as long as its posterior width, its anterior margin straight, strongly depressed on either side at base, so that the flat meson is raised as in species of *Oxyscelio*; 2 one-half longer than 1; 3 scarcely longer than 2, a little more than one-half as long as wide; 4 a little shorter than 3; 5 two-thirds as long as 4, one-half as long as its basal width; 6 as long as 5, as long as its basal width, bluntly acuminate at apex which is depressed and without a sub-apical plate; 1 striate, densely punctate between the striae; 2-4 rather strongly confluently punctate with a longitudinal arrangement; 5 and 6 more shallowly confluently punctate; pubescence short on 1-4, long below the lateral carinae and on 5 and 6.

Male.—Unknown.

Habitat.—South-west Queensland; Goondiwindi, one female in January, A. P. Dodd.

Holotype in the Queensland Museum.

A very distinct species on account of the shorter broader abdomen and the shorter first funicle joint, and with the general appearance of species of *Hoploteleia* Ashmead and *Oxyscelio* Kieffer.

PROSAPEGUS FUSCICORPUS Dodd.

Cacellus fuscicorpus Dodd, Trans. Royal Soc. South Aust., xl, 1916, p. 24.

Female.—Length, 2.80-3.50 mm. Head black; thorax and abdomen dull or dusky brown or reddish-brown; legs, including the coxae, pale yellow; antennal scape pale yellow, the pedicel and funicle joints brownish-yellow, the club black.

Head from dorsal aspect less than twice as wide as long; occipital border rounded and not margined; upper frons and vertex with numerous punctures of moderate size which sometimes become dense and sub-confluent toward the occiput; lower two-thirds of frons with a broad smooth shallow impression which is separated from the eyes by one row of punctures; cheeks smooth with scattered punctures; mandibles tridentate, the teeth small. Antennal scape moderately slender; pedicel slender; funicle 1 elongate, one-third longer than the pedicel; 2 a little shorter than the pedicel, fully twice as long as wide; 3 a little longer than wide; 4 as wide as long; club compact, 6-jointed, joint 1 almost as long as wide, 2-5 each plainly wider than long. Thorax one-half longer than its greatest width; pronotum with dense punctures; parapsidal furrows deep and punctate; anterior half of median lobe of scutum with dense punctures, the posterior half and the lateral lobes with scattered indefinite shallow punctures; scutellum smooth except for scattered indefinite punctures; scutum and scutellum with a pubescence of fine white hairs; propodeum long laterally, rather short medially, the lateral carinae long and distinct, the posterior margin within the lateral carinae deeply concave and strongly margined; propodeum armed medially with a pair of parallel carinae, close together, which project for half their length in the form of slender teeth beyond the posterior margin but not further than a line drawn across the posterior ends of the lateral carinae; outside the median carinae on either side there is a short straight carina joining the posterior margin; surface of propodeum shining and hardly sculptured within the lateral carinae. Forewings reaching to posterior margin of fifth abdominal segment; slightly stained; venation yellow; marginal vein a little longer than the stigmal, the postmarginal 2½ times as long as the marginal; basal and median veins faint, pale yellow. Posterior tarsi a little longer than their tibiae, their basal joint a little shorter than 2-5 united. Abdomen one-half longer than the head and thorax united, three-fourths as wide as the thorax, widest at posterior margin of segment 3: segments 1-4 carinate laterally; 1 as long as its posterior width, slightly raised at base, its anterior margin straight and free from the thorax; 2 one-third longer than 1; 3 a little longer than 2, slightly longer than wide; 4 as long as 2; 5 two-thirds as long as 4; 6 as long as 5, slightly longer than its basal width, narrowly truncate or faintly concave at apex; 1 with several striae, punctate laterally, smooth at base medially; 2-4 confluently punctate and irregularly striate; 5 more finely shallowly punctate and finely striate; 6 finely punctate and densely coriaceous; 1-4 dorsally with short pubescence; 5 and 6 and sides of abdomen with longer denser pubescence.

Male.—Length, 2.85 mm. Black, the propodeum and sides of thorax brownish; legs, including the coxae, golden-yellow; antennal scape yellow, the pedicel dusky-yellow, the flagellum black.

Propodeum densely reticulate-punctate, moderately long medially, the posterior margin rather gently concave, the median process reduced to a pair of raised carinae which are parallel and close together. Segment 1 of abdomen somewhat longer than its posterior width; 2 and 3 sub-equal; 4 somewhat shorter; 5 slightly shorter than 4; 6 two-thirds as long as 5; 7 transverse, armed with a pair of stout spines. Antennal scape moderately short; pedicel short and stout; funicle 1 slender, 2½ times as long as wide; 2 and 3 a little shorter, sub-equal; 4 distinctly but not greatly shorter than 3; 4-9 slightly decreasing in length, 9 one-half longer than wide.

Habitat.—North Queensland; Cairns district, six females, two males in July to January, A. P. Dodd.

Holotype in the South Australian Museum, I. 5,423.

The only Australian species which is not wholly black. The female resembles *augustus*, *regalis* and *illustris* in propodeal characters and in the straight anterior margin of the abdomen, but differs in the weak punctuation of the scutum posteriorly. This same character separates the male from *fissilis* and *augustus* and allies it with male *discissus*; in the latter species, however, the propodeum has the median carinae wide apart at base, and the postmarginal vein is much shorter in relation to the marginal.

Prosapegus infusus n. sp.

Female.—Length, 4.15 mm. Black, the tegulae dusky; antennae black, the scape washed with red; coxae black, washed with red, the trochanters, femora and posterior tibiae deep red, the anterior and intermediate tibiae blackish except the red base and apex, the tarsi blackish.

Head from dorsal aspect twice as wide as its median length vertex sloping shortly to the posterior margin from well behind the lateral ocelli, the posterior margin rather gently concave; cheeks broad ventrally; frontal impression broad and deep, smooth, with fine oblique striae ventrally and a few fine tranverse striae dorsally; vertex and upper frons somewhat coriaceous, with rather large sub-confluent punctures which behind the lateral ocelli tend toward arrangement in transverse rows; cheeks polished, the punctures numerous but separated; pubescence fine and pale. Antennal scape moderately long and slender; pedicel over twice as long as its greatest width; funicle 1 one-third longer then the pedicel; 2 hardly more than one-half as long as 1; 3 shorter, as wide as long; 4 a little widened, somewhat wider than long; club slender, joint 1 as long as wide, 2-5 somewhat wider than long. Thorax almost one-half longer than its greatest width; parapsidal furrows deep and foveate, approaching rather close together posteriorly; median lobe of scutum on anterior half with moderately large dense punctures, with scattered punctures along lateral and posterior margins, a posterior-central area smooth except for a longitudinal line of small punctures, and there are fine impressed longitudinal striae against the anterior half of the parapsidal furrows; lateral lobes with scattered punctures and fine impressed lines; scutellum very strongly foveate at base, its surface with large punctures but the median line bears small punctures; punctures of scutum and scutellum bearing long fine white hairs; propodeum long laterally, moderately short medially, the posterior margin sharply rather deeply concave within the limits of the lateral carinae, the surface pubescent outside the lateral carinae, punctate within these carinae, which are long and strong; on either side of the median process is a strong carina which diverges somewhat to join the lateral carina in a projecting tooth at the posterior margin; median process narrowly triangular, extending beyond the concave posterior margin almost to a line drawn across the ends of the lateral carinae, hollowed out, its lateral margins carinate and forming at apex a bidentate tooth, the teeth short, sub-acute, close together. Forewings reaching to apex of fifth abdominal segment; distinctly brownish; venation blackish; marginal vein as long as the long stigmal, the postmarginal three times as long as the marginal; median vein marked by a thick brown line, the basal vein by a pale line. Posterior tarsi slightly longer than their tibiae, their basal joint slightly longer than 2-5 united. Abdomen one-half longer than the head and thorax united, its greatest width a little yet distinctly less than that of the thorax, four times as long as its greatest width toward the base of segment 3, its lateral outline regularly gently convex, its dorsal surface flat; segments 1-4 strongly carinate laterally; 1 slightly longer than its basal width, three-fourths as long as its posterior width, its anterior margin straight and distinctly separated from the propodeum, with a deep fovea on either side at base, so that the median area is strongly raised basally; 2 one-third longer than 1; 3 a little longer than 2, three-fourths as long as wide; 4 as long as 2, slightly shorter than its posterior width; 5 four-fifths as long as 4, one-fourth longer than its posterior width; 6 a little shorter than 5, hardly longer than its basal width, depressed just before apex but without a plate, the apex in the form of a sub-acute tubercle; 1 strongly striate, punctate between the striae; 2-5 with strong sub-confluent punctures which are separated in irregular longitudinal rows by irregular striae and are shallow on 5 and posterior half of 4 ; 6 densely shallowly punctate and coriaceous ; pubescence very short and hardly noticeable on dorsum of 1-4, long and dense on 5 and 6 and along lateral margins.

Male.—Length, 4.00 mm. Coxae and tarsi dusky-black, the legs bright reddish yellow, the first two pairs of tibiae washed lightly with brown. Antennae wholly black ; scape stout and rather short ; funicle 1 almost twice as long as the pedicel, $2\frac{1}{2}$ times as long as its greatest width ; 2 two-thirds as long as 1 ; 2-9 sub-equal. Propodeum longer medially than in the female, the posterior margin moderately deeply concave, the process shorter and scarcely projecting beyond the posterior margin. Abdomen widest at apex of segment 3, a little more than three times as long as its greatest width ; segments 2 and 3 with a strong median stria or carina ; foveae at base of 1 shallow, the median area not as strongly raised as in the female ; 5 two-thirds as long as 4, somewhat shorter than its posterior width ; 6 two-thirds as long as 5 or as its posterior width ; 7 very short, truncate, armed on either side with a short stout spine ; pubescence on dorsum fine but more noticeable than in the female.

Habitat.—New South Wales ; Canberra, one female, one male, in January, Miss L. F. Graham.

Holotype and *Allotype* in the collections of the Division of Economic Entomology, Canberra.

This species has no very close allies and may be recognised by the following combination of characters :—Dark coxae, unevenness of the punctuation of the scutum, rather stout abdomen with its straight anterior margin in the female, and the long straight carina on either side of the propodeal process joining the lateral carina posteriorly.

Prosapegus extensus n. sp.

Female.—Length 5.10 mm. Black, the tegulae yellow ; legs, including the coxae, bright golden-yellow, the tarsi dusky ; antennae golden-yellow, the club black.

Vertex and frons with moderately large dense punctures, confluent toward the occiput ; frontal impression smooth, deep, rather narrow, not margined, separated from the eyes by two or three rows of punctures ; cheeks with dense punctures, confluent above. Pedicel slender ; funicle 1 elongate, one-third longer than the pedicel ; 2 a little shorter than the pedicel ; 4 as wide as long ; club slender, joint 1 as long as wide, 2-5 slightly wider than long. Thorax one-half longer than its greatest width ; parapsidal furrows deep and complete, widening and approaching rather close together posteriorly ; median lobe of scutum with moderately large punctures, confluent anteriorly, more open posteriorly, the lateral lobes, except along the punctate-foveate margins, with fine impressed reticulation and shallow scattered punctures ; pronotum, scutum and scutellum with a pubescence of long white hairs ; propodeum very short medially, its posterior margin very deeply concave, the lateral carinae straight and moderately short, the surface densely pubescent outside the carinae, punctate within the carinae ; median process of propodeum densely finely punctate and pubescent, projecting over the abdominal prominence, as long as its basal width, its lateral margins parallel, its posterior margin in the form of two stout rounded teeth, the concavity between the teeth not extending for one-half its length ; from lateral aspect the process is in the form of a strong curved stout spine. Posterior tarsi one-fourth longer than their tibiae, their basal joint one-half longer than 2-5 united. Forewings extending to one-half the length of segment 4 of abdomen; lightly brownish; venation fuscous; marginal vein as long as the stigmal, the postmarginal twice as long as the marginal; basal and median veins faint. Abdomen twice as long as the head and thorax united, its greatest width three-fourths that of the thorax, gradually tapering to apex from segment 2; segment 1 a little shorter than its posterior width, at base with a rounded prominence that projects forward into the propodeum; 2 one-half longer than 1, one-fourth longer than wide; 3 as long as 2; 4 a little shorter than 3; 5 about one-fifth shorter than 4, one-third longer than its basal width; 6 as long as 5, over twice as long as its basal width, the apical margin convex; 1 strongly punctate, medially with several strong striae, the basal prominence almost smooth in front; 1-3 with a strong lateral carina, 2 and 3 with a faint median carina; 2-4 with large confluent punctures in irregular longitudinal rows; 5 and 6 more shallowly punctate; pubescence short on 1-3, long and dense on 4-6 and sides of abdomen.

Male.—Length, 4.30-4.60 mm Propodeum moderately deeply concave medially, the lateral carinae normally long, the process somewhat narrower than in the female. Abdomen rather shorter, about three-fourths longer than the head and thorax united, not noticeably tapering to apex from segment 2; segment 1 with the anterior margin straight, the meson rather narrowly raised and flat, the raised area with three strong striae; 5 hardly longer than its basal width; 6 two-thirds as long as 5, as long as its basal width; 7 short, its apical margin concave and rather strongly bispinose. Antennae black, the scape bright yellow; funicle 1 one-half longer than the pedicel, 2 as long as the pedicel, 3 no longer than 2, 4-9 almost sub-equal, each slightly longer than wide.

Habitat. — North Queensland; Cairns district; two females, seven males in February, A. P. Dodd.

Holotype and *Allotype* in the Queensland Museum.

Paratypes in the author's collection.

This species may be recognised by the form of the propodeal process in both sexes, the long first metatarsal joint, and the long tapering abdomen of the female.

PROSAPEGUS ILLUSTRIS n. sp.

Female.—Length, 4.25 mm. Black, the tegulae deep brown; legs, including the coxae, bright golden-yellow, the tarsi dusky; antennae black, the scape suffused with red.

Upper frons and vertex with rather dense large punctures, which are confluent behind the ocelli; frontal impression large, smooth, separated from the eyes by a row of large punctures. Pedicel fully twice as long as its greatest width; funicle 1 slender, several times as long as its greatest width, rather less than twice as long as the pedicel, 2 as long as the pedicel, 3 shorter, one-half longer than wide 4 wider than long; club joint 1 a little wider than long, 2-5 each twice as wide as long. Thorax one-half longer than its greatest width; parapsidal furrows complete, consisting of a row of punctures; median lobe of scutum with very large well-separated punctures, which are smaller and confluent toward the anterior margin, the lateral lobes with a few scattered punctures; scutellum with numerous large punctures; propodeum rather long, densely pubescent outside the long straight lateral carinae, almost smooth within the carinae, the carinate posterior margin within the lateral carinae rather deeply concave for one-half the propodeal length; median area of propodeum rectangular, lightly pubescent, armed with a long slender bicarinate tooth whose carinae are parallel and close together, the tooth faintly bidentate at apex; from lateral aspect this tooth is sub-erect, stout, and strongly curved. Posterior tarsi one-fifth longer than their tibiae, their basal joint as long as 2-5 united. Forewings reaching to one-half the length of the fifth abdominal segment; distinctly brownish; venation thick, fuscous; marginal vein as long as the stigmal, the postmarginal twice as long as the stigmal; median vein marked by a light brown thick line, the basal vein faint and very oblique. Abdomen two-thirds longer than the head and thorax united, about one-fourth narrower than the thorax; widest at the third segment, the lateral outline uniformly very gently convex; segment 1 flat medially, its anterior margin straight and well-separated from the thorax; 2 one-half longer than 1, 3 as long as 2, 4 about four-fifths as long as 3, 5 two-thirds as long as 4; 6 three-fourths as long as 5, a little shorter than its basal width, its sub-apical plate distinctly concave and shortly bispinose; 1-4 with a strong lateral carina and with a faint median carina; 1 with strong sparse striae, smooth between the striae except laterally where shallow punctures occur; 2-5 confluently punctate, the punctures divided into irregular longitudinal rows by wavy striae, the punctures shallow and more or less obscure on 5; 6 densely coriaceous and indefinitely punctate; 1-4 with short inconspicuous pubescence, which is long and dense on 5 and 6 and lateral margins of 1-4.

Male.—Length, 4.05 mm. Agreeing very closely with the female except that the apex of the abdomen is broader and blunter; segment 6 somewhat shorter than its posterior width; 7 very short, broadly concave and shortly bispinose at apex. Antennae black, the scape suffused with deep red; pedicel less than twice as long as its greatest width; funicle 1 two-thirds longer than the pedicel, over thrice as long as its greatest width; 2 as long as the pedicel; 3 slightly longer than 2, faintly excised on one side; 3-9 very gradually shortening; 9 one-half longer than wide.

Habitat.—North Queensland; Cairns district, two females, one male in December, A. P. Dodd.

Holotype and *Allotype* in the Queensland Museum.

Paratype in the author's collection.

This species agrees with *regalis* and *augustus* in the form of the propodeal process and in the anterior margin of the abdomen being straight and well-separated from the thorax. It differs from those two species in the larger punctures of the scutum, and in the first abdominal segment being flat medially, while the propodeal process is similar in both sexes and is not reduced in the male.

Prosapegus augustus Dodd.

Cacellus augustus Dodd, Archiv. fur Naturg., Berlin, lxxx, 1915. *C. propinquus* Dodd, Trans. Royal Soc. South Aust., xl, 1916, p. 23.

Female.—Length, 4.35 mm. Black; tegulae dull yellow; legs, including the coxae, golden-yellow, the tarsi dusky brown; antennal scape yellow, the pedicel and funicle joints suffused yellowish, the club black; mandibles red.

Vertex and upper frons with rather large confluent or sub-confluent punctures; lower two-thirds of frons with a deep smooth immargined impression which is separated from the eyes by one or two rows of punctures; cheeks with numerous non-confluent punctures. Antennal scape moderately long and slender; pedicel twice as long as its greatest width; funicle 1 a little less than twice as long as the pedicel, several times as long as wide, 2 as long as the pedicel, 3 shorter than 2, less than twice as long as wide, 4 as wide as long; club 6-jointed, compact, joint 1 the longest, scarcely wider than long, 2-5 each twice as wide as long. Thorax one-half longer than its greatest width; pronotum narrowly visible laterally, its anterior angles rounded; scutum large, broadly rounded anteriorly, with rather long fine pubescence, the median lobe with moderately large confluent punctures, the lateral lobes with shallow confluent punctures and finely coriaceous; parapsidal furrows complete and distinct, separated posteriorly by rather more than one-half their length; scutellum with rather dense punctures laterally, with scattered punctures medially; metanotum a foveate line, not raised or armed; propodeum moderately long, densely pubescent outside the lateral carinae, shining and weakly pubescent inside the lateral carinae, these carinae rather long, curved posteriorly to join the posterior margin in a projecting point; a strong shorter carina occurs on either side nearer the median line; posterior margin rather deeply concave and margined within the lateral carinae; median process of propodeum in the form of two adjacent sub-parallel carinae which project beyond the posterior margin for nearly one-half their length in a slender shortly bidentate tooth, which from lateral aspect is almost horizontal. Legs slender; posterior tarsi one-fifth longer than their tibiae, their basal joint as long as 2-5 united. Forewings reaching to base of apical abdominal segment; lightly stained brownish, the infuscation inclined to be lighter along the margins; venation thick; marginal vein as long as the long moderately oblique stigmal, the postmarginal $2\frac{1}{2}$ times as long as the marginal; median vein marked by a thick brown line, the basal vein pale and very oblique. Abdomen two-thirds longer than the head and thorax united, its greatest width two-thirds that of the thorax, somewhat narrowed at base, almost pointed at apex, the lateral margins of segments 2-4 sub-parallel; segment 1 a little raised and convex at base medially, its anterior margin straight and well-separated from the propodeum, two-thirds as wide basally as posteriorly, as long as its posterior width; 2 one-half longer than 1; 3 as long as 2, as long as or slightly longer than wide; 4 very slightly shorter than 3; 5 two-thirds as long as 4; 6 a little shorter than 5, a little longer than its basal width, its sub-apical plate concave and shortly bispinose; 1-4 with a strong lateral carina; 1 smooth and with several striae medially, densely punctate laterally; 2-4 with moderately large confluent punctures with an irregular longitudinal arrangement; 5 with shallow punctures; 6 densely coriaceous and with indefinite punctures; pubescence of 1-4 of fine short hairs; 5 and 6 and lateral margins with dense long fine hairs.

Male.—Length, 4.30 mm. Propodeum long medially, finely punctate and sparsely pubescent, the posterior margin gently concave within the lateral carinae, the median process reduced to a pair of parallel carinae, rather close together, which do not project beyond the posterior margin. Abdomen three-fourths longer than the head and thorax united, slender, gradually widening to the apex of segment 4 ; segments 1-3 carinated laterally ; 1 a little longer than its posterior width, without a definite raised area medially where there are two strong and two weaker striae, densely punctate laterally ; 2 almost one-half longer than its posterior width ; 3 one-third longer than its posterior width ; 4 a little longer than wide ; 6 one-half as long as 5 or as its basal width ; 7 very short and transverse, concave and very strongly bispinose at apex. Antennae black, the scape golden-yellow ; funicle 2 a little longer than the pedicel, twice as long as wide, 1 one-half longer than 2, 3 as long as 2 and slightly excised on one side, 4-9 very gradually shortening, 9 one-half longer than wide.

Habitat.—North Queensland ; Cairns district, a small series in July-December, A. P. Dodd.

Holotype in the South Australian Museum, I. 11,055.

Closely related to several species, such as *regalis*, *accultus*, *solitus* and *fissilis*, but at once differing in the concave bispinose sub-apical abdominal plate. The straight basal margin of the abdomen, well separated from the propodeum, is found in *regalis*. The male is nearest *fissilis*, the differences being pointed out in the discussion of that species.

Prosapegus regalis Dodd.

Cacellus regalis Dodd, Trans. Royal Soc. South Aust., xxxix, 1915, p. 445.

Female.—Length, 4.15 mm. Black ; tegulae dull yellow ; legs, including the coxae, golden-yellow, the tarsi dusky ; antennal scape yellow, the pedicel and funicle fuscous or suffused with yellow, the club black.

Vertex and upper frons with moderately large confluent punctures which are numerous but not confluent on the cheeks. Pedicel twice as long as its greatest width ; funicle 1 elongate, two-thirds longer than the pedicel, 2 slightly shorter than the pedicel, 3 shorter than 2, one-half longer than wide, 4 quadrate ; club compact, joint 1 as long as wide, 2-5 each plainly wider than long. Thorax one-half longer than its greatest width ; parapsidal furrows deep and complete ; median lobe of scutum with moderately large sub-confluent punctures, the lateral lobes shallowly punctate and somewhat coriaceous ; scutellum sub-confluently punctate ; pubescence of scutum and scutellum of moderately long, rather dense fine hairs ; propodeum moderately long laterally, short medially, the posterior margin moderately concave, the lateral carinae curved, with a short carina on either side either close to the lateral carinae or to the median process ; median process with two approximate parallel blunt carinae, joined basally, shortly divided and curved outward at apex, and projecting well beyond the posterior margin. Forewings reaching to base of apical abdominal segment ; lightly brownish ; marginal vein a little longer than the stigmal, the postmarginal one-half longer than the marginal ; median vein represented by a thick brown line, the basal vein by a very pale line. Basal joint of posterior tarsi as long as 2-5 united. Abdomen two-thirds to four-fifths longer than the head and thorax united, its greatest width somewhat narrower than that of the thorax, its lateral outline uniformly gently convex, segment 3 being slightly the widest ; segment 1 as long as its posterior width, somewhat convex at base medially, the anterior margin straight and well-separated from the propodeum ; 2 one-half longer than 1 ; 3 a little longer than 2 or than its greatest width ; 4 as long as 2 ; 5 two-thirds as long as 4 ; 6 as long as 5, one-third longer than its greatest width, its sub-apical plate slightly convex ; 1-3 with a lateral carina ; 1 with several strong striae medially, densely punctate laterally ; 2-6 with moderately large confluent punctures with a tendency toward longitudinal arrangement, the punctures shallow on 5-6 ; pubescence short on dorsum of 1-4, long on 5-6 and along lateral margins.

Male.—Length, 4.00 mm. Propodeum moderately short medially, its posterior margin rather gently concave within the lateral carinae ; median process reduced to two strongly raised carinae which converge somewhat posteriorly and do not project beyond the posterior margins Abdomen three-fifths longer than the head and thorax united, it. lateral outline regularly gently convex, segment 3 being slightly the widest ; 2 one-fourth longer than its posterior width ; 3 slightly longer than its posterior width ; 6 two-thirds as long as 5 ; 7 very short, transverse, its posterior margin concave and shortly bispinose. Antennae black, the scape yellow ; segmentation as in *augustus* but the flagellar joints are somewhat shorter 2 less than twice as long as wide , 9 a little longer than wide.

Habitat.—North Queensland ; Cairns district, four females, six males in April and November, A. P. Dodd.

Holotype in the South Australian Museum; I. 5,168.

This species is very close to *augustus* but in the latter the sub-apical plate of the abdomen in the female is concave and bispinose, the postmarginal vein is longer in relation to the marginal and in the male the propodeum and its carinae are rather long medially while the abdomen is more slender, segments 2 and 3 being considerably longer in relation to their width. The females of *accultus, solitus,* and *fissilis* differ in the deeply concave propodeum and produced basal margin of the abdomen. The male is very close to *accultus*, in which the posterior margin of the propodeum is deeply concave medially.

Prosapegus distinctus Dodd.

Macroteleia distincta Dodd, Proc. Royal Soc. Qld., xxvi, 1914, p. 100.

Female.—Length, 3.70 mm. Black, the tegulae dull yellow ; legs, including the coxae, golden-yellow ; first six antennal joints reddish-yellow.

Head normal, from dorsal aspect twice as wide as long, gradually sloping to the occiput ; cheeks, upper frons and vertex with moderately large dense punctures which are confluent with a tendency toward transverse arrangement behind the ocelli. Pedicel twice as long as its greatest width ; funicle 1 elongate, two-thirds longer than the pedicel, 2 as long as the pedicel, 3 plainly shorter than 2, one-half longer than wide, 4 quadrate ; club compact, 6-jointed. Thorax one-half longer than its greatest width ; parapsidal furrows deep and complete ; median lobe of scutum with moderately large dense punctures which are confluent anteriorly, the lateral lobes shallowly punctate and coriaceous ; scutellum with numerous punctures ; propodeum moderately long laterally, short medially, the posterior margin within the lateral carinae rather deeply concave and strongly carinate, the lateral carinae straight ; propodeal process in the form of a sub-erect long narrow bicarinate tooth which projects for half its length beyond the median posterior margin, the carinae parallel, close together and joined except at extreme apex, not curved outward at apex. Forewings failing by a little to reach apex of abdomen ; stained brownish ; marginal vein a little longer than the stigmal, the postmarginal twice as long as the marginal; median vein represented by a thick light brown line, the basal vein faintly marked. Basal joint of posterior tarsi as long as 2-5 united. Abdomen one-half longer than the head and thorax united, its greatest width somewhat narrower than that of the thorax, widest at apex of segment 3, its lateral outline regularly convex; segment 1 as long as its posterior width, somewhat convex medially at base, the anterior margin straight and well separated from the propodeum; 2 one-fourth longer than 1; 3 slightly longer than 2, scarcely as long as wide; 4 somewhat shorter than 2 or than its posterior width; 5 two-thirds as long as 4; 6 as long as 5, no longer than its basal width, its subapical plate gently convex; dorsal surface of abdomen not convex; segments 1-4 with a lateral carina; 1 strongly striate, densely punctate laterally; 2-5 densely punctate and with traces of fine irregular striae, the sculpture becoming finer on 4 and 5; 6 shallowly punctate and densely coriaceous.

Male.—Length, 3.60 mm. Propodeum much as in the female, short and deeply concave medially; propodeal process short, scarcely projecting beyond the posterior margin, the carinae divergent at base, approaching close together posteriorly. Abdomen, as in the female, one-half longer than the head and thorax united, its greatest width at the apex of segment 3; 1-3 with a lateral carina, 2 with a median carina; 1 somewhat shorter than its posterior width; 2 one-third longer than 1; 3 scarcely longer than 2, no longer than wide; 4 a little shorter than 3 or than its posterior width; 5 two-thirds as long as 4, no longer than its posterior width; 6 two-thirds as long as 5; 7 very short, broad, armed with a short spine or tooth at either posterior angle. Antennae black, the scape yellow; funicle 1 fully twice as long as wide, 2 one-half longer than wide, 3-9 very gradually shortening, 9 scarcely longer than wide.

Habitat.—New South Wales; one pair without further data.

Holotype and *Allotype* in the Macleay Museum, University of Sydney.

In the female, the form of the propodeal process and the straight anterior margin of the abdomen denote a close relationship with *regalis* and *augustus*; the latter species may be distinguished by the concave bispinose apex of abdomen. The differences between *regalis* and *distinctus* are small but numerous, and are shown hereunder :—

Lateral carinae of propodeum curved; carinae of propodeal process curved outward at apex; postmarginal vein one-half longer than the marginal; abdomen at least two-thirds longer than the head and thorax, segment 2 one-half longer than 1, 6 longer than its basal width	*regalis*
Lateral carinae of propodeum straight; carinae of propodeal process not curved outward at apex; postmarginal vein twice as long as the marginal; abdomen one-half longer than the head and thorax; segment 2 one-fourth longer than 1, 6 no longer than its basal width	*distinctus*

In the male, *distinctus* has the reduced propodeal process as in *regalis*, from which it differs in having the posterior margin of the propodeum deeply concave. In general and propodeal characters the male is nearly allied to that of *accultus*, differing as follows :—

Abdomen three-fourths longer than the head and thorax, six times as long as its greatest width, the segments relatively longer, 1 to 4 each plainly longer than its posterior width	*accultus*

Abdomen one-half longer than the head and thorax, not more than four times as long as its greatest width, the segments shorter, 1 to 4 each not longer than its posterior width .. .. *distinctus*

Prosapegus fissilis n. sp.

Female.—Length, 5.00 mm. Black; tegulae yellow; legs, including the coxae, golden-yellow, the tarsi a little dusky; antennal scape yellow, the pedicel and funicle joints dusky yellow or deep brown, the club black.

Frons and vertex with rather large sub-confluent punctures which are dense but not confluent on the cheeks; pubescence of fine rather short pale hairs; frontal impression smooth, rather narrow, separated from the eye by three rows of punctures. Pedicel fully twice as long as its greatest width; funicle 1 two-thirds longer than the pedicel, 2 a little longer than the pedicel, 3 somewhat shorter than 2, 4 slightly longer than wide; club slender, joint 1 as long as wide, 2-5 slightly wider than long. Thorax one-half longer than its greatest width, its dorsal surface almost flat; parapsidal furrows deep and complete, rather close together but not widening posteriorly; median lobe of scutum with moderately large confluent or sub-confluent punctures, the lateral lobes with shallow punctures and fine impressed lines of reticulation; scutellum with numerous non-confluent punctures; pubescence of scutum long, fine and rather dense; propodeum long laterally, its posterior margin broadly and deeply concave almost to its base medially, the lateral carinae long and rather delicate, and with a shorter carina on either side nearer the median line, the surface finely punctate and lightly pubescent inside the carinae, densely pubescent outside the carinae; median process of propodeum finely punctate and pubescent, broadly and deeply divided almost to its base and forming two rather narrow bluntly triangular teeth which project over the abdominal prominence. Posterior tarsi one-fourth longer than their tibiae, their basal joint almost one-half longer than 2-5 united. Forewings extending almost to apex of segment 5 of abdomen; lightly infuscate; marginal vein as long as the stigmal, the postmarginal fully twice as long as the marginal; basal and median veins marked by thick light lines. Abdomen a little less than twice as long as the head and thorax united, four-fifths as wide as the thorax, its lateral outline uniformly gently convex, segment 3 being slightly the widest; dorsum of abdomen not flat, but with a broad convex median ridge; segments 1-3 without the usual lateral carinae; 1 almost as long as its posterior width, at base with a rounded prominence that projects forward into the propodeum; 2 one-third longer than 1, as long as wide; 3 as long as 2; 4 very slightly shorter than 3; 5 three-fifths as long as 4, distinctly (about one-fourth) shorter than its basal width; 6 as long as 5, one-third longer than its basal width, its apical plate faintly concave; 1 densely punctate, and with irregular striae, its prominence with smaller punctures but smooth anteriorly; 2-4 confluently punctate, the punctures of moderate size and with a tendency toward longitudinal arrangement; punctures more shallow on 5 and 6; apical half of 6 densely coriaceous; pubescence short and inconspicuous on 1-4, longer and dense on 5-6 and lateral margins of 1-4.

Male.—Length, 4.50 mm. Propodeum rather long at meson, its posterior margin gently concave, the lateral carinae long and distinct; median process reduced to two strongly raised, well separated pubescent carinae that do not project beyond the posterior margin and which from lateral aspect form blunt triangular teeth. Abdomen three-fourths longer than the head and thorax united, not raised or bluntly ridged medially ; segments 1 and 2 with a lateral carina which is hardly marked on 3 ; 1 with its anterior margin straight, its meson convex and with three strong striae ; 5 hardly as long as its basal width ; 6 two-thirds as long as 5, three-fourths as long as its basal width ; 7 short, armed on either side with a strong apical spine. Basal joint of posterior tarsi a little less than one-half longer than 2-5 united. Antennal scape yellow, the basal flagellar joints a little suffused with yellow ; segmentation as in *extensus*.

Habitat.—Queensland ; Cairns district, three females, eight males in December to February, A.P.D. ; Gympie, one female, A. A. Girault ; Mt. Tambourine, one female, two males in April, A.P.D., one female in February, H. Hacker.

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

The description is based on the Cairns examples, from which the holotype female and allotype male have been selected. In the female from Gympie, fine impressed reticulation is present on the median lobe against the parapsidal furrows, and segment 6 of the abdomen is almost wholly coriaceous. The specimens from Mt. Tambourine are smaller, 4.10 mm., the abdomen is not more than two-thirds longer than the head and thorax united, and the basal joint of the posterior tarsi is one-fourth longer than 2-5 united.

One of the main group of closely related species. The female may be distinguished by the convex dorsal ridge and absence of lateral carinae on the basal abdominal segments. The male agrees very closely with *augustus*, but in that species the basal joint of the posterior tarsi is a little shorter than 2-5 united, and the abdomen is more slender, segments 2 and 3 being very distinctly longer than wide.

Prosapegus solitus n. sp.

Female.—Length, 3.50 mm. Black ; tegulae reddish ; legs, including the coxae, reddish-yellow ; antennal scape and funicle joints reddish-yellow, the pedicel fuscous, the club black.

Vertex and frons with moderately large confluent punctures, the cheeks less densely punctate ; frontal impression deep, smooth, narrow, separated from the eyes by three rows of punctures. Pedicel slender ; funicle 1 elongate, one-third longer than the pedicel, 2 about one-third shorter than the pedicel and hardly one-half as long as 1, 3 and 4 as wide as long ; club joint 1 almost as long as wide, 2-5 each much wider than long. Median lobe of scutum with moderately large dense punctures which become confluent anteriorly, the lateral lobes with fine impressed reticulation and shallow indefinite punctures parapsidal furrows foveate, not widening posteriorly ; scutellum densely punctate ; pubescence of scutum and scutellum fine and long ; propodeum very short medially, the lateral carinae well marked, the posterior margin carinate and very deeply concave ; propodeal process punctate and pubescent, triangular, about as long as its basal width, projecting over base of abdomen, very narrowly divided for some distance from apex, the two teeth narrow and sub-acute. Fore-wings reaching to apex of fifth abdominal segment ; marginal vein a little longer than the stigmal, the postmarginal twice as long as the marginal; basal and median veins very faint. Posterior tarsi one-fifth longer than their tibiae, their basal joint one-fifth longer than 2-5 united. Abdomen one-half longer than the head and thorax united, three-fourths as wide as the thorax; narrowed at base, pointed at apex, its lateral outline gently regularly convex, widest at base of segment 3; segments 1-3 carinate laterally; 1 somewhat raised at base and projecting forward into the propodeum, somewhat shorter than its posterior width; 2 one-half longer than 1; 3 a little longer than 2, as long as wide; 4 slightly shorter than 2; 5 three-fourths as long as 4, a little shorter than its basal width; 6 as long as 5, one-third longer than its basal width, its sub-apical plate convex; 1 densely punctate laterally, with several striae medially, of which the median pair are strongest; 2-4 confluently punctate with a longitudinal arrangement; 5 and 6 shallowly confluently punctate; pubescence as in *regalis* and related species.

Male.—Length, 3.50 mm. Propodeum longer medially than in the female, the posterior margin carinate and rather deeply concave between the lateral carinae, the median process narrower, the teeth projecting for some distance beyond the posterior margin. Abdomen one-half longer than the head and thorax united; segments 1-3 strongly carinate laterally, 4 more feebly so; 1 with two strong median striae; 6 one-half as long as 5, two-thirds as long as its basal width; 7 shortly strongly bispinose. Antennae black, the scape reddish-yellow; funicle 1 one-half longer than the pedicel, 2 and 3 as long as the pedicel, 4-9 each slightly longer than wide.

Habitat.—North Queensland; Cairns district, one pair in January, F. P. Dodd. New South Wales; Sydney, one female in November, A. P. Dodd.

Holotype and *Allotype* in the Queensland Museum; *Paratype* in the author's collection.

A rather small species with the second funicle joint in the female shorter than the pedicel, and the abdomen shorter in relation to the head and thorax. The base of the abdomen in the female is produced forward into the propodeum, thus differing from *augustus* and *regalis*; the basal hump is not developed as strongly as in *fissilis* and *accultus*, in both of which the propodeal process is broadly and deeply divided. In the male this process is more strongly developed than in the above four species. However, in the male *accultus* the median carinae project a little beyond the posterior margin, but they are shorter and wider apart, the posterior margin is more deeply concave, while the abdomen is longer.

PROSAPEGUS ACCULTUS n. sp.

Female.—Length, 4.60 mm. Black; tegulae reddish; legs, including the coxae, bright reddish-yellow; antennal scape and funicle joints 1 and 2 reddish-yellow, the pedicel and funicle 3 and 4 fuscous, the club black.

Frons, vertex and cheeks with moderately large confluent or sub-confluent punctures; frontal impression deep, smooth, rather narrow, separated from the eyes by two or three rows of punctures. Pedicel slender; funicle 1 one-half longer than the pedicel; 2 slightly shorter than the pedicel, twice as long as wide; 3 shorter; 4 as wide as long; club rather slender, joint 1 as long as wide, 2-5 plainly wider than long. Thorax one-half longer than its greatest width; parapsidal furrows deep, foveate, narrow anteriorly, widening posteriorly; median lobe of scutum with moderately large punctures, dense but not confluent except anteriorly where they are smaller; lateral lobes shallowly punctate and with fine impressed reticulation; scutellum with numerous rather large punctures; pubescence fine and rather long; propodeun very short medially, long laterally, the posterior margin deeply concave and strongly margined within the limits of the lateral carinae which are well developed, the surface outside the lateral carinae densely pubescent; median process of propodeum punctate, pubescent, deeply broadly divided almost to its base in the form of two sub-acute well separated teeth which are moderately long and project over the abdominal prominence. Posterior tarsi one-fourth longer than their tibiae, their basal joint slightly longer than 2-5 united. Forewings extending beyond apex of fourth abdominal segment; lightly brownish; marginal vein slightly longer than the stigmal, the postmarginal twice as long as the marginal; basal and median veins very faint. Abdomen almost twice as long as the head and thorax united, its greatest width two-thirds that of the thorax, its lateral outline regularly gently convex, segment 3 being slightly the widest; dorsum almost flat, the lateral carinae distinct on segments 1-3; 1 a little shorter than its posterior width, at base with a rounded prominence that projects into the propodeum; 2 one-half longer than 1; 3 as long as 2, slightly longer than wide; 4 a little yet distinctly shorter than 3; 5 two-thirds as long as 4, almost as long as its basal width; 6 as long as 5, one-half longer than its basal width, its sub-apical plate convex; 1 with several strong striae, densely punctate laterally, the apex of the basal prominence smooth; 2-4 confluently punctate with a longitudinal arrangement; 5 and 6 shallowly confluently punctate; pubescence short on dorsum of 1-4, long on 5 and 6 and along lateral margins.

Male.—Length, 4.10 mm. Propodeum, as in the female, short medially, the posterior margin very deeply concave and strongly margined within the limits of the lateral carinae, the process very narrow, in the form of two strongly raised carinae which project a little beyond the posterior margin and from lateral aspect appear as triangular raised blunt teeth. Abdomen three-fourths longer than the head and thorax united; segment 1 with three strong striae medially, its anterior margin straight; 1-3 with a lateral carina which is faint on 4; 3 a little longer than 2, a little longer than wide; 5 three-fourths as long as 4, somewhat shorter than its basal width; 6 two-thirds as long as 5, plainly shorter than its basal width; 7 transverse, shortly strongly bispinose. Antennae black, the scape red; funicle 1 two-thirds longer than the pedicel, 2 and 3 each slightly longer than the pedicel, 4-9 each one-half longer than wide.

Habitat.—South Queensland; Mt. Tambourine, 2,000 feet, one female, one male in April, A. P. Dodd.

Holotype and *Allotype* in the Queensland Museum.

One of several closely related species. In the female the deeply concave propodeum, the form of the propodeal process, and the well-developed abdominal prominence are much as in *fissilis*, which species differs in the convex dorsal ridge and absence of lateral carinae on segments 1-3 of the abdomen. In the male the propodeum is shorter medially, its posterior margin more deeply concave than in *fissilis* and *regalis*, and is nearest *solitus*, the differences being pointed out in the discussion of that species.

The Geomorphology of the Moreton District, Queensland: An Interpretation.

By C. A. Sussmilch, F.G.S., Technical Education Branch, Sydney.

Plate V., one map and four geological sections.

(*Communicated by Professor H. C. Richards, D.Sc., to the Royal Society of Queensland*, 28th *November*, 1932).

1.—INTRODUCTION.

The Moreton district occurs in the south eastern corner of Queensland, extending from the southern border of the State northwards to the head waters of the Brisbane River; eastwards it is bounded by the Pacific Ocean and westwards it extends to the Darling Downs Tableland. The region thus included has an area of about 6,000 sq. miles and forms the drainage areas of the Brisbane and Logan rivers together with some of the adjoining coastal streams.

No previous attempt has been made to describe the geomorphology of this region as a whole; various writers have from time to time made reference to the physiography of certain parts of the area, for the most part incidental to the description of the geology. These will be referred to later in the text while a list of references will be given at the end of the paper. Nearly the whole of the area has been surveyed geologically but for the most part in no great detail; the published geological maps have supplied much useful information, however, which has been fully availed of. Excellent contour maps are available for about one half of the area and these have proved very valuable in supplying detailed information with regard to the topography and have enabled a much fuller description to be made of the areas so covered than would have been possible otherwise. The information available in the published literature has been supplemented by a number of field trips carried out by the writer during several recent visits to Brisbane, but owing to the size of the area and the limited time available the personal inspection of the area has been largely in the nature of a reconnaissance and much detailed field work will be necessary before it will be possible to give a complete detailed account of the geomorphology of this very interesting area. Nevertheless it is considered that sufficient information has been gathered together to demonstrate the essential features and that this will form a satisfactory basis for future work in this area. The writer desires to convey his thanks to Dr. W. H. Bryan, Professor H. C. Richards, Dr. E. O. Marks and Dr. F. Whitehouse for very kind assistance in the field work and particularly the first named who accompanied him on almost all of his field trips.

II. GEOGRAPHICAL FEATURES.

The geographical features of this district are in many ways abnormal and quite unlike what one expects to find in a region of normal river development following uplift. Along its eastern margin the Moreton district is bounded by a low lying coastal plain while to the west lies a continuous tableland (the Darling Downs tableland) about 2,000 feet in altitude. Between these two there exists a complex series of relatively high tablelands separated from one another by wide relatively low-lying regions as shown diagramatically in the accompanying map. It should be understood that the boundaries shown on this map are merely approximations, particularly in the southern part of the area. In all of that part of the district which lies to the south of the Brisbane river these earth blocks are parallel to one another, have a definite north-south trend and are in general markedly rectangular in shape. The sub-divisions of this southern region, starting from the coastal plain, are as follows :

1. The Tambourine Horst,
2. The Birnam Range Fault-block,
3. The Beaudesert Senkungsfeld,
4. The Mt. Flinders Horst,
5. The Fassifern Senkungsfeld,
6. The Lockyer Fault-block.

In that part of the Moreton district which lies to the north of the Brisbane river the geographical conditions are more complex. In the eastern part of the area the earth blocks have a general N.N.W. trend but in the western part of the area the general trend is E.N.E., that is practically at right angles to those in the eastern area. In this northern region the earth blocks, starting from the east, are as follows :

1. The D'Aguilar Horst,
2. The Upper Brisbane Rift-valley,
3. The Rosewood Bluff Horst,
4. The Lockyer River Senkungsfeld,
5. The Yarraman Tableland.

It might be noticed that this complex region occurs where the N.S. trends of the Late Tertiary tectonic lines of New South Wales change to the N.N.W. trends of Queensland. A detailed description of each of these earth blocks will be given in which will be shown that there is abundant evidence for the belief that they are primarily of tectonic origin and have resulted from a differential elevation which took place in this region at the beginning of the present cycle of erosion, but before doing this it will be desirable to make some brief reference to the geology of the area.

III. GENERAL GEOLOGY.

The geological formations present in the Moreton District, arranged in chronological order, are as follow :

Tertiary (*a*) The Volcanic Series
(*b*) The Freshwater Beds :—Redbank Plains Series and Petrie Series.
Jurassic (*a*) The Walloon Series
(*b*) The Bundamba Series.
Triassic (*a*) The Ipswich Series
(*b*) The Upper Esk Series
(*c*) The Lower Esk Series.
Carboniferous—The marine and freshwater beds of the Mt. Barney inlier.
Lower Palaeozoic—The Brisbane Schist Series.

The Lower Palaeozoic strata (Brisbane Schist Series) are all highly tilted and more or less metamorphosed whereas the Mesozoic strata (Triassic and Jurassic) are for the most part only gently folded and rest unconformably upon the former.

The close of the Jurassic period appears to have been followed by earth movements which produced a considerable uplift and this was followed by a long cycle of erosion (perhaps two cycles) which extended throughout Cretaceous time and probably well into Lower Tertiary time, as a result of which there was produced in this region a well marked peneplain developed alike in the Palaeozoic and Mesozoic strata. Some previous writers, notably Reid[18] and Morton[17], do not consider that this period of erosion produced a true peneplain throughout this area, but with that opinion the writer cannot agree. In his account of the coal measures of the West Moreton district Reid[18] gives a series of very instructive geological sections. In his two sections of the region to the north of Toowoomba given in plate I on page 464, the Tertiary volcanic rocks are shown resting upon a well developed peneplain surface cut alike out of Palaeozoic and Mesozoic strata. A much longer section is given on page 465; this section extends along a north-south line through the Darling Downs tableland from Mt. Jockey to the Main Range just south of Mt. Paradise and this section shows quite convincingly the presence of the abovementioned peneplain upon which the Tertiary volcanic rocks rest. As shown in all of these sections the peneplain in this region to-day stands at an altitude of from 1,750 feet to 2,000 feet; it must have been developed at or near sea-level and subsequently elevated to its present position.

In his paper on the volcanic rocks of south-eastern Queensland, Richards[21] also gives some interesting sections illustrating this point. In his north-sou thsection on plate II., which extends from the McPherson Range in the south to the northern end of the Tambourine Plateau, Tertiary velcanic rocks are shown to be resting upon a well developed peneplain cut alike out of Lower Palaeozoic and Mesozoic strata. In this region the peneplain surface is no longer horizontal, but both it and tho volcanic series resting upon it are tilted from south to north. Such geological evidence as is available, therefore, indicates that prior to the deposition of the Tertiary volcanic rocks the area had been well peneplained and this peneplain surface to-day survives over quite large areas. It is not assumed, of course, that this peneplain was everywhere a perfect plain; no doubt residuals of the highlands out of which the peneplain had been eroded still survive in places. Some of these will be referred to later. But it is considered that peneplanation had been carried to a fairly complete stage and that the Tertiary volcanic rocks were poured out on to a broadly level surface at a time prior to its uplift to form the present tablelands.

This peneplain is of importance in studying the geomorphology of this region, as it supplies an important datum for determining the approximate amount of elevation which has taken place since its development.

IV. THE TECTONIC SCARPS.

The Moreton district, as will be shown later, consists of a series of differentially elevated earth blocks. Some of these have been subjected to considerable elevation (up to 2,400 feet), other blocks have suffered relatively less elevation, while still other blocks have not been appreciably elevated at all. The higher blocks are separated from the lower blocks which adjoin them in most cases by steep scarps and in the case of most of these the physiographical evidence suggests that they have been produced either by faulting or by monoclinal folding

In some cases there is definite geological evidence that faulting has actually taken place along the foot of the scarp ; in others there is corroborative, although not complete, geological evidence, in proof of the faulting ; but in a number of cases, owing to the absence of detailed geological surveys, geological evidence at present is wanting and in these cases the writer has had to depend entirely on the physiographical evidence. With regard to some of these tectonic scarps, geological demonstration of the faulting will be difficult to obtain owing to the nature of the geological structure. The Brisbane Schists, for example, are a very thick and highly folded series of metamorphic rocks and as the tectonic scarps within this series have much the same trend as the strike of the strata, proof of the faulting will be unavailable until such time as very detailed geological surveys are made.

The Bundamba Series and the Walloon Series, both of which have a considerable thickness, consist predominantly of siliceous and felspathic sandstones associated with which are some beds of shale and both are characterised by a practical absence of " persistent horizons " of any real value for field mapping purposes. As a result it is not only difficult at times to say to which particular series a particular outcrop should be referred but also to determine the exact horizon of an outcrop in either of these series. Consequently here again faulting will be difficult to prove even where geological surveys have been made. This would be particularly the case where a scarp has resulted from a series of parallel faults rather than from one big fault. Throughout much of the region the only satisfactory geological datum for proof of differential uplift is the peneplain surface already described and the base of the Tertiary Volcanic Series where they rest upon it.

The fact, of course, has not been lost sight of that some of the scarps may have been produced by monoclinal folding but as such scarps are genetically similar to fault scarps the distinction is not very important. Some of the scarps also, instead of having been produced by one single fault, may have resulted from a number of closely set, parallel faults or again may have resulted from a combination of faulting and warping. This applies particularly to those which occur in Mesozoic strata. In the case of the highly folded Brisbane Schists the development of steep monoclinal folds would be highly improbable and the tectonic scarps in this formation are much more likely to be fault scarps.

V. THE DARLING DOWNS TABLELAND.

This tableland bounds the Moreton district along its western side. It has a general elevation of from 2,000 feet to 2,200 feet along its eastern margin but has a definite tilt towards the west, its altitude gradually falling in that direction. Throughout the greater part of the area the underlying formation consists of gently dipping Mesozoic strata capped by a veneer of Tertiary basalt ; but at the northern end the Mesozoic strata give place to Lower Palaeozoic strata with their associated plutonic intrusions ; these latter are also capped by Tertiary basalts. As has already been explained, the upper surface of the Palaeozoic and Mesozoic strata is in this area an almost perfect peneplain and this peneplain now has an altitude of from 1,750 feet to 2,000 feet above sea level. The Tertiary basalts rest as practically horizontal layers on this peneplain surface and are in general from 200 feet to 400 feet in thickness. The surface of the tableland is occupied by a series of broad, gently rounded ridges between which are broad, shallow valleys all more or less aggraded ; the valleys are from 300 feet to 400 feet in depth. The ridges, which rise to a similar elevation, are for the most part capped with basalt, but in the main river valleys the underlying Jurassic strata are exposed. The topography is therefore a thoroughly mature one produced during the previous cycle of erosion. Some deepening of the valleys of the main streams has apparently taken place during the present cycle of erosion.

In the southern part of the tableland and situated right on its eastern margin there is a range of volcanic mountains rising fairly abruptly above the general level of the tableland to altitudes of about 4,000 feet, that is about 2,000 feet above the tableland level. In this volcanic range the topography is of a youthful character.

Messrs. Wearne and Woolnough[22] considered these high peaks represented denuded remnants of a peneplain and on this point they wrote as follows : " The contour of the Main Dividing Range which separates West Moreton from the Darling Downs, reveals the fact that two successive uplifts occurred, the first an uplift of about 2,000 feet and the second of 2,700 feet. The summits of the Main Range—Mt. Castle (3,700 feet), Mt. Cordeaux (4,100 feet), Mt. Mitchell (4,000 feet) and Wilson's Peak (4,060 feet) are practically at a uniform height above sea level. They represent the denuded remnants of an uplifted peneplain." With this conclusion the author cannot agree. There is no evidence that the whole of the thick series of lava flows and tuffs which constitutes this volcanic range ever extended right across the Darling Downs as their conclusion suggests. On the contrary the evidence suggests that the range represents a row of Tertiary volcanoes built up along a north-south line of fracture and that these are therefore mountains of accumulation and not residual mountains. Several transverse valleys cut across this range, such as Cunningham's Gap, Spicer's Gap and Wilson's Gap. With regard to these Wearne and Woolnough[22] state that " they represent the U shaped mature valleys eroded to base level which have since been lifted to a height of 2,700 feet above sea level." As a matter of fact the base level of erosion for these valleys is the surface of the adjoining Darling Downs Tableland whose general level is only from 2,000 feet to 2,200 feet, while the mature valleys on its surface are still lower ; the 2,700 feet level of these gaps is therefore not a base level of erosion.

The question might also be raised as to whether these gaps are entirely due to erosion. They may, perhaps, and probably do represent, primarily, spaces left between adjoining volcanic cones as the latter were being built up, deepened of course to some extent by subsequent erosion.

In view of all these facts there is therefore no evidence for Wearne and Woolnough's first uplift of 2,000 feet, while the amount of their second uplift which produced the present Darling Downs Tableland, should be from 2,000 feet to 2,200 feet, the general elevation of the tableland itself, and not 2,700 feet, the level of the bases of the so-called gaps.

VI. THE LOCKYER FAULT BLOCK.

This is a roughly triangular area bounded on the south and west by the Darling Downs Tableland, on the east by the low Fassifern block and on the north by the low Lockyer River block. This is the region referred to by Wearne and Woolnough[22] as the Lockyer fault block and they describe it as follows: "This block is traversed by four meridional ridges—the Little Liverpool Range, the Mt. Mistake Range, the Hiproof Range and another of unknown name with horizontal crests rising to a uniform level of 2,000 feet. Immediately to the east of Toowoomba this faulting carried down a portion of the old mature valley about 500 feet below its original level. The faulting here is somewhat complex and this fault is associated with one or more others increasing the total throw."

These writers are somewhat vague as to the actual area they intended to include in this block and they do not seem to have had accurate information as to the height of the ranges constituting the block which, they state, as mentioned above, rise to a uniform height of 2,000 feet. If this last statement were correct the area would possibly not be a fault block at all but merely a dissected part of the Darling Downs Tableland. J. H. Reid[18] has, however, given more detailed information regarding the altitude of the abovementioned ranges in a very interesting section which he has drawn across the block and shown in Plate VII., page 469, of his account of the geology of this region.

Using the peneplain level (which is also the level of the base of the basalt) as a datum, it will be seen from this section that the Darling Downs Tableland level continues as far east at least as the eastern edge of what he calls the Egypt and Spring Park Plateau and probably also continues as far eastwards as the eastern margin of the Mt. Paradise ridge which forms the divide between the Ma Ma Creek and Blackfellows Creek. Mt Paradise has an altitude of 2,245 feet and is basalt capped, the basalt according to Reid being about 400 feet thick. To the author it would appear that the Mt. Paradise ridge forms the true eastern margin of the Darling Downs Tableland in this area and that the eastern side of this ridge is a line of faulting with a throw to the east of from 400 feet to 500 feet and would suggest that this be called the Mt. Paradise fault-scarp. The author is in doubt as to whether this is where Messrs. Wearne and Woolnough placed their 500 feet fault, as they are somewhat vague in their description of its location. The Lockyer Fault-block, therefore, begins at this fault-scarp. This fault-block appears to consist really of two parallel fault-blocks for which the author proposes the names (*a*) The Mt. Mistake Block and (*b*) The Little Liverpool Range Block.

(*a*) THE MT. MISTAKE BLOCK. This has a probable width of about six miles and includes both the Hiproof Range and the Mt. Mistake Range of Wearne and Woolnough.

Reid's east-west section of the West Moreton district crosses the Hiproof Range near its northern end and gives the altitude of the base of the basalt as being from 1,250 feet to 1,350 feet thick; Richards[21] describes this range as consisting of Jurassic strata to a height of

1,150 feet, capped by a thickness of 600 feet of basalt. The altitude of the base of the basalt at Mt. Paradise, according to Reid, is 1,750 feet. There is thus a difference of elevation between the two blocks of from 400 feet to 600 feet according to which figure is taken.

The eastern side of the Mt. Mistake Block is marked by a scarp which may be a fault-scarp, having a probable throw of about 300 feet on the line of Reid's section. It is, of course, possible that this may be a line of monoclinal folding or warping. It will be convenient to refer to this scarp as the Mt. Mistake Scarp. Followed southwards, it passes to the west of Mt. Castle where it joins the Main Range Fault. According to figures supplied by Reid the base of the basalt at Mt. Castle is at an altitude of 800 feet to 900 feet so that the combined faults here much have a throw of at least from 1,100 feet to 1,200 feet.

In looking at this part of the scarp from Kalbar on the opposite side of the Fassifern depression this splitting of the Main Range Fault is well shown by the topography, giving a beautiful example of a splintered fault-scarp. This geological evidence at Mt. Castle as well as the physiographic features leave no doubt in the writer's mind that the Lockyer Fault-block as a whole has been faulted from the Darling Downs Tableland.

(*b*) The Little Liverpool Range Block. This has a probable width of about four miles and lies immediately to the east of the Mt. Mistake Fault-block and has a general elevation of about 1,000 feet. At Mt. Castle, which lies at the southern end of this block, the base of the basalt is at an elevation of from 800 feet to 900 feet and as Mt. Castle itself has an altitude of 3,700 feet, the basalt here must have a thickness of about 2,800 feet. At the northern end of the block, where Reid's section crosses it, the base of the basalt is also at an elevation of from 900 feet to 950 feet but the thickness of the basalt here is only about 200 feet. This fault-block along its eastern margin is bounded by a well marked fault-scarp which separates it from the low-lying Fassifern Block. This fault, which has a throw of about 700 feet, is a direct northerly continuation of the Main Range Fault and will be referred to again when discussing that fault.

The Lockyer Fault-block as a whole extends northwards to the southern margin of the great Lockyer River depression.

VII. THE FASSIFERN SENKUNGSFELD.

This relatively depressed region with an altitude of from 300 feet to 600 feet lies between two relatively high regions. The Darling Downs Tableland and Lockyer Fault-block, already described, lie to the west of it while the Mt. Flinders Horst bounds it on its eastern side. To the north of it lies the Rosewood Bluff Horst while on its southern margin is the McPherson Range. Its major axis has a north-south trend and its length in this direction is about 36 miles.

In its northern portion this depressed region has a width in an east-west direction of about 14 miles and its general elevation here is from 250 feet to 300 feet. The senkungsfeld as a whole, however, has not a uniformly level surface, the south-eastern and southern portions being somewhat higher. South from Harrisville the eastern part of the region has been warped up to an average altitude of about 600 feet and this higher portion really forms a separate tableland lying between the lower part of the Fassifern Senkungsfeld proper and the Mt. Flinders Horst. It will be convenient to refer to this higher portion as the Boonah Tableland although still considering it as being a part of the Fassifern Senkungsfeld.

The Boonah Tableland starts immediately to the south of the Flinders railway station and is here known as the Mentone Ridge; it has an altitude of about 600 feet and a width of about 3 miles. Followed southwards it widens and at Boonah the width has increased to about 6 miles. Beyond here its western margin swings around to a south-west course and continues thence to the foot of the Main Range. Where the road from Aratula to Mt. Edwards crosses this margin it presents a well-marked scarp. To the south of this scarp the 600 feet level continues to the foot of the McPherson Range. From Harrisville to Aratula the margin between the Boonah Tableland and the lower part of the Fassifern Senkungsfeld has a gently warped surface but from here to the Main Range, as already pointed out, a definite scarp separates the 600 feet and 300 feet levels and some faulting may occur here.

Throughout the whole of the Fassifern Senkungsfeld the underlying rocks are of Jurassic age, capped over very considerable areas by varying thicknesses of Tertiary basalt. The topography of its surface is a thoroughly mature one even on its southern margin. Around Boonah, for example, one finds a series of broad shallow aggraded valleys 300 feet to 400 feet deep, separated from one another by gently rounded ridges rising to a general elevation of 600 feet to 700 feet. Many of these ridges are basalt-capped. We have here, therefore, at an elevation of from 600 feet to 700 feet above sea level, an exactly similar topography to that which occurs on the Darling Downs Tableland at an altitude of about 2,000 feet and in both cases the underlying geological structure is the same.

The general level of the Fassifern Senkungsfeld is interrupted in places by the occurrence of Tertiary volcanic hills and ridges. In the far south we have the isolated trachyte hills of Mt. Moon—Mt. Alford (2,200 feet), Mt. Greville (2,700 feet), Mt. Edwards (2,300 feet), and Mt. French (1,900 feet), while in the central part of the area there is a well-marked basaltic ridge with a meridional trend which forms the divide here between the Bremer River and Warrill Creek. The higher points on this basaltic ridge include Mt. Walker (1,550 feet), Bald Hills (821 feet), Kangaroo Mountain (856 feet) and Mt. Fraser (1,200 feet).

As has already been mentioned in describing the Darling Downs Tableland and the Lockyer Fault-block, a very pronounced scarp separates them from the low-lying Fassifern block. This scarp has previously been described as a fault-scarp by Andrews[1], Jensen[9], Wearne and Woolnough[22] and Richards[21], but later observers including Reid[18] and Marks[16] deny the existence of faulting and ascribe the scarp to differential erosion.

The physiographic evidence of faulting is as follows:—

(*a*) The surface of the Darling Downs Tableland at an altitude of from 2,000 feet to 2,200 feet presents an "old age" topography consisting of broad, shallow, aggraded valleys 300 feet to 400 feet deep between which are wide gently rounded basalt-capped ridges all rising to a uniform altitude. The surface of the Fassifern Senkungsfeld presents an exactly similar topography but at an elevation of only 300 feet to 600 feet. In both cases the underlying geological structure is identical. Under no conceivable circumstances could one expect exactly similar topographies under exactly similar geological conditions to be produced side by side at such very different altitudes.

(*b*) If the lower region were to be suddenly elevated to the height of the higher region (or conversely the higher lowered to the lower level) the two topographies would exactly fit, not only with regard to the mature valleys and low rounded ridges but even with regard to the volcanic hills and ridges which rise above the general level in both regions.

A steep scarp separates the two levels along their whole length. This scarp has a practically straight north-south trend with no lateral ridges extending from it out on to the lower country. The face of this scarp represents a very youthful topography as compared with the very mature topographies above it and below it.

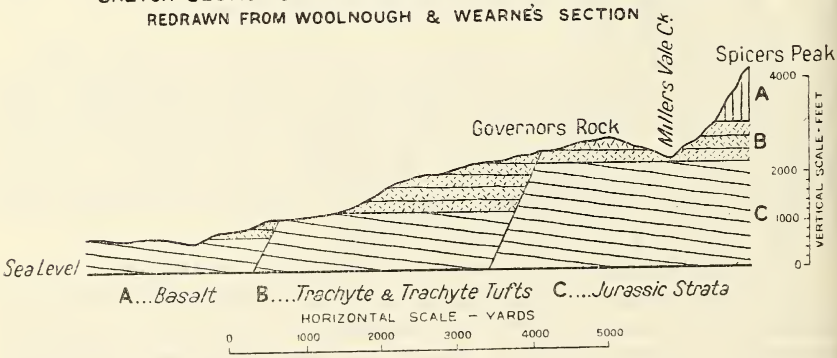
This physiographical evidence of faulting is strongly supported by the geological evidence. This evidence is as follows: (*a*) The Darling Downs Tableland, along its eastern margin from Wilson's Peak to Mt. Cordeaux up to the 2,200 feet level, consists of Jurassic strata. Above this level are the volcanic rocks of the Main Range. If the scarp along the eastern edge of this tableland had been produced by erosion during the present cycle, one would expect to find Jurassic strata outcropping in the face of the scarp from its base up to an elevation of 2,200 feet; if one refers to the geological section of this scarp previously published by Jensen[9] and by Wearne and Woolnough[22], it will be found that the face of the scarp under Mt. Spicer consists almost entirely of volcanic rocks, mainly trachyte and trachytic tuffs. If one refers to Richards' section[21] of the Main Range at Mt. Spicer, it will be found that the volcanic rocks there have the following thicknesses:—

Upper basalts—about 1,200 feet.
Trachyte and trachytic tuffs—about 600 feet.
Lower basalts—about 300 feet.

Total: 2,100 feet.

Fig. I

SKETCH SECTION OF MAIN RANGE ALONG OLD WARWICK ROAD
REDRAWN FROM WOOLNOUGH & WEARNE'S SECTION



These rocks, as already pointed out, rest upon the Jurassic formation at an altitude of about 2,200 feet. The above thicknesses have been scaled from Richards' section and are all only approximate.

According to both of the published geological sections, the trachyte and trachytic tuffs up the face of the scarp have a strong westerly dip, and, if the thicknesses and dips given are correct, the trachyte series must have a thickness of several thousands of feet, that is many times greater than the 600 feet in the Main Range.

It seems quite obvious to the writer that not only does the trachyte series owe its low position in the scarp as compared with its counter-part in the Main Range to faulting, but that there must be several parallel faults producing duplication of these strata to give their apparent great thickness. In fig. 1 Wearne and Woolnough's section has been redrawn, showing at least two parallel faults.

These suggested faults would account for:

1. The concealment of the outcrops of the Jurassic strata which should otherwise show in the face of the scarp,
2. The abnormal thickness of the trachyte series, and
3. The occurrence of the trachyte series itself in the face of the scarp.

One of the arguments against faulting is that if the scarp were due to faulting, the volcanics of the Main Range should have been faulted down; the evidence shows that this has actually happened. It is true that just at this point (Spicer's Peak) the thick upper series of basalts has not apparently been faulted down, but that would be due to the fact that the fault here has only cut through the eastern flank of Spicer's Peak and not through its centre as shown in the section in fig. 1. The actual throw of the fault (or group of faults) would be from 1,400 feet to 1,600 feet. Further to the north the upper series of basalts has been subjected to faulting. At Mt. Castle, according to Reid, the base of the basalts is at an altitude of about 900 feet. On the tableland immediately to the west, the altitude of the base of the basalt is about 2,000 feet and it is obvious, therefore, that a fault with a throw of at least 1,110 feet lies between Mt. Castle and the Darling Downs Tableland. Reid[18] has recorded that at Bible and Warrill Creeks (between Mt. Castle and Mt. Cordeaux) dips occur in the Walloon Series of 50° and 27° respectively. These abnormally high dips occur on the line of the supposed faulting and may be taken to be corroborative evidence of it. Just south of Mt. Castle the Main Range fault (or faults) splits into two definite branches, one branch passing to the west of Mt. Castle with a throw of about 1,100 feet. the other passing to the east of Mt. Castle with a throw of about 600 feet. The western branch has already been referred to in describing the Lockyer Fault-block. The eastern branch maintains the general north-south trend of the Main Range fault and extends northwards along the foot of the Little Liverpool Range where it forms the boundary between the Lockyer Fault-block and the Fassifern Senkungsfeld. The Little Liverpool Range has an altitude of 1,000 feet and upwards and, except at its far northern end, it is capped throughout its length with basalt of varying thickness. But along its whole length from Mt. Castle northwards, the base of the volcanic series according to Reid[18] is at an elevation of about 900 feet. As the corresponding levels of the basalts in the lower block is at an elevation of less than 300 feet the fault must have a throw of at least 600 feet. Throughout its whole length this fault-scarp presents a very youthful topography as compared with the mature topography of the Fassifern block and the change from one to another is a very abrupt one. This line of fault crosses the railway line to the west of Grandchester and there appears to swing to the east parallel to the southern margin of the Rosewood Bluff Horst which bounds the Fassifern Senkungsfeld on its northern margin.

VIII. THE MT. FLINDERS HORST.

Between the Fassifern Senkungsfeld already described and the Beaudesert Senkungsfeld to be described later there lies a relatively high earth-block with the same north-south trend of the neighbouring blocks. This feature at present seems to have no definite name and it is proposed to call it the Mt. Flinders Horst from the name of the wellknown mountain which occurs on its surface. The road from Beaudesert to Boonah crosses this block approximately at right angles and here it has an altitude of about 1,400 feet and a width of about 8 miles. It is noteworthy that this is the only important road which crosses this block throughout its whole length.

Followed to the northward the altitude of the block gradually decreases. At Spring Mountain the altitude is from 800 feet to 1,000 feet and from here northward it flattens very rapidly ultimately merging into the Redbank Plains. Its north-western portion is known as the Grampian Hills and these lie about three miles due south from the town of Ipswich. Within the area so far defined the details of its topography can be studied from the Ipswich and Flinders military maps. These show a region with a very rugged topography with the higher points occurring along its eastern margin; these higher points include Spring Mountain (1,163 feet), Mt. Joyce (1,530 feet) and Mt. Jubbera (1,412 feet); it also appears to have a definite tilt from east to west.

The writer has had no opportunity of seeing this region south from the Beaudesert-Boonah road, but in this direction it appears to join up and be continuous with the Mt. Maroon Tableland. In his description of the geology of South Moreton C. C. Morton[17] gives a section which crosses this southern area and this section shows a high tableland of sedimentary strata capped by thick rhyolite flows.

The altitude reached by the upper surface of the sedimentary rocks ranges from 1,450 feet to 1,850 feet with a well marked tilt from east to west. The overlying rhyolites constitute high peaks such as Mt. Maroon (3,300 feet), Mt. Toowoonan, Mt. May and Mt. Barney (4,300 feet). These high points owe their great altitude to the great thickness of the rhyolite lava flows which here attain a thickness of at least 1,600 feet. The Mt. Flinders Horst as a whole, therefore, apparently increases in altitude southwards. Near the north-western margin of the Mt. Flinders Horst there is another group of volcanic cones rising above the general level of the tableland and known as the Flinders Range. These volcanic peaks lie for the most part on a north-south series of fractures parallel to but some little distance east of the western margin of the Mt. Flinders Horst.

The western margin of the Mt. Flinders Horst where it joins the lower Fassifern block presents a moderately steep scarp. Jensen[9], in describing this region, suggests as a possibility that the wellknown Great Moreton Fault which further to the north has a N.N.W.-S.S.E. trend continues into this region and swings around to a north-south course. If Jensen's suggestion is correct this fault would follow along the foot of the scarp above referred to. In that case the scarp would be a fault scarp with a throw of about 700 feet. This feature, however, needs further investigation; it may be a monoclinal fold.

Further to the south in the neighbourhood of Boonah the scarp appears to be definitely due to monoclinal folding. If one refers to Morton's map of the area[17] it will be found that along the line of the scarp for a considerable distance both north and south of Boonah the dips of the Jurassic strata range from 8° to 15° whereas both to the west and to the east of the scarp one finds the normal low angle dips of 2° to 5° to the south-west characteristic of the Jurassic formation. This steepening of the dips along this line would be sufficient to account for the difference in altitude here between the higher Mt. Flinders Horst (1,200 feet) and the lower Boonah Tableland (600 feet-700 feet). It would seem probable, therefore, that the scarp here has resulted from monoclinal folding during uplift, a view supported by the features of the topography. The author has had no opportunity of studying this scarp further to the south and the published literature does not provide any definite information.

The eastern scarp of the Mt. Flinders Horst is a more abrupt one and it is quite a striking feature when viewed from the east. At Mt. Jubbera the contour map shows a drop from 1,412 feet to 300 feet in $1\frac{1}{2}$ miles. At Mt. Joyce and at Spring Mountain near the northern end of the scarp there are similar steep slopes. The writer has crossed this scarp at only one place and that is between Mt. Jubbera and Mt. Joyce and here the physiography gives the suggestion of a fairly steep monoclinal fold. The dips of the Jurassic strata as given by Morton[17] supply some useful information on this point. Within the horst itself and notably in the immediate neighbourhood of Mt. Jubbera the dips are to the south-west at low angles, 2°-5°, whereas along the line of the scarp immediately to the east of Mt. Jubbera, Morton shows a number of steep easterly dips ranging from 30° to 65°, while still further to the east in the Beaudesert Senkungsfeld the normal low dips of about 2° to the south-west again prevail. The correspondence between the position of the abnormally high reverse easterly dips with the position of the scarp is surely not accidental and may it not be that instead of this being a true anticlinal fold as suggested by Morton, it is a late Tertiary monoclinal fold with a sharp throw to the east superimposed upon the older gentle dip to the south-west of the Jurassic beds. In such a gently folded series as these one would not expect to find an unsymmetrical anticline of orogenic origin having a westerly limb with a dip of from 2° to 5° while the eastern limb has a dip of 65°. It is suggested therefore that the eastern scarp of the Mt. Flinders Horst in the neighbourhood of Mt. Joyce is a monoclinal fold.

The Mt. Flinders Horst has been well dissected during the present cycle of erosion and but little of the original tableland surface appears to remain. The main streams draining this area, such as Woolaman Creek, Teviot Brook and Allens Creek, all of which are tributaries of the Logan River, have not only cut their channels down to base level but have also developed narrow flood plains in the eastern part of their courses. It is noteworthy that although this region has a tilt from east to west, the greater part of it is drained by streams flowing in the opposite direction, that is from west to east. The course of the

Teviot Brook is a particularly interesting one. It rises in the McPherson Range, and for many miles follows a northerly course. In the neighbourhood of Boonah this stream is flowing in a mature valley on the surface of the Boonah tableland already described, along the foot of the western scarp of the Mt. Flinders Horst, but at Coulson, a few miles north of Boonah, it suddenly turns eastward and flows in a youthful valley right across the higher Mt. Flinders Horst. A more natural course would have been for it to continue its northern direction along the foot of the scarp to join the Bremer River. This stream is obviously a revived stream, its west-east course across the present day Mt. Flinders Horst having already been determined prior to the uplift of the horst, the uplift being sufficiently slow to enable the stream to keep pace in cutting down its channel in the rising block. Jensen[9] has also commented upon the anomalous course of this stream.

IX. THE BEAUDESERT SENKUNGSFELD.

This is a relatively low region lying between the Mt. Flinders Horst already described and the Tambourine Horst ; along part of its eastern boundary the small Mt. Birnam Fault-block lies between it and the Tambourine Horst. Northwards it extends to the foot of the D'Aguilar Horst while southwards it extends to Beaudesert, giving it a total length in a north-south direction of about 30 miles. This senkungsfeld does not end, however, at Beaudesert but continues southwards to the foot of the McPherson Range, but as this southern portion has a more complex structure its details will be described separately.

The Beaudesert Senkungsfeld proper (from Brisbane River to Beaudesert) has a somewhat variable width ; at its northern end (Cooper's Plains and Brown's Plains) the width is from 11 to 12 miles and here on its eastern margin it joins and is continuous with the Brisbane Gap to be described later ; at Beaudesert the width is about six miles. The greater part of the area is occupied by Jurassic strata with thin cappings of Tertiary basalts over limited areas, but in its northern portion in the district known as Cooper's Plains some moderately extensive areas are covered by Lower Tertiary freshwater beds. The surface topography consists of a series of gently rounded ridges all of which rise to a general level of from 250 feet to 300 feet and between these are a series of broad, shallow, aggraded valleys. The region as a whole is drained by the Logan River and its tributaries and along the main streams extensive flood plains have been developed, whose surfaces are raised but little above sea level. All these features are well shown in the military contour maps.

As already stated this senkungsfeld does not end at Beaudesert but continues southwards to the foot of the McPherson Range, a further distance of about 10 miles. The new railway line from Brisbane to Kyogle in New South Wales traverses this region and one gets a good general view of its main features from the train. Apart from two train journeys, the writer has only visited a small part of this area by road and the views now put forward are merely suggestions based to a large extent upon the published work of other observers. The geology of this region has been described by Morton[17] and Reid[19] and the former's geological map and section give some very helpful suggestions. On the western side of his section occurs the Mt. Maroon

Tableland consisting of Walloon strata up to an altitude of about 1,800 feet capped by Tertiary rhyolite lava flows ranging up to 1,500 feet in thickness. This part of the section gives one the impression that this tableland is a horst with a very definite tilt from east to west. The southern part of this region in the neighbourhood of Mt. Barney has recently been visited by Professor H. C. Richards, Dr. W. H. Bryan and Dr. Whitehouse and they have informed me that the tableland here is a horst made up of strata of Carboniferous (Burindi) age, capped by Tertiary rhyolite flows. The Carboniferous strata are highly tilted and along the eastern margin of the tableland there is a faulted junction between these strata and the Walloon series, the downthrow being to the east.

This fault has a north-south trend running just to the east of Yellow Pinch and here the Carboniferous strata have a vertical dip. There is good geological evidence, therefore, of the occurrence of a well-marked fault along the eastern margin of the Mt. Barney-Mt. Maroon Tableland with a north-south trend. The north-south course of the Upper Logan River from Mt. Ernest to Mt. Maroon appears to have been largely determined by this fault.

Immediately to the east of this fault there is a lower tableland with an altitude of about 1,700 feet which Morton describes as follows : " Between Palen Creek and the Logan River is a dissected plateau made up of acid lavas, conglomerates and tuffs rising in places to a height of approximately 1,700 feet." This tableland, according to Morton, sonsists of members of the Walloon Series with a gentle dip of 3°-5° to the south-west. In the southern part of the area the Walloon beds are capped with rhyolites and rhyolite tuffs, while in the northern part they are capped in places with basalts. No figures are given by Morton as to the altitude of the upper surface of the Walloon Series but according to his section it must be at least 1,000 feet. This tableland might be conveniently referred to as the Palen Creek Tableland and would appear to be a southern continuation of the Mt. Flinders Horst.

Immediately to the east of the Palen Creek Tableland lies a much lower region, the southern continuation of the Beaudesert Senkungsfeld. Here the upper surface of the Walloon Series as shown in the railway cuttings has an altitude of only 400 feet and these are capped by a moderately thick series of basalt flows. The scarp separating this low-lying region from the Palen Creek Tableland to the west is a direct southern continuation of the eastern scarp of the Mt. Flinders Horst prevously described and appears to correspond with the line of folding and faulting shown as passing close to the village of Rathdowney in Morton's map and section. Speaking of this line, Reid[19] writes as follows : " Faulting on an approximately north-south line along the eastern flank of the anticline, that is along the west side of the Logan Valley, is indicated between Beaudesert and the New South Wales border (with a downthrow to the east) by (1) a sudden flattening of steeply dipping strata ; (2) a strip of almost vertical strata between areas of uniformly inclined strata about two miles west of Innes Plain ; (3) the preservation of large areas of Tertiary basalt at low levels on the east of the Logan River and its absence on the west of it. This faulting is believed to be connected with the rather acute folding of the east flank of the anticline."

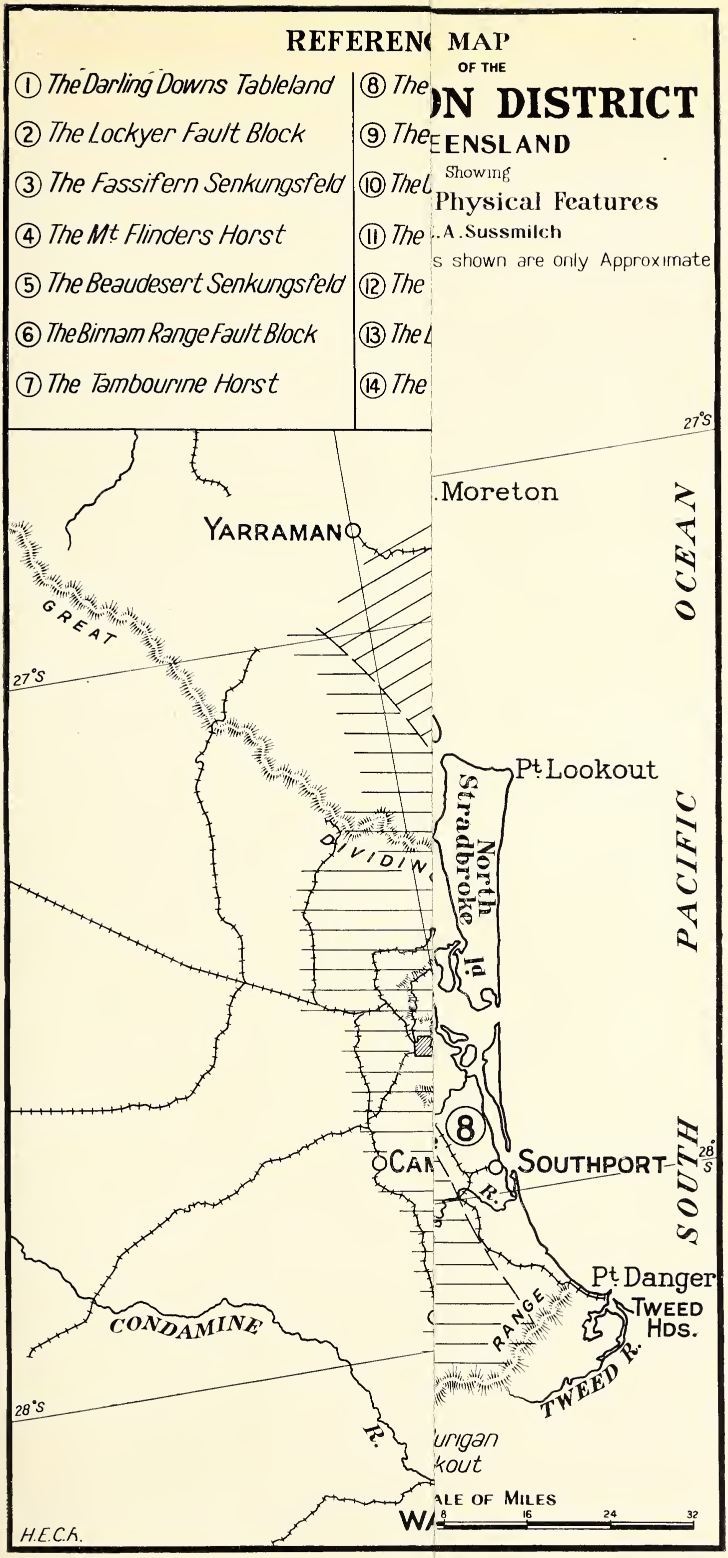
The writer has already made the suggestion that this so-called anticlinal fold may be a Late Tertiary monoclinal fold (in this area accompanied by faulting) superimposed upon the older gentle south-west dips of the Walloon series. All three of the above points stressed by Reid support this view, particularly his third point which is a definite proof that the movement is post-volcanic, that is Late Tertiary.

Turning to the eastern side of Morton's section, strongly marked monoclinal folding (or folding and faulting) is indicated near the head of Widgee Creek. Morton[17] points out that the top of the Walloon Series at the head of Widgee Creek is 700 feet to 800 feet higher than the base of the basalt at Beaudesert. This represents an elevation of upwards of 1,000 feet above sea level for the top of the Walloon Series. In writing of this area he makes the following statement—"Immediately to the north-west of Widgee Mountain on the upper portions of Widgee Creek and the Albert River is an inlier of sedimentaries a few square miles in area, which have been folded. On the road close to portions 127, 62, 127 and 203, Parish of Telemon, a section can be seen showing basalts of different types with a thickness of between 200 feet and 300 feet apparently tilted in conformity with the underlying rocks at angles of from 45° to 60° in a westerly direction. The overlying basalts of the middle division in the hills close by show no sign of this movement and are therefore assumed to have post-dated it." Morton states further that "the age of this movement may on these observations be assigned to the early Cainozoic immediately after the commencement of volcanicity.

If such a folding movement had taken place in south-eastern Queensland in early Cainozoic times between the lower and middle volcanic epochs, as Morton suggests, surely there would be a more widespread evidence of it, but all published sections of the Tertiary volcanic series show that all the members of the series are conformable to one another. In discussing these occurrences at Mt. Widgee, Bryan[4] states that "one is forced to the conclusion that the steep dips of the Mt. Widgee basalts are the results of a movement of folding or faulting later than the movement which folded the Mesozoic strata." The writer is of opinion that this feature is a monoclinal fold possibly accompanied by normal faulting formed at the close of the Cainozoic era at the time the present tablelands were being uplifted. It occurs just where the topography suggests the existence of a tectonic scarp and it is probably the southern continuation of the western scarp of the Mt. Tambourine Horst. Morton's section shows that the base of the Volcanic Series at Mt. Widgee to the east of this scarp is at as high an elevation at least as the top of the Volcanic Series to the west of the scarp and the whole occurrence is simply explained as the result of a differential uplift, the strata to the east of the scarp having been elevated at least 1,000 feet more than those to the west of the scarp.

The writer would suggest, therefore, that the region between the Mt. Maroon Tableland and Widgee Mountain is a typical rift valley or senkungsfeld.

It is quite possible, however, that there is more than one line of faulting (or faulting and folding) between Widgee Mountain and Running Creek; in travelling along the road from Beaudesert to Lara Vale one gets the impression that the hills immediately to the east of the road consist of a series of steep-faulted blocks; this, however, needs further investigation. This rift valley extends to the foot of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s shown are only Approximate
① The Darling Downs Tableland
② The Lockyer Fault Block
③ The Fassifern Senkungsfeld
④ The Mt Flinders Horst
⑤ The Beaudesert Senkungsfeld
⑥ The Birnam Range Fault Block
⑦ The Tambourine Horst
⑧ The
⑨ The
⑩ The
⑪ The
⑫ The
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27°S
.Moreton
YARRAMAN
GREAT
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OCEAN
Pt Lookout
North Stradbroke Id
PACIFIC
8
SOUTHPORT
28°S
SOUTH
CAN
R.
Pt Danger
TWEED HDS.
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TWEED R.
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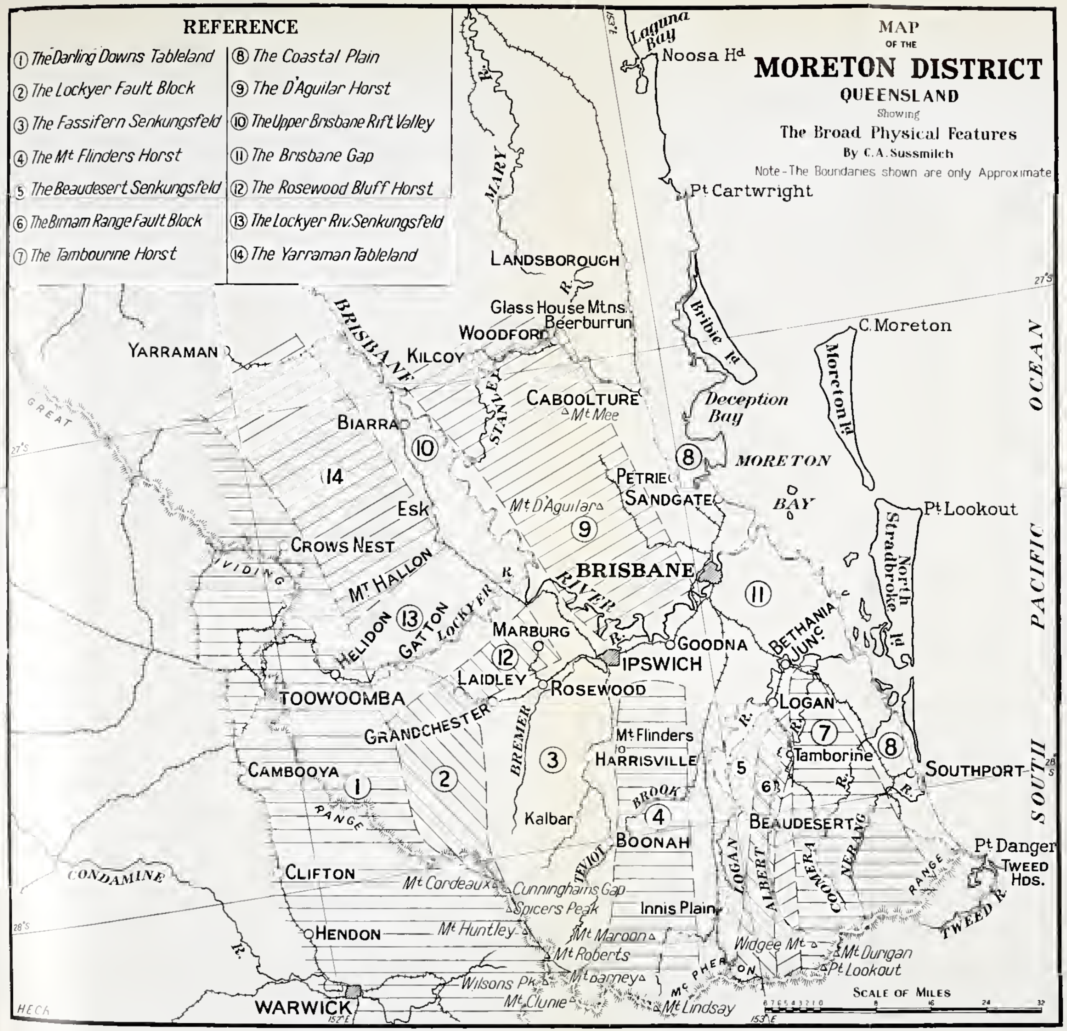


MAP OF THE MORETON DISTRICT QUEENSLAND
Showing
The Broad Physical Features
By C.A. Sussmilch
Note - The Boundaries shown are only Approximate
REFERENCE
① The Darling Downs Tableland
② The Lockyer Fault Block
③ The Fassifern Senkungsfeld
④ The Mt Flinders Horst
5 The Beaudesert Senkungsfeld
⑥ The Birnam Range Fault Block
⑦ The Tambourine Horst
⑧ The Coastal Plain
⑨ The D'Aguilar Horst
⑩ The Upper Brisbane Rift Valley
⑪ The Brisbane Gap
⑫ The Rosewood Bluff Horst
⑬ The Lockyer Riv. Senkungsfeld
⑭ The Yarraman Tableland
Laguna Bay
Noosa Hd
Pt Cartwright
Landsborough
Glass House Mtns.
Beerburrum
Woodford
Kilcoy
Yarraman
Bribie Id
C. Moreton
Moreton Id
Deception Bay
Caboolture
Mt Mee
Biarra
Esk
Crows Nest
Mt Hallon
Petrie
Sandgate
Mt D'Aguilar
Moreton Bay
Pt Lookout
North Stradbroke Id
Brisbane
Brisbane River
Marburg
Goodna
Ipswich
Bethania Junc
Helidon
Gatton
Lockyer
Laidley
Rosewood
Toowoomba
Grandchester
Logan
Tamborine
Southport
Mt Flinders
Harrisville
Bremer
Camboova
Kalbar
Boonah
Beaudesert
Pt Danger
Tweed Hds.
Tweed R.
Clifton
Condamine
Great Dividing Range
Mt Cordeaux
Cunninghams Gap
Spicers Peak
Innis Plain
Teviot
Hendon
Mt Huntley
Mt Maroon
Mt Roberts
Widgee Mt
Mt Durigan
Pt Lookout
Wilsons Pk
Mt Barney
Mt Clunie
Mt Lindsay
McPherson Range
Logan
Albert
Coomera
Nerang
Warwick
Mary R.
Stanley
Brook
South Pacific Ocean
Scale of Miles
27°S
28°S
152°E
153°E

the McPherson Range but as a structural feature it does not stop there but continues across the border into New South Wales, its surface being interrupted here, however, by the east-west line of Tertiary volcanoes which constitutes the McPherson Range. The railway cuttings on both sides of the range show that the upper surface of the Jurassic strata does not rise above an altitude of 400 feet. Corresponding with this there is a well marked break in the crest of the range itself known as the Richmond Gap. To the east of this gap occur such high points as Mt. Widgee (3,400 feet), Mt. Duringan (3,500 feet) and the Mt. Roberts Plateau (2,850 feet), while to the west of this gap lie the high peaks of Mt. Lindesay (4,064 feet), Mt. Barney (4,300 feet) and Mt. Clunie (3,725 feet). This greater height of the McPherson Range on both sides of the Richmond Gap is not due entirely to the Volcanic Series having a greater thickness in the higher regions but is, in part at least, due to the greater altitude to which the underlying sedimentary formations rise both on the eastern and western sides of the gap. Morton[17] states that in the crest of the McPherson Range at a distance of from $1\frac{1}{2}$ to $2\frac{1}{2}$ miles west of Mt. Lindesay, Walloon sandstones occur at an elevation of 1,450 feet to 1,850 feet above sea level, while Richards'[21] and Morton's sections show that to the east of the gap the upper surface of the sedimentary rocks rises to an altitude of at least 1,000 feet as compared with the 400 feet of the upper surface of these rocks in the Richmond Gap itself. The physiography on the New South Wales side of the border from the foot of the McPherson Range to Kyogle suggests the occurrence there of a similar senkungsfeld to that which lies on its northern side. It is this relatively low-lying region which is drained by the upper Richmond River where it cuts right in behind the watershed of the Tweed River.

X. THE BIRNAM RANGE FAULT BLOCK.

This is a relatively small block with a length of about 13 miles lying between the Beaudesert Senkungsfeld and the Mt. Tambourine Horst. It has an approximate north-south trend : its northern margin is situated about two miles south of Logan Village and here its altitude is 350 feet and its width about one mile ; at Mt. Dunsinane, some seven miles to the south, the altitude has increased to 1,050 feet and the width to about three miles. South from here the altitude gradually decreases and about one mile south from Beaudesert it merges into the 300 feet level of the Beaudesert Senkungsfeld. The greater part of the range, according to Marks[15], consists of Walloon Series. From Mt. Dunsinane to its southern margin the crest of the range is capped with Tertiary basalts the base of which has a very definite tilt towards the south. The western margin forms a well marked, moderately steep scarp with a general north south trend ; along the line of this scarp Marks[15] has recorded a number of relatively steep dips ranging from 12° to 30° whereas the dips just to the west of this line are all low angle dips. There is some geological evidence, therefore, to support the view that this scarp is a tectonic one due either to faulting of to monoclinal folding. The eastern side of this fault-block displays a much more gentle slope and has the appearance of being the "back slope" of a tilted fault-block. The crest of this "back slope" is near the western margin of the block, consequently most of the drainage from it flows to the east to the Albert River, the latter lying in the fault-angle between this easterly tilted block and the adjoining Mt. Tambourine Horst. The Birnam Range thus appears to be a tilted fault-block with its fault slope facing to the west and its back slope tilted to the east. It is also mildly arched along its north-south axis and it merges into the plain at both ends. As has already been pointed out the tilt to the south of the southern part of this block is accompanied by a similar southerly tilt of the base of the Tertiary basalts.

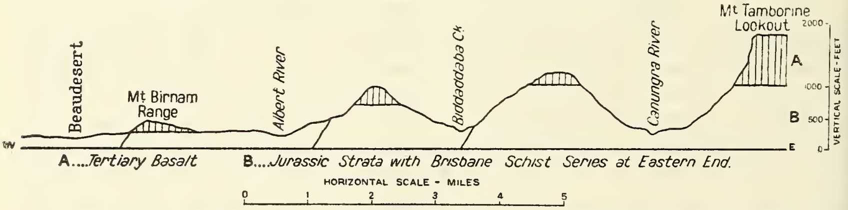
XI. THE MT. TAMBOURINE HORST.

That part of the coastal highlands occurring to the south of the Brisbane River will be referred to here as the Tambourine Horst, while that lying to the north is known as the D'Aguilar Horst. These two are separated by a low-lying area situated between the lower courses of the Brisbane and Logan Rivers, which will be described later as the Brisbane Gap. It is desirable that these two branches of the coastal range should be described separately as they are really quite distinct units.

The Tambourine Horst starts at the New South Wales border where it is known as the Springbrook Tableland and forms part of the McPherson Range. Here it has an altitude of about 3,500 feet; northwards it gradually decreases in altitude; at Mt. Tamborine itself, the altitude has fallen to 2,000 feet and followed still further northwards the altitude gradually decreases to a few hundred feet at the Logan River valley. This horst is for the most part covered by thick flows of basalt. At its southern end in the Springbrook Tableland these basalts, according to Richards[21], have a thickness of about 1,500 feet, but at Mt. Tambourine the basalts range up to about 800 feet in thickness, being much thicker on the western side of the tableland than on the eastern side

Fig. 2

SKETCH SECTION FROM BEAUDESERT TO MT TAMBORINE LOOKOUT



North from Mt. Tambourine the basalts rapidly thin out and disappear. Underlying the basalts throughout the greater part of the tableland are the Brisbane Schist Series with some limited areas of Ipswich Coal Measures and Bundamba beds. The tableland as a whole has a length of about 40 miles, relatively narrow at its northern end (4 to 5 miles wide) but gradually widening southwards, having its greatest width where it joins the McPherson Range. It has a very rough topography throughout, the streams which drain it being entrenched in deep narrow gorges.

Not only has the tableland itself a tilt from south to north but the base of the volcanic rocks and the peneplain surface upon which it rests has a similar south-north tilt. Immediately to the east of the Mt. Tambourine Horst lies the low coastal plain still to be described, while bounding it on the west is the low Birnam Range Fault-block and the Beaudesert Senkungsfeld. The western scarp of this horst is a very steep one and forms a very prominent feature.

At Mt. Tambourine trigonometrical station (altitude 1,801 feet) there is a fall to the west of 1,500 feet in 1½ miles. At this point the Mesozoic strata extend up the face of the scarp to the base of the basalts and display very steep dips to the westward. South of Mundoolun the scarp appears to split into two branches, the eastern branch following the course of Baddaddaba Creek, the western branch following the course of the Albert River as shown in figure 2. On the ridge between Canungra Valley and Baddaddaba Creek the base of the basalt is at an altitude of about 1,000 feet.

On the ridge between the latter stream and the Albert River the altitude of the base of the basalt is about 700 feet whereas in the Mt. Birnam Range still further to the west the same feature has an altitude of about 300 feet. The two branches of the fault would thus have a combined throw of about 700 feet. These features could of course be explained as being due to monoclinal folding but the topography is more suggestive of faulting. In this connection the river valleys afford some suggestive evidence. The Albert River for many miles flows in a northerly direction in a wide mature valley, the valley being a structural feature probably caused by the tilting of the Mt. Birnam Fault-block towards the Mt. Tambourine Horst. This structural valley continues northwards without any break to the Logan River but the Albert River, instead of continuing its northern course in this structural valley throughout, suddenly changes its course in the neighbourhood of Plunkett railway station and enters a deep gorge cut across the northern end of the Mt. Tamborine Horst (which is here 900 feet in altitude) before joining the Logan River. This gorge traverses the Brisbane Schists. The structural valley which the Albert River has ignored to the north of Plunkett railway station nowhere exceeds 150 feet in altitude above sea level and is confined to the Jurassic strata, but instead of following this natural course, the Albert River gives the appearance of having deliberately avoided it. From these facts it is quite obvious that the Albert River in the lower part of its course is a revived stream and that during the elevation of the Mt. Tamborine Horst athwart its course it maintained its original channel against the rising ground.

The fact that the Albert River leaves the so-called less resistent Jurassic strata and a natural depression in order to cut a gorge through the so-called more resistent strata of the Brisbane Schist Series, is sufficient evidence that differential erosion cannot explain the facts.

The writer has had no opportunity of inspecting this scarp south from Beaudesert and the published literature seems to afford no information. The southern end of it at Mt. Widgee has already been discussed in the description of the southern end of the Beaudesert Senkungsfeld. With regard to the eastern scarp of the Mt. Tamborine Horst there appears to be little doubt that it is also a fault-scarp but it will be described when dealing with the coastal plain in the nest section.

XII. THE COASTAL PLAIN.

A low-lying plain, usually termed the Coastal Plain, occurs along the whole of the eastern margin of the Moreton district. At its southern end this plain is quite narrow, being about two to three miles in width. It gradually widens northwards and at Brisbane the width is about six miles and this width is maintained northwards to beyond the region now under consideration. The general altitude of this coastal plain may be taken as 150 feet but considerable areas are lower than this and much of it is not much more than 50 feet above sea level.

The underlying formations consist partly of the Brisbane Schist Series and partly of freshwater Triassic strata the Schists predominating in the southern part of the area and the latter in the northern part. At the Pine River the surface over about 25 square miles is occupied by the Petrie Series of Lower Tertiary age. In places, particularly for some miles immediately to the north and south of the Brisbane River, the abovementioned strata are capped by horizontal sheets of Tertiary basalts of no great thickness. These rest alike upon the truncated ends of the Palaeozoic and Mesozoic strata and also upon the Petrie Series. It is quite obvious from these facts that here, as in other parts of the district already described, a peneplain had been developed prior to the pouring out of the Tertiary basalts and that here at sea level we have the same peneplain as that which occurs in the adjoining Mt. Tamborine Horst at an altitude of 1,700 feet and in the Darling Downs Tableland at an altitude of 2,000 feet.

The line of junction of this Coastal Plain with the adjoining coastal ranges (Mt. Tambourine Horst and D'Aguilar Horst) is a well marked scarp with a trend slightly west of north and both the physiographical and the geological features suggest that this scarp is a fault-scarp. This Coastal Plain cannot be ascribed to recent marine erosion because it had already been developed prior to the pouring out of the Tertiary basalts. For the same reason it cannot be ascribed to differential sub-aerial erosion during the present cycle. Denmead[6] has shown that the Brisbane Schist Series outcropping in the southern part of the coastal plain belong to the Neranleigh beds, the most resistent member of the whole series. As the Neranleigh beds occur both in the Coastal Plain and in the adjoining Mt. Tambourine Horst where they reach an altitude of 1,700 feet, according to information supplied to me by Dr. W. H. Bryan, this gives another argument against differential erosion.

The evidence from both the geological and physiographical side, therefore, suggests that this eastern scarp of the Mt. Tamborine Horst is a definite fault-scarp. Similar arguments apply to the scarp further north where it separates the Coastal Plain from the D'Aguilar Horst.

XIII. THE D'AGUILAR HORST.

The D'Aguilar Horst is an elevated region, rectangular in shape, bounded on its eastern side by the low-lying Coastal Plain and on its western side by the Lockyer River Senkungsfeld. Northwards it extends to the Blackall Range and southwards to the Brisbane River. Its width in an east-west direction is about 14 miles. That this region might be a horst was first suggested by L. C. Ball[2] who in referring to the Hemmant-D'Aguilar fault and the West Moreton fault states: "These two faults define a horst that formerly extended from the south-east corner of the State right across the Moreton district." The D'Aguilar Horst, however, is not a simple fault-block but consists of a series of parallel fault blocks all trending N.N.W. as shown in figure (3) which gives a diagramatic east-west section across it.

These separate fault blocks taken from east to west are as follows :

(1) The Taylor Range Fault Block—altitude 900 feet - 1,200 feet.
(2) The D'Aguilar Range Fault Block—altitude 1,350 feet - 2,200 feet.
(3) The Horse Mountain Fault Block—altitude 1,000 feet - 1,200 feet.
(4) The Pine Mountain Fault Block—altitude 700 feet - 900 feet.

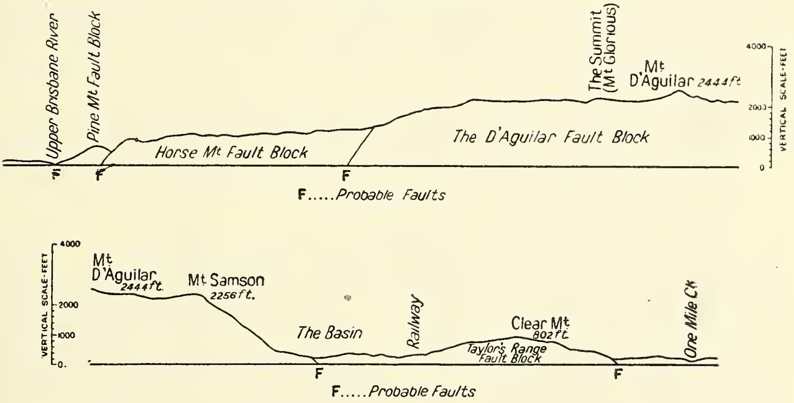
The D'Aguilar Horst in its southern portion consists of the Brisbane Schist Series with their intrusive igneous rocks. Some of the higher portions are capped over a limited area by Tertiary basalts and rhyolites.

(1) THE TAYLOR RANGE FAULT BLOCK.—This is a prominent feature when looking north-west from Brisbane and appears as a well-marked line of hills running parallel to the higher tableland lying to the west of it. The eastern flowing coastal streams such as Enoggera Creek, Cedar Creek, South Pine River and North Pine River, where they flow across this block, have cut their channels down to base level and have developed moderately wide flood plains and thus have divided the block into a number of separate sections, ranging from in altitude 950 feet to 1,250 feet, the block as a whole having a tilt from north to south.

The eastern margin of this block presents a fairly straight steep scarp with a definite N.N.W. trend and has every appearance of being a fault-scarp. The Hemmant-D'Aguilar fault as described by Ball[2] cannot have any relation to this scarp because, as pointed out by Bryan[4], it cuts right across the line of escarpment. The argument in favour of this being a fault-scarp are given in the description of the Coastal Plain.

Fig. 3

SKETCH SECTION ACROSS THE D'AGUILAR HORST FROM THE UPPER BRISBANE RIVER TO THE COASTAL PLAIN



(2) THE D'AGUILAR FAULT BLOCK.—This at its southern margin has an altitude of about 1,350 feet. At Mt. Glorious the altitude reaches 2,390 feet while still further to the north Mt. D'Aguilar has an altitude of 2,444 feet. In this northern area the general altitude appears to be about 2,200 feet. The block as a whole is well dissected but some more or less flat topped areas still remain around about Mt. Glorious and Mt. D'Aguilar and small parts of these are capped by Tertiary basalts. This block forms the divide between the westward flowing tributaries of the Upper Brisbane River and

the coastal streams but the amount of lowering of the divide that has taken place is quite small. From the figures given above it will be seen that the block has a definite tilt from north to south ; the width at Mt. D'Aguilar is about six miles. A well-marked scarp separates it on its eastern side from the Taylors Range Block ; for example, between Mt. Sampson and Mt. Kobble there is a drop of 1,000 feet in little more than a mile, and a similar steep scarp exists on its western side. Both of these are probably fault scarps but in the absence of detailed geological surveys there is no geological proof of the faulting.

(3) The Horse Mountain Fault Block.—The writer has had no opportunity of seeing this block except from a distance and its probable existence has been determined mainly from the contours given on the military contour map. It appears to have a general elevation of from 1,000 feet to 1,200 feet and a width of from 5 to 6 miles. Near its southern end is Horse Mountain with an altitude of 1,150 feet ; it is well developed between England Creek and Kipper Creek and here Mt. England (1,002 feet) occurs on its western margin. It appears also to be well developed to the north of Kipper Creek.

(4) The Pine Mountain Fault Block.—This is a narrow block about one to two miles wide extending along the western margin of the Mt. D'Aguilar Horst with an altitude of from 750 feet to 900 feet. At its southern margin is Pine Mountain with an altitude of 750 feet while near its northern end is Varley's Hill with an altitude of 914 feet. This block has been well dissected by the streams which cross it from east to west and these streams have cut their channels down to base level and developed well-marked flood plains where they cross the block, so that it now appears as a row of isolated hills as shown in Plate V., figure 1.

That the eastern margin of this block is a fault-scarp, there can be no question. Dr. Dorothy Hill[7] in her map of this region shows a well-marked faulted junction between the Mesozoic Strata and the Brisbane Schist Series ; this is known as the West Moreton fault. The writer has plotted this fault on to the military contour map and its position is found to coincide exactly with the foot of the scarp. The existence of a fault at the foot of this scarp along its whole length can be no mere coincidence. The question remains, however, as to whether the scarp is a true fault-scarp or a fault-line scarp.

The position of the Brisbane River in relation to this scarp affords some interesting evidence ; this river first comes into contact with the scarp some two miles to the north of Northbrook and from here southwards, except for a meander to the west at Northbrook, it hugs the foot of the scarp for a distance of five miles. It then makes a huge meander to the west at Lowood but here it turns north-east, reaching the scarp at a point about two miles north of Fernvale where it leaves the low-lying country which it had previously traversed, cuts eastwards across the scarp and flows for about four miles in a gorge cut in the Pine Mountain Fault-block. At Fairney View the river again turns westwards across the scarp only to turn eastwards again and entrench itself in the Pine Mountain Fault-block in which it flows southwards for a further distance of four miles until it finally turns eastwards along the southern margin of the D'Aguilar Horst. It is quite obvious from these facts that the Brisbane River is a rejuvenated stream and that its course is older than the fault scarp and that as the scarp was produced during the uplift of the Pine Mountain Fault-block, the stream maintained its course against the rising block. It is quite possible that the West Moreton fault originated as far back as Mesozoic times but it is considered that a fresh movement took place along it in Late Tertiary times when the present tablelands were uplifted and that the scarp is a true fault-scarp. Had it been a fault-line scarp re-exposed during the present cycle of erosion the Brisbane River would have kept its course in the supposedly weaker Mesozoic strata and not have meandered backwards and forwards across the line of faulting into the supposedly more resistent Brisbane Schist Series.

The southern end of the D'Aguilar Horst is also marked by the presence of a steep scarp ; that this is a fault scarp is suggested by the physiographic evidence and has much geological support as follows :

(*a*) At the foot of the scarp, as pointed out by Denmead[6], there is a faulted junction between the Brisbane Schist Series and the Mesozoic strata.

(*b*) Immediately to the south of the scarp lie the freshwater Lower Tertiary strata of Redbank Plains and Cooper's Plains capped in places by horizontal sheets of Tertiary basalts now elevated but little above sea level. To the south of this again lies the Mt. Flinders Horst of Jurassic strata ranging up to 1,500 feet in altitude. Had this part of the valley of the Brisbane River been produced by differential erosion one would have to assume either that (1) the Redbank Plains Series must have been at one time at least 1,500 feet thicker than they are now and that they had been eroded to their present level before the overlying Tertiary basalts had been poured out over them, or (2) that the Tertiary basalts overlying the fresh-water beds were originally 1,500 feet in thickness and that the present valley of the Brisbane River had been cut out of these basalts. There is nothing to warrant the adoption of either of the assumptions.

The topography of the D'Aguilar Horst is of such a youthful character that one does not need to go further back than the beginning of the Pleistocene period to account for its development.

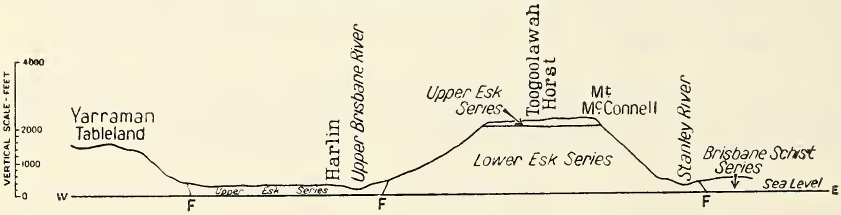
(5) THE STANLEY RIVER (?) RIFT VALLEY.—Followed northwards the D'Aguilar Horst exhibits a well marked physiographic break at the valley of the Stanley River. This stream rises at the southern end of the Blackall Range (a probable northerly extension of the D'Aguilar Horst) and only about 12 miles from the sea coast, but instead of taking the shorter easterly route to the sea it flows in a general south-west direction to join the Upper Brisbane River near Esk. This is the only important tributary which the Brisbane River receives on its left bank. For the first half of its course the Stanley River flows over an extensive and mature erosion surface cut alike out of Palaeozoic granites and Mesozoic strata ; this erosion level has an altitude of about 600 feet and has been described by Jensen[11] as the "Woodford Peneplain." Its eastern margin is a direct continuation of the eastern margin of the D'Aguilar Horst and presents a steep scarp to the Coastal Plain ; this scarp has a remarkably even sky line along its whole length with an altitude of about 600 feet.

The Stanley River along its lower course, that is from Kilcoy to its junction with the Brisbane River, follows fairly closely a well-marked line of faulting which separates Mesozoic strata from the Brisbane Schist Series. This fault, which is considered by Morton[8] to be a northern continuation of the West Moreton fault, runs parallel to and close to the foot of the Toogoolawah Horst which bounds the valley of the Stanley River on its north-western side. At one place, called The Gorge, the Stanley River is actually entrenched for a distance of several miles in the granites of the Toogoolawah Horst itself, showing that it is a rejuvenated stream. The above facts all seem to indicate that part at least of the region drained by the Stanley River has had a tectonic origin ; much more field work, however, will be necessary before this view can be definitely affirmed. At its western end this low-lying region joins the Lockyer River Senkungsfeld, being separated from it only by the Brisbane River.

(6) THE TOOGOOLAWAH HORST.—This is a high region upwards of 2,000 feet in altitude lying between the converging courses of the Upper Brisbane and Stanley Rivers. Its western margin is in perfect alignment with the western margin of the D'Aguilar Horst and it may be looked upon as being a northern continuation of the latter but separated from it by the valley of the Stanley River just described. Dr. Dorothy Hill's description[8] of the geology shows this horst to consist of strata of the Lower Esk Series capped on its higher levels by outliers of the Upper Esk Series as shown in fig. 5. It has very steep slopes both on its eastern and western sides and at the foot of each of these slopes there is a well-marked line of faulting. The West Moreton fault which, as pointed out previously, follows the foot of the western scarp of the D'Aguilar Horst apparently branches at a point somewhere near Bellevue.

Fig 4

SKETCH SECTION ACROSS UPPER BRISBANE RIVER RIFT VALLEY AND THE TOOGOOLAWAH HORST



F.....Probable Faults

The eastern branch, as shown by Dr. Hill's map, trends almost due north along the eastern foot of the Toogoolawah Horst. Dr. Hill does not show on her map any fault along the western margin of this horst but her map gives abundant evidence of the existence there of a fault. Along this suggested line of faulting Dr. Hill shows the Upper Esk Series to be dipping steeply to the east against the Lower Esk Series of the adjoining high block as shown in fig. 4. It is quite possible that there is more than one fault as the details given on Dr. Hill's map suggest the possibility of at least two parallel faults. It will be convenient to call this the Toogoolawah Fault and it is suggested that it is probably a branch of the West Moreton fault. There is therefore very strong evidence that the great western scarp of the Toogoolawah Range is a typical fault-scarp and that the range itself is a typical horst.

XIV. THE UPPER BRISBANE RIFT VALLEY.

This is a narrow low-lying region with a general altitude of about 400 feet, situated immediately to the west of the Toogoolawah Horst. It extends from the town of Esk northwards to at least as far as Avoca Vale and is traversed throughout its length by the Upper Brisbane River ; its general trend is N.N.W. and its length in this direction is upwards of 30 miles ; its width appears to be from 4 to 6 miles. The geology of this region has been described in some detail by Dr. Dorothy Hill[8] who shows it to consist of strata belonging to the Upper Esk Series lying in a faulted trough bounded on the east by the Toogoolawah Mountains and on the west by a relatively high tableland of Palaeozoic strata. As this tableland appears to have no definite name the author suggests that it be called the Yarraman Tableland from the town of that name situated on its surface.

The Toogoolawah Range, as has already been pointed out, is a typical horst with a strongly marked fault separating it from the Brisbane River valley. Dr. Hill has shown that this latter feature has also a well-marked line of faulting along its western margin separating it from the Yarraman Tableland. There is ample geological evidence, therefore, in support of the view that the valley of the Brisbane River from Esk to Avoca Vale is a typical rift-valley separated from the highlands on either side by faulting. The highlands to the east have an elevation of upwards of 2,000 feet, those to the west of upwards of 1,200 feet.

XV. THE BRISBANE GAP.

It will be seen from the descriptions already given that although the D'Aguilar Horst and the Tambourine Horst occupy similar positions with respect to the Coastal Plain, they are separated from one another by a very definite break which lies a few miles to the south of the town of Brisbane ; it will be convenient to call this break in the coastal highlands, the Brisbane Gap.

In this Gap the country is elevated but little above sea level and its surface to the east merges into the low-lying Coastal Plains and to the west into the Beaudesert Senkungsfeld. It has a width in a north-south direction of from 8 to 10 miles and it is interesting to note that it occurs where the general north-south direction of the Tambourine Horst changes to the N.N.W. direction of the D'Aguilar Horst. In this Gap the surface strata consist mainly of Ipswich beds but with a moderately broad belt of Brisbane Schists outcropping along both its northern and southern margins.

It has already been shown that the D'Aguiliar Horst ends abruptly along its southern margin in a fault-scarp and this scarp forms part of the northern margin of the area now under consideration. Along its southern margin is the warped surface of the Tambourine Horst and there may actually be a line of east-west faulting here as suggested by Denmead[6]. These two features suggest that this Gap has had a tectonic origin and this suggestion is supported by the following additional facts :—

(*a*) The Tambourine Horst and the D'Aguilar Horst each consists of a continuous belt of Brisbane Schist which to-day almost completely separate the outcrops of the Mesozoic formations of the Coastal Plain from those of the interior, the only place where these latter extend across the line of the coastal ranges being in the Brisbane Gap. That Mesozoic strata at one time did extend across both of the above-mentioned horsts seems quite probable but if so they had been removed from these areas by denudation during the cycle (or cycles) of erosion which preceded the present one, certainly prior to the time when the Tertiary basalts were poured out. That Mesozoic strata still remain in the Gap is due to the fact that this region persistently lagged behind during the elevation (or elevations) which produced the D'Aguilar and Tambourine Horsts.

(*b*) A thick series of Tertiary freshwater beds occur in the western part of the Gap and not far south from the foot of the southern fault-scarp of the D'Aguilar Range. Their occurrence here gives further evidence that this region persistently lagged behind, in fact actually subsided during a part of Tertiary time.

(*c*) There occur also in this low-lying region several areas of horizontal Tertiary basalts which in places rest upon the above-mentioned Tertiary freshwater beds. Dr. W. H. Bryan has informed me that his study of the soils derived from these basalts suggests a considerable geological age for them.

(*d*) The main drainage channels of the district, namely the Brisbane and Logan Rivers, do not flow through the lowest part of the Gap as one would expect if this feature had resulted entirely from erosional activities. Instead, the former is entrenched in the Brisbane Schist along the northern margin of the Gap, while the Logan River traverses its southern margin where its channel is entrenched in the Brisbane Schists in the toe of the Tambourine Horst. The Gap itself is drained by a short unimportant coastal stream called Tingalpa Creek.

Along the northern margin of the Gap there occur several isolated hills rising notably above their surroundings, such as Mt. Gravatt (650 feet), Mt. Petrie (553 feet) and Pine Mountain (500 feet). These hills all consist of some of the more resistent members of the Brisbane Schist Series and are probably residuals of an older tableland out of which the great Tertiary peneplain had been eroded. Mt. Cotton (762 feet) in the southern part of the area probably had a similar origin.

XVI. THE ROSEWOOD BLUFF HORST.

This is a relatively narrow elevated block extending from the north-eastern margin of the Lockyer Fault-block in an E.N.E. direction towards the western foot of the D'Aguilar Horst. At its western margin its elevation is upwards of 1,100 feet, but eastwards the altitude gradually decreases to 300 feet at its eastern margin near Marburg and from here this 300 feet level continues to the foot of the D'Aguilar Horst. The underlying strata are according to Reid[20] of Jurassic age and belonging mainly to the Walloon Series. These are capped in places by Tertiary basalts ranging from 100 feet to 400 feet thick. The base of the basalt has an easterly tilt corresponding to that of the horst itself. On both its northern and southern margins there are moderately steep scarps which appear to be fault-scarps, the southern one facing towards the low-lying Fassifern Senkungsfeld, the northern one facing towards the low-lying Lockyer River Senkungsfeld. Most of the drainage from this block flows north-north-eastwards to join the Brisbane River.

XVII. THE LOCKYER RIVER SENKUNGSFELD.

This is a low-lying region lying to the north of the Rosewood Bluff Horst and has a general elevation of from 300 feet to 400 feet. It is rectangular in shape with its longer axis trending in an E.N.E. direction. It has a length of about 30 miles and a width of from 8 to 10 miles. It is entirely surrounded by higher earth blocks. Along its eastern margin lies the D'Aguilar Horst, to the south lies the Rosewood Bluff Horst and the Lockyer Fault-block, to the west lies the Darling Downs Tableland, while to the north lies the Yarraman Tableland.

The underlying strata, according to Reid[18], belong mainly to the Bundamba Series. The surface of this region displays throughout a thoroughly mature topography which extends almost to the foot of the Main Divide and this topography is essentially similar to that already described for the Beaudesert and Fassifern Senkungsfelder.

The change in elevation from this low-lying region to its higher neighbours is everywhere abrupt and no spurs run out from these higher blocks on to the lower surface. Its eastern margin is bounded by the western fault-scarp of the D'Aguilar Horst previously described. Along its western margin extends the Mt. Paradise fault referred to in describing the Mt. Lockyer Fault-block. The fault-scarp which must have existed here at one time has now been completely broken down by the denudation of the Lockyer River and its tributaries during the present cycle of erosion with the result that both the scarp and the Main Divide have migrated westwards to an extent of at least 3 to 4 miles. The scarp forming the boundary between this region and the tableland to the north has not been visited but from a distance has every appearance of being a fault-scarp.

It is considered, therefore, that this region owes its low elevation to the fact that during the movement which elevated the surrounding tablelands this region lagged behind and that its origin, therefore, is primarily a tectonic one. The question should be considered as to whether this low-lying region could be explained as having resulted from normal river erosion during the present cycle. Its features as compared with ordinary river valleys are quite abnormal and there is nothing in the geological structure to indicate differential erosion in relatively weak strata ; the highlands both to the south and west consist of similar Jurassic strata and this same formation also occurs in the southern margin of the tableland bounding it on the north ; it is only the highlands to the east (D'Aguilar Horst) that have a different geological structure and evidence has already been given that the scarp here is a fault-scarp.

THE YARRAMAN TABLELAND.

This occupies the north-west portion of the Moreton District and lies between the Darling Downs Tableland and the Upper Brisbane Rift-valley. The writer has had no opportunity of visiting this part of the district and the literature with regard to it is very scanty. Along its eastern margin occurs the fault-scarp referred to in the description of the Upper Brisbane Rift-valley and where the railway line ascends this scarp between Linville and Benarkin the ascent is a fairly abrupt one to an altitude of about 1,400 feet. The Darling Downs Tableland to the west has an altitude of about 2,000 feet and as to whether the junction between the two tablelands is a line of faulting or of warping, the writer is unable to say. It is quite possible however, that the Mt. Paradise fault, which further to the south marks the eastern margin of the Darling Downs Tableland, may continue into this region either as a fault or as a monoclinal fold.

The Yarraman Tableland is drained by a series of parallel streams (Cooyar Creek, Emu Creek, Cressbrook Creek, etc.) which rise in the Main Divide and flow in a north-easterly direction to join the Brisbane River ; this suggests that the Tableland may have a tilt in a north-east direction and that the streams are consequent streams.

SUMMARY.

The West Moreton District throughout the Jurassic period was covered by a fresh water lake (Lake Walloon). At the close of the period an uplift took place followed by one or more cycles of erosion which by the middle of Tertiary time had produced an extensive peneplain throughout the whole of the area. Then followed an epoch of vulcanism which covered much of the region with lava flows and tuffs of very variable thickness, and this was followed by a minor cycle of erosion which continued until the end of the Cainozoic era. It was this last cycle of erosion which produced the " Upland Valleys " which still exist in places on the surface of some parts of the tableland ; volcanic activity continued during a part of this cycle. Then followed an epeirogenic movement of uplift (Koscuisko Epoch) which produced the existing tablelands. This uplift was a differential one and resulted in the production of a series of earth blocks some of which were elevated to produce tablelands and horsts while other blocks lagged behind and now form relatively depressed regions or senkungsfelder. The higher blocks are bounded by tectonic scarps, the result either of normal faulting or monoclinal folding or both. Since the uplift the more elevated regions have been more or less maturely dissected by weathering and stream action but they still retain, to a considerable extent, their original features.

A study of the drainage systems shows that most if not all of the principal rivers are rejuvenated streams which must have had their main channels determined in a large part, before the Koscuisko uplift. The geomorphology of the region as a whole is similar in all its essential features to those of the tableland regions of New South Wales and Victoria and affords further evidence in favour of E. C. Andrews' theory of the geographic unity of Eastern Australia.

Since the above paper went to press Dr. E. O. Marks has drawn my attention to the fact that to the south and south-west of Tambourine in the valleys of the Coomera and Canungra Rivers there are developments of Tertiary basalts at levels hundreds of feet below the base of the volcanic rocks as shown in Dr. H. C. Richards' section quoted in my paper. My intention was to show that along the line of this section the surface of the older rocks covered by the Tertiary volcanic rocks is reasonably even and that this surface represents a peneplain ; no peneplain ever has, however, an absolutely flat surface. I endeavoured to show that this peneplain surface had a tilt from south to north ; it may also have a tilt in an east or west direction. It is quite possible also that both step-faulting and trough-faulting have occurred within the Tambourine Horst itself and if so this would account for variations in the level of the base of the volcanic rocks.

Fig. 1.

The western margin of the D'Aguilar Horst, as seen from Lowood showing the dissected Pine Mt. Fault-Block with the higher D'Aguilar Horst in the background.

Fig. 2.

Surface of the Lockyer River Senkungsfeld from Mt. Tarampa and looking N.W. towards Benarkin Tableland.

I have already pointed out the probable existence of step-faulting along the western margin of this horst. All these points, however, can only be settled in the future by a detailed survey of the whole region.

REFERENCES.

1. Andrews, E. C. .. Geographical Unity of Eastern Australia in late and Post-Tertiary Times. Proc. Royal Society of N.S.W., Vol. XLIV, 1910.
2. Ball, L. C. .. .. Notes on a Great Fault System in the East Moreton District, Queensland Govt. Mining Journal, 1916, p. 169.
3. Bryan, W. H. .. .. Geology and Petrology of The Enoggera Granite. Proc. Royal Society Queensland, Vol. XXVI, 1914.
4. do. .. .. Earth Movements in Queensland. Proc. Royal Society Queensland, Vol. XXXVII, 1925.
5. do. .. .. Handbook Brisbane Meeting A.A.A.S., 1930.
6. Denmead, A. K. .. A Survey of The Brisbane Schists. Proc. Royal Society Queensland, Vol. XXXIX, 1928, p. 77.
7. Hill, Dr. Dorothy .. The Stratigraphical Relationship of the Shales about Esk to the Sediments of the Ipswich Basin. Proc. Royal Society Queensland, Vol. XLI, 1930, p. 162.
8. do. .. The Development of the Esk Series between Esk and Linville. Proc. Royal Society Queensland, XLII, 1930, p. 28.
9. Jensen, H. I. .. .. Notes on the Geology of Mt. Flinders and Fassifern Districts Queensland. Proc. Linnean Society of N.S.W., Vol. XXXIV, pt. 1, 1909.
10. do. .. The Building of Eastern Australia. Proc. Royal Society of Queensland, Vol. XXIII. pt. II., 1911, p. 18.
11. do. .. Geology of The East Moreton and Wide Bay Districts. Proc. Linnean Society of N.S.W, 1906.
12. Jones, A. O. .. .. The Tertiary Deposits of The Moreton District, South east Queensland. Proc. Royal Society Queensland, Vol. XXXVII, 1926, p. 23.
13. Marks, E. O. .. .. Notes on the Geological Ages of the Volcanic Activity of South-east Queensland. Proc. Royal Society of Queensland, Vol. XXIII, 1911.
14. do. .. The Physiographical Significance and Non Migration of Divides. Proc. Roy. Socy. Queensland, Vol. XLII, 1930.
15. do. .. The South East Moreton Coal Measures.
16. do. .. Streams and their Past. The Queensland Naturalist, Vol. VI, No. 2, 1927, p. 4.
17. Morton, C. C. .. .. South Moreton Geology. Queensland Govt. Mining Jour. Vol. XXIV, July, 1923, p. 244.
18. Reid, J. H. .. .. Coal Measures of West Moreton Queensland. Queensland Govt. Mining Jour. Vol. XXIII, Dec. 1922, p. 462.
19. do. .. Petroleum Prospects in The Beaudesert District. Queensland Govt. Mining Journal 1922, p. 432.
20. do. .. Geology of The Walloon-Roseville Coalfield.
21. Richards, H. C. .. The Volcanic Rocks of S.E. Queensland. Proc. Roy. Soc. Queensland, Vol. XXVII, 1916.
22. Wearne, R. A. and Woolnough, W. G. Notes on the Geology of West Moreton. Jour. Roy. Soc. of N.S.W., Vol. XLV., 1911.

Some Observations on the Physiography of the Brisbane River and Neighbouring Watersheds.

By E. O. MARKS, B.E., M.D.

(One Map.)

(*Read before the Royal Society of Queensland, 28th November, 1932*).

The writing of these notes is occasioned by the recent visit of Mr. C. A. Sussmilch, the pleasure of whose company in the field and whose lecture before the Royal Society of Queensland were of such stimulating interest that the publication of his views is keenly awaited. Knowing that, approaching the subject from a different angle, his views are not likely to be identical, and feeling that it is desirable that all aspects should be considered at the same time, the writer has endeavoured to put together observations which are in themselves scattered and incomplete.

DIFFERENTIAL EROSION.

As is usual elsewhere differential erosion appears to be the most important factor in the development of land forms within the area considered. It is the factor which has to be excluded, and which is usually difficult to exclude, in regard to all suggestions of relative movement.

The rock formations are very varied and vary in themselves in resistance to weathering. The basement rocks, the Brisbane Schist Series, vary from soft phyllites to hard massive greywackes and quartzites, the granitic rocks from more acid to more basic types, from coarser to finer grain, with accompanying change in land form. The mesozoic shales, both of the Ipswich Series and Walloon Series are interspersed with varying proportions of more durable sandstone and even the extensive sandstone of the Bundamba Series varies greatly in character and resistance. While the Cainozoic strata are soft the variability of the volcanic rocks is very marked.

Though differential weathering is the major factor, perhaps the only important factor, in the sculpturing of the land into the form in which we now know it, we must be careful not to credit to it what may have been due to relative movement. Because an area is hilly we are not entitled to argue that the rocks are resistant, though that is the most probable explanation.

FIXITY OF DIVIDES.

In physiographical literature the migration of divides under the influence of denudation is usually accepted as having an important part in the development of the drainage systems either directly or by river-captures.

In a previous paper the writer questioned this widely accepted view and gave evidence for concluding that the process takes place only to a minor extent and in unusual circumstances. Having appealed in vain to various authorities for some definite logical evidence in favour of the migration hypothesis it is necessary to accept the conclusions previously arrived at from field observations, and realise that so far as denudational effects are concerned divides may be regarded as stationary.

River Courses and Drainage Areas.

This general fixity of the divides gives to them a much greater significance in physiographical interpretation than they are usually accorded.

Observations on the streams indicate with equal clearness the fixity also of their courses apart from the trivial effect of meanders. This is the generally accepted view, except for questions of river-capture which depend on the misconception that divides migrate, and in any case have never seriously been claimed in this area.

The fixity of the divides and of the streams means that these are the most permanent, the most important and probably the oldest features of the landscape. Their positions must have been determined by tectonic movements, lava flows, or a combination of these with the pre-existing irregularities of the surface, and are independent of any present elevation which may depend largely on subsequent erosion.

In considering the physiography of an area we have thus two aspects to deal with :—

1. The positions of the streams and divides.
2. The present land forms, elevation, etc., in conjunction with the solid geology.

While the former, because of the action of denudation, necessarily affects the latter, the present land form may have little similarity to the surface on which the streams originated.

Streams and Divides of the Area.

In a general way the streams arrange themselves into fairly well-defined groups, a grouping due presumably to some common tectonic origin.

Let us consider the main Brisbane River first as being the main drain into which the others, or most of them, empty. It turns and twists in large irregular meanders, "entrenched" in the harder ground, meanders that have no suggestion of that swinging to and fro in wider and wider curves that gives rise to true meanders in an alluvial plain. No doubt there has been some cutting away of the concave bank, but the irregularity and the frequent straight reaches show some other control than oscillation. Indeed the straightest part of the river is its estuary.

From near Ipswich to the sea there are few large tributaries but above this, with the confluence of the Bremer, the basin opens out like a fan. From its source to near Ipswich the main stream is remarkable in meandering about a straight N.N.W.-S.S.E. line. This is in line with, and to the south coincides with the great fault to the west of Ipswich. Dr. Hill has shown that the Upper Brisbane lies in a geological trough with this axis. Leaving this axis the general course of the river turns eastwards, skirting the edge of the Brisbane

Schists. The wide meanders, however, both along the line of fault and after leaving the fault, seem to take the river quite impartially into the hilly schist country or the less hilly mesozoic strata. The great fault for some distance forms the boundary of the schists, but east of this line the boundary is not a faulted one though in some places perhaps it may be determined by some of the numerous faults known to have affected the Ipswich coalfield.

Tributaries of the Upper Brisbane.—With the exception of the Stanley the larger tributaries are all on the western side. They run courses north-east to join the main stream at right angles. They rise in the Main Divide and mostly run considerable distances at an elevation comparable with the streams on the western or Darling Downs side of the divide. Northward of the Brisbane watershed, the head-waters of Barambah Creek and the Stuart River are parallel, have a similar elevation, and head in the same line of divide but are part of the Burnett River watershed. They are plainly part of the same group of streams.

The Main Divide, at least North-West from Crow's Nest, is very straight although it varies in elevation from 2,000 to 3,600 feet, and has been extensively denuded as is shown at the Bunya Mountains. This line is nearly parallel to the axis of the Upper Brisbane and the streams on its western fall run regular courses away from it at right-angles. It seems difficult to avoid the conclusion that the divide was a tectonic ridge or anticline on the N.E. side of which the water flowed into the roughly parallel depression, be it trough or syncline, deep or shallow, now occupied by the Brisbane River.

The drainage down the slope was not quite regular, and there is a suggestion of a minor N.W.-S.E. ridge a few miles N.E. of Crow's Nest. On the other side of the river the smaller tributaries also come in at right angles representing perhaps the other side of the trough or syncline. While Cooyar, Emu, Anduramba and Maronghi Creeks each show the characteristic N.E. direction of the group, Buaraba Creek the next large stream to the south does not show this. The Lockyer, however, into which it runs, also shows the regular N.E. direction from near Gatton, and if we take Flagstone Creek as the main head, the course is regular from the source in the Main Divide to the junction with the Brisbane. Throughout practically the whole of its course the Lockyer is in a widely alluviated valley from the foot of the Main Range escarpment. Apart from Buaraba Creek all its tributaries worth mentioning are on the southern side, and with them there is a merging of the drainage arrangement into another quite distinct group.

These branches on the right or southern side of the Lockyer rise in the Main Divide and mostly traverse deep valleys with flat alluvial bottoms, valleys separated by remnants of the basaltic table-land, as has been shown so well by Mr. Reid. At Toowoomba the divide is on the scarp overlooking the low Lockyer drainage, and there is no range of hills as approached from the Darling Downs side. The appearance of the scarp is very suggestive of being eaten back by the steep eastern drainage, an appearance supported by the map. It is difficult to determine actually how much migration there has been, and one must remember that the appearance would be much the same in the field if the divide be stationary or migrating. There is nothing to indicate a migration of more than three or four miles, if so much.

Southward the divide is a range of hills as approached from the west, a range increasing in altitude. At the head of Heifer Creek (of the eastern drainage), about 20 miles from Toowoomba the stream gradient and the ridge at its head forming the divide are much the same as on the western side of the ridge, showing that migration is not taking place there. This is also indicated by Ma Ma and Flagstone Creeks heading in the same line, an occurrence which would be extremely improbable if they were independently eating back the divide. South of the Toowoomba region there is not the least suggestion of migration, while north of it the divide not being on the edge of the high ground there is not even any theoretical reason for it.

Ma Ma, Blackfellow and Laidley Creeks run northerly courses to join the Lockyer. On its eastern side Laidley Creek is separated from the Bremer by the Little Liverpool Range, which is not so high or important looking as the similar range separating Laidley from Blackfellow's Creeks. Indeed part of this was called Mount Mistake because it was originally thought to be the Main Range, and not merely a spur off it. To the east the Bremer is separated by a low divide (from which rises the Mount Walker residual) from its tributary Warril Creek, and this from the Teviot Brook of the Logan watershed.

These streams, Ma Ma, Blackfellow's and Laidley Creeks of the Lockyer drainage, the Bremer and its tributary Warril Creek, and Teviot Brook of the Logan waters form our second group of streams having much in common. They have fairly regular, more or less parallel courses, diverging slightly so that a north direction becomes a north-east in the Teviot. Four of these streams head in the vicinity of Mount Castle which is on a spur slightly in front of the Main Range at a node where this changes its direction from N.W. to a more westerly direction, and is joined by the Little Liverpool and Mount Mistake Ranges. From Mount Castle the Main Divide runs for 20 miles south-easterly to Wilson's Peak where the Macpherson Range joins it. For the first 12 or 15 miles it is very straight and stands up as a bold escarpment, the very picture of a fault scarp, over the low Fassifern district, the peaks being about 4,000 and the gaps 2,000 feet above the sea, but the elevation not affecting the position of the divide. This part of the range will be referred to again later in reference to the question of faulting. From it the drainage runs at right-angles on the western side but at an angle of about 60° on the eastern side.

Running eastwards from Wilson's Peak, the Macpherson Range at first has an irregular course but later keeps a pretty regular direction which is not deviated from in association with the very great variations in elevation. The main streams from it run north, later trending eastwards. The upper part of the Logan has a series of streams joining it from the western side which form another small but fairly distinct group, of which the lower part of the Teviot Brook seems to be part, before the Teviot joins the Logan and the Logan itself takes a north-easterly trend. There is conveyed from its general direction on the map an impression that the Teviot should have been regarded as the main stream, though it has not so large a drainage area.

Only near the Macpherson Range are there any tributaries on the east side of the Logan, and these, Running and Christmas Creeks, are the first two of another well-marked group rising in the basaltic plateau of the Lamington National Park and Springbrook, and running nearly parallel as between neighbouring streams, but slightly divergent courses. Some still have part of their courses on the plateau but are mostly sunk in deep valleys separated by remnants of the plateau, until reaching the open country. The summation of the slight divergences of a dozen streams rising within a distance of 20 miles on the northern side of the Macpherson Range converts a western direction of Running Creek to a north-east in Currumbin Creek.

Some of them unite before reaching the sea, but many run long and closely parallel courses before uniting. Their courses seem to have no association with the present height of the intervening divides. For instance, the Canungra and Coomera run closely parallel courses, deep sunk in narrow gorges which later widen out somewhat but are separated by the high basalt-covered remnant of the plateau. Near Canungra there is quite a low gap at the south end of Tambourine Mountain. The Canungra, diverging a little westwards, emerges into the wide open country to join the Albert to the west of the mountain while the Coomera instead of going through the low gap has cut its way in the gorge which separates Beech Mountain from Tambourine, both about 1,800 feet in elevation, and enters the sea independently.

Somewhat similarly the Albert, in wide open sandstone country is, near Plunkett, separated from the Logan by a very low divide, but enters a narrow valley in high schist hills before finally uniting. The Logan, again, is separated from Oxley Creek and the Brisbane watershed by a very low divide, but passes through comparatively hilly schist country before joining the Albert and entering the sea.

It was suggested by Richards that the long, finger-like processes of basalt separating the streams in their upper courses had originated as flows down pre-existing valleys and that the valleys had since developed in the softer rocks between. A consideration of Back Creek, for instance, which runs for some miles on the top of Beech Mountain parallel to and between the Nerang and Coomera Rivers (both at low level), before Back Creek itself drops into a deep gorge and continues the same course at the lower level, leaves no doubt that the streams must have originated on the surface of the basalt and have merely cut down their gorges into the rocks below.

From near Ipswich to Moreton Bay, and running northwards into the river and the bay we find a not very well defined group of streams, none of them important or rising in any well-defined line. This, our fifth group, seems on the west to merge with Purga Creek into the second group, to which Warril Creek its next neighbour belongs. The group includes Bundamba, Woogaroo, Oxley, Bulimba, Tingalpa and Eprapah Creeks. Oxley, the longest, in its upper part has a north-east direction suggesting some consonance with the Logan in this vicinity, it being separated only by a low divide. A curious feature of the upper part of the Oxley is that, owing to some change in the conditions, the main stream has aggraded its bed, damming the branch valleys into shallow lagoons.

To the north of Brisbane we find a sixth group of streams, particularly well-defined and quite distinct from any of the rest of the drainage. It consists of the numerous short streams running easterly courses to the sea and rising in one very regular divide. This group may be said to begin in the south with Moggil and Breakfast Creeks (which join the Brisbane) and includes Kedron Brook, the North and

South Pine Rivers, Burpengary Creek, Caboolture and so on up to the Maroochy River. Beyond this the drainage is on quite a different pattern.

North from Landsborough the divide has a western fall into the Mary River waters, south from this it falls into the Stanley and other eastern tributaries of the Upper Brisbane. This Blackall-D'Aguilar divide runs in a very regular direction, its very minor irregularities having no relationship with its elevation which is very varied. Near the highest point, Mount Glorious, the direction changes from north-south to south-easterly as if here it had come under the influence of the movements which determined the position of the Upper Brisbane. This very regular divide, heading such a distinct series of streams, plainly signifies a tectonic origin though it has no apparent relationship with the solid geology or with faulting. It may have been the crest of an anticline, or monocline with a slope to the east. The western fall has not the regular drainage away from it which characterises the eastern fall.

The only remaining streams to be considered are the Stanley River and its tributaries. This basin seems to form a system of its own, having nothing in common with the coastal streams and very little in common with the Upper Brisbane.

Whatever may be the significance we thus find that the streams of this part of Queensland fall into seven distinct groups, in addition to the main Brisbane River. We have seen that the Upper Brisbane, in a geological fault trough, meanders about a remarkably straight axial line evidently determined by the faulting or by some subsequent movement along the same line of weakness. That it was not determined by the difference in resistance of the rocks of which the faulting has determined the outcrop is shown by the indifference with which the river meanders into the harder or softer country. The lower Brisbane similarly meanders across the boundary of the schists and later rocks, suggesting a similar determining cause for its position. This boundary however is not a faulted one except perhaps for local faults, so this explanation does not hold, whatever may be the true one.

While the Brisbane River is thus seen to have a definite association with the geological structure in its general course (until perhaps in the vicinity of the city itself), in its meanders it shows a complete disregard of structure. All the other streams, whether in their general courses or details seem to show also a complete disregard for the geological structure, be it folding or faulting or the hardness of the rocks. Geological boundaries seem to have no significance for them. This singular disregard for structure is nowhere better shown than by the Stanley meandering into its gorge at Mount Brisbane when a similar meander in the opposite direction would have avoided the obstruction or by Reynold's Creek cutting through the trachyte mass of Mount Edwards rather than make a small deviation round it.

With the exception of those streams in our first group which rises in the Main Divide north of Toowoomba and have courses at considerable elevation, and of the streams still on top of the basaltic plateau, all the streams are well graded to near their sources, the larger rivers having a very low gradient.

Like the streams, the divides seem also to exhibit a complete disregard for geological structure, unless it be in relation to the edges of basaltic or volcanic plateaus, a relationship which probably indicates that the position of the divide has determined, through denudation, the edge of the plateau. The positions of the divides seem quite uninfluenced either by the elevation or the rocks traversed.

Surface Relief.

Having referred to the main features in the drainage distribution we may consider those comparatively ephemeral features, the relative elevations. In contrast to our experience with the drainage system which must have been determined by tectonic movements, volcanic effusions, or a combination of these with the pre-existing surface, and which we found to have little or no relationship to the solid geology apart from the basaltic plateaus, we find a nearly constant association between the elevation and the resistant nature of the rocks. With some few exceptions, this relationship of elevation and the solid geology is not with the structure but merely with the component rock. To interpret the present elevations and what movements they may signify, we have therefore to be very careful to exclude the effects of differential weathering over an area which has suffered thousands of feet of denudation. Until this is done, other reasoning is vitiated.

Main Divide.—To the west of our area we have the high lands of the Darling Downs, forming at Toowoomba a scarp of some 2,000 feet. In the region of our survey, right from Wilson's Peak to the Bunya Mountains, the Main Divide is on volcanic rocks—almost entirely basalts. North from Toowoomba the divide ceases to be on the edge of the scarp, the high ground extending to the east and breaking away more gradually to the upper Brisbane valley. The high ground continues northwards into the Burnett watershed from which it is not separated by any marked dividing range.

South of Toowoomba, as already mentioned, the divide becomes a range of mountains, whether approached from east or west. The western aspect of these shows as "juvenile" a topography as does the eastern fall if one allows for the fact that the base level of the western flowing streams is in the region of 2,000 feet and the east is 500 feet.

To the south of Mount Castle the divide reaches elevations of 4,000 feet (Mount Superbus is 4,493) and looks out over the low Fassifern district which has numerous trachitic and other volcanic residuals rising from it, up to over 4,000 feet in the case of Mount Barney, and over 3,000 in Mount Maroon. Mount Lindesay, on the Macpherson Range about midway between the Main Range and the plateau of the National Park which approaches 4,000 feet, is also over 4,000 feet. The mesozoic strata forming the top of the range a little to the west of Mount Lindesay have elevations of from 1,450 to 1,850 feet as observed by Morton.

Mt. Flinders Area.—Between the Fassifern and the Beaudesert districts, both consisting mainly of the Walloon strata, but containing also extensive developments of volcanic rocks, there is a range of sandstone hills rising up to 1,500 feet at Mount Joyce. These are on an anticline which has brought up the Bundamba Sandstone, the division stratigraphically next below the Walloon Series. This belt of high sandstone country extends north to the trachyte peak of Mount

Flinders (2,223 feet) and to the vicinity of Ipswich and Bundamba, where it gives place to the Ipswich Measures on a lower stratigraphic horizon. The Teviot Brook runs across this anticline from the comparatively open Fassifern district through the hills to join the Logan in the Beaudesert district.

As we travel north the western limb of the anticline steepens until it becomes the great fault which passes immediately to the west of Ipswich, separating the Ipswich from the Walloon strata, and continues northward as already referred to in relation to the course of the Upper Brisbane. It is very noticeable at Ipswich how the Bremer with its tributaries Warril and Purga Creeks have wide valleys with extensive alluvial flats, but immediately the fault is crossed the valley is narrow. The Lockyer also has a very wide valley with extensive alluvium much wider than that of the Brisbane which it joins and which is situated more or less on the fault line.

The different character of the valleys of these streams when they meet this line suggests some comparatively recent relative movement along the line, for the Ipswich Measures are not particularly resistant where the Bremer passes into them though forming hilly country up to 250 feet, while the wide alluvium west of the fault suggests some retardation in the drainage. The Bundamba sandstone is often a very resistant rock and differential denudation could account for the hills of the anticline as compared with the Beaudesert and Fassifern districts. For instance there are sandstone hills in the Birnam Range north of Beaudesert up to 800 feet and this is not on the anticline. Further, the geological structure shows that a very great thickness of sandstone has been denuded away from the top of the anticline. However, allowing as we must that differential denudation could account for all, and almost certainly does account for the greater part of the difference in elevation, there remains a strong suspicion that part may be directly due to a comparatively recent relative movement, so slow as not to disturb the Teviot.

National Park-Tambourine Mountain.—Attaining its greatest elevation, nearly 4,000 feet, at the border, where it falls away in precipices on the New South Wales side the basaltic plateau extends northwards to Tambourine (1,800 feet), though dissected by the streams into long finger-like projections and isolated fragments. It has plainly all been part of the one plateau. As there is a thickness of some 800 feet of basalt at its northmost point and along the western side of Tambourine, it is certain that the area covered by basalt was formerly much more extensive. On the eastern side the main plateau is separated from the smaller Springbrook by the valley of Nerang River with a low gap of not more than 1,000 feet at its head. On the western side, where overlying the mesozoic sediments the plateau remnants stand up in bold precipices.

Southern Schist Area.—At Tambourine Mountain the country on the eastern side is composed of hard greywackes which form ranges up to only a few hundred feet less than Tambourine itself. Now the contrast between the mountain and the wide valley of the Canungra and Albert on its western side is clearly the result of differential weathering for we see the same contrast on either side of the Canungra further up its course, and in various other streams running on sandstone between basalt capped remnants of the plateau, the only difference being that there is basalt capping on one side of the valley only. Further, this contrast in elevation cannot be due to relative movement for the basalt is not faulted down on the lower side. If now we consider that the basalt covers, at an elevation of 1,000 feet or more, sandstones, rhyolite and greywackes, and that its upper surface is more or less level, we must realise that the relative elevation of the greywacke and the sandstone where not covered by basalt must necessarily also be due to differential denudation and cannot be due to any differential movement.

The greywackes form part of the Brisbane Schist Series of which there is a large area extending from the border at Point Danger nearly to Brisbane. There is great variation in the nature of the contained rocks, some of which as near Tambourine Mountain are very resistant and form mountainous or hilly country. On the whole there is a marked contrast between the schist country and the mesozoic rocks. That this definitely is due to differential denudation and not to relative movement is proved by Tambourine Mountain.

North of the Logan River some of the schist is sandy and weathers into country not very dissimilar to that occupied by sandstone in the vicinity. Near Brisbane is a narrow neck of mesozoic (Ipswich) strata connecting the inland area with that extending along the coast. North of this narrow neck the schists occur again, forming the hills in and about Brisbane and the block of the D'Aguilar Range.

D' Aguilar Block.—This D'Aguilar Block consists of hilly or mountainous country, some 15 miles wide with elevations reaching up to 2,400 feet. It includes several granitic intrusions. These are mostly deeply weathered, and they form, or tend to form areas of mild relief, miniature peneplains surrounded by a sea of schist hills. Of these the Samford Basin, some six miles by four, with an elevation of 200 to 300 feet and surrounded by hills of from 600 to 1,800 feet in elevation, is probably the best example.

On Mount Glorious, almost the highest point of the range, there is a small area of basalt.

Further north is Mount Mee, a tableland of schist 1,500 feet in elevation with some basalt on it. It is about 12 miles long and several miles wide. Mounts Byron and Archer appear to be outlying remnants of the same tableland. North again, across the Stanley valley at Woodford the Belthorpe Range, a southern or south-western extension of the Blackall Range tableland suggests that these were part of the same tableland, now separated by the Stanley. On its eastern side at least the Blackall Range is of basalt capping mesozoic strata, the junction with the more ancient rocks passing under the basalt. With the western side of the tableland I am not acquainted.

The Blackall Range, Mount Mee, Mount Archer and Mount Byron, all about the same level, the two former several miles in length and breadth, appear to be parts of one formerly continuous plateau. Whether this was a plain of sub-aerial or marine denudation there is nothing to show. Part being schist and part basalt would suggest that it was formed after the basalt flow.

At Mount Glorious the D'Aguilar divide is not so narrow as elsewhere, though it can hardly be called a tableland. This greater width however, and especially the presence of basalt is suggestive of it also being a remnant of the old land surface which has been raised higher than Mount Mee. If we look at the summits of the D'Aguilar Range from certain parts of the southern suburbs of Brisbane we see what appear to be various flat topped mountains all coming up to the same plane which descends to earth so to speak at the observer's eye. The impression conveyed that they were all part of the same old peneplain is very striking. The summits are not really flat, but more or less horizontal ridges, giving the mountains totally different appearances as seen from different directions. The suggestion that they represent the old land surface, inclined downwards towards the south is very attractive, but numerous difficulties appear when we examine into it, and accentuate the caution required in interpreting such visual impressions.

The mountain tops are mostly narrow ridges, more or less horizontal. Physically it is not difficult to understand remnants of a plateau remaining, not yet dissected. It is however very hard to picture the plateau being dissected to a long narrow ridge, the crest of the ridge still representing the old land surface, while all the rest had been denuded away. While no doubt it is possible, it seems unlikely. Now there is a marked tendency in the schist country for the formation of long leading spurs to the higher points and long horizontal ridges where not leading up to anything. These are plainly the result of some physical control and occur between the higher mountains, as well as elsewhere, in places where they could, as well as where they could not, be interpreted as old denudational levels. The higher mountains may well be something of the same sort on a higher scale.

It is so easy to see in the landscape old surface levels, like seeing pictures in the fire, and so difficult to remove or disprove the impression once our minds are biassed to the idea, that we need to be extremely cautious. Nevertheless one has the feeling, not strictly justified, that some of the higher points like Mount O'Reilly and Mount Nebo represent something near the old land surface, in addition to Mount Glorious.

This does not however in any way imply that there has been a differential movement such as block-faulting between the higher ground of the schist block and the lower mesozoic strata around it. We have seen how the schist hills near Tambourine Mountain definitely cannot be due to differential movement and one must look for the same indications in the similar if more extensive D'Aguilar Block. When we do, we find it with equal plainness. As mentioned, there are several areas of deep-weathered granitic rocks within the schist block. The Samford Basin, a miniature peneplain surrounded by schist hills, as well as the other smaller areas, obviously owe their low level and low relief to their weathering character as compared with the mountainous country surrounding them. If these enclosed areas have weathered thus to a low level we must realise that the soft mesozoic strata outside the schist area would do the same.

If we go further north to the Stanley, which crosses the schist block in a fully graded valley, flanked by high ground of 1,500 feet or more, we find the river at Woodford on an area of the deeply weathered granite while further up it is on mesozoic sandstones. On both these the relief is very low, and the river has wide alluvial flats. It is separated by the low escarpment of the D'Aguilar divide (it is hardly a range here), from similar country of low relief on the coastal side.

Jensen thought that the Woodford area represented an elevated Tertiary peneplain, but he could not have been familiar with the similar granite areas entirely surrounded by mountains.

The low escarpment between the two fully graded drainage systems is a divide scarp, such as W. M. Davis has pointed out would result through the longer stream having a higher local base level than the shorter. Actually from the low escarpment rises the trachyte plug, Beerwah, the highest (1,700 feet) of the Glasshouse Mountains, the remainder of which rise from the lower coastal plain. This escarpment is the low part of the D'Aguilar divide plainly lowered at least 1,000 feet by differential weathering and forming almost the ideal natural experiment in differential migration.

After leaving the Woodford "peneplain" and traversing the schist block, the Stanley, near Kilcoy, gets on to tilted strata of the Esk Series (Lower Triassic) which have been intruded at Mount Brisbane by granitic rocks. Here, as previously mentioned, the Stanley meanders into a gorge through the upstanding harder rock, which a similar meander in the opposite direction would have avoided. It is evident that the Stanley must have lowered its bed from an elevation higher than the lower side of the gorge (about 1,000 feet) and probably higher than the higher side, Mount Brisbane, 2,300 feet. The low divide escarpment has an elevation about 500 feet so that the Stanley Gorge is further evidence, were it needed, that the low level is due to denudation. Had it been due to any tectonic lowering of the Woodford "peneplain" the water would necessarily have made exit over the low divide. A similar difficulty would occur on Jensen's idea of it being a raised peneplain lifted from near sea level.

Evidence of Peneplanation.

Having referred now to the drainage systems and the land-form in a very imperfect and scattered manner because of the imperfect and scattered nature of the observations of an area which should have close, consistent and continuous study, we may consider whether we are in a position to make any general interpretations therefrom. Our first attention must be as to the existence or otherwise of the Tertiary peneplain and its "Kosciusko Uplift" which seem to form almost part of the creed of our southern neighbours. In giving this our attention we must keep our minds quite clear as to whether the peneplain was the surface on which the volcanic rocks were poured out or whether it was a surface reduced by denudation subsequent to the volcanic extrusions. If the latter, was it after the first, second or third of the divisions into which Richards has classified them, he regarding them as being of Lower, Middle and Upper Cainozoic age respectively.

Andrews, the author of the peneplain hypothesis, thought it was late Tertiary. If that is correct, and Richards is correct, the peneplanation must have occurred at least subsequent to the extrusion of the second division. This of course profoundly affects our enquiry for it would at once put out of count any evidence from the base levels of the lower basalt flows. Such evidence might be of value in relation to questions of block-faulting as showing that the faulting had not taken place, but on the other hand the occurrence at different levels would not necessarily mean faulting, for it might have been due to an uneven surface.

We have further the difficulty of deciding in any particular place as to whether the basalt is of the first or the third division. We know that both the first and second division rocks suffered movement as well as denudation prior to the effusion of the third division, for Morton has recorded basalt flows at Widgee Creek tilted with the mesozoic strata, while at Christmas Creek there is a rock mainly of pyroclastic materials both rhyolitic and basaltic, containing some waterworn pebbles, which in one place has a vertical dip. Morton pointed out that the upper parts of the basalt of the plateau did not seem to have been affected by the disturbance.

If we regard the surface on which the third division was poured out as being the peneplain, we must remember that according to Richards a common thickness of the third division was 2,000 feet. Remembering this, we can realise that the topography before that great effusion could have little in common with the present topography in which the remnants of that effusion play so large a part. Add to this both Reid's and Morton's opinions that the surface on which the basalts flowed (presumably the first division) was very uneven and it will be appreciated how unsatisfactory the position is, and how impossible, on the present information, to make any claim of evidence for a peneplain at any stage.

We do not know at what period sedimentation ceased and denudation began or to what extent denudation and the movements indicated by the faulting and folding of the strata were concurrent. We know that some movements went on after some of the vulcanicity and after the formation of the tertiary sediments near Ipswich and Brisbane, involving the basalt associated therewith while there is a flow, apparently of the same basalt, on the denuded outcrop of the great West Ipswich Fault. The basalt associated with these tertiary sediments has been met in boring at a depth of 800 feet below sea level at Bundamba and Wellington Point !

The physiographical history as well as the present topography over great part of the area we are dealing with, is so inextricably mixed up with the volcanic phenomena that it is necessary to deal with the problem they present at some length. The more we know of them the more complicated do they become. Very varied views have been held as to their age or ages both by different writers and even by the same writers. Both R. A. Wearne and the present writer followed Rands and Jack in regarding part at least of the vulcanicity as contemporaneous with the mesozoic strata. Gregory, Skertchly, Jensen and Andrews regarded them all as of Tertiary age (excluding the Brisbane Tuff underlying the Ipswich Measures and certain rocks north of the area we are dealing with which Jensen regarded as mesozoic). Richards in 1916 made a more extensive and connected examination than any of the previous writers and came to the conclusion that excepting the Brisbane Tuff all the volcanic rocks are of Tertiary age and none mesozoic. He showed three divisions in the volcanic rocks, an upper and lower basaltic, and an intermediate acid or sub-acid.

Since that time work in the Esk district has shown contemporaneous andesitic and trachytic rocks in the Lower Esk Series though both Richards and Miss Hill disagree with Reid and Morton in regard to other trachytes in the district which the latter consider to be mesozoic and the former consider to be Tertiary.

Since Richards wrote his paper we have also become aware of pebbles of igneous rocks in the mesozoic sandstone at Caloundra and in what is probably mesozoic sandstone at Deception Bay. These serve to show with what caution the question of the age of any particular rock must be approached and there seems little doubt that much further work is needed before the relationship of the various igneous rocks to one another and to the mesozoic sediments is fully understood.

For instance Richards' section through Tambourine Mountain does not convey the correct relationship of the rhyolite to the schist and sandstone, between which it occurs in a belt running apparently also under the basalt of Beechmont and across the Nerang Valley to Springbrook, all three rocks occurring in the river beds as well as high up the mountain sides, and all three capped by basalt. It is hoped that further work will elucidate this relationship at present unintelligible.

In their present topographic aspect, as was pointed out by the writer in 1910, there is a great distinction between the basalts forming the cappings of mountains and that associated with the Cainozoic sediments near Ipswich and Brisbane and fringing Moreton Bay. Though in certain localities this forms low hills it mostly is at a low level with higher mesozoic rocks in the vicinity. As mentioned, bores have shown it to extend 800 feet below sea level in two places. A bore at Nundah in a valley surrounded on three sides by hills of mesozoic strata, passed through 40 feet of it down to about 70 feet below sea level. At Manly it surrounds on three sides hills of mesozoic strata as if it had flooded around them. To the writer this seems to indicate a very much more recent age than those rocks which have weathered up into mountains showing denudation of thousands of feet.

On the other hand the tertiary sediments with which these low lying basalts are associated do not give the impression of being particularly recent and the faulting they have been subjected to in places does not show itself in the present topography. They are however very soft and would be rapidly denuded. The occurrence of these tertiary beds, their level and distribution also have a serious bearing on the question of the peneplain, as they have on its elevation or otherwise.

From Bundamba to Oxley they are near the present course of the Brisbane River, and occurring elsewhere mostly in low ground and along the margin of Moreton Bay, suggest having had some association with a drainage which may not have been vastly different from the present though certainly not closely identical with the present course of the river. There is a considerable difficulty in regard to the significance of the great depth, 800 feet, below sea level which the bores at Bundamba and Wellington Point have demonstrated. There is no geological reason to suppose that these areas are faulted sunken blocks which have resulted in the preservation of these strata, formerly more extensive. They may have been sunken areas subsequently filled in by sedimentation, or they may have been valleys in an extremely youthful topography. If the latter is the explanation we must bear in mind that the deep valley at Bundamba is separated from the Wellington Point occurrence by the older rocks. The position is far from clear and their relationship in time to the other volcanic rocks also requires clarifying. Lithologically the sediments do not suggest derivation from the denudation of basaltic areas.

Whatever may eventually be shown as to the occurrence of these areas of Tertiary sediments and as to their age, and the distribution of the associated doleritic basalt, the present knowledge of them does not accord with the peneplain hypothesis.

Supposed Tertiary Uplift.

The question of the supposed "Kosciusko" uplift or any other general uplift whether with or without previous peneplanation naturally comes into consideration with these Tertiary sediments for very plainly they have not been affected by any uplift but have been actually depressed.

In dealing with the question of uplift, before we can regard any area as having been raised we must know what the previous level was. We know that the area now occupied by mesozoic rocks was a fresh-water basin undergoing sedimentation at least into the Jurassic period. There are no Cretaceous strata, such as occur in Western Queensland, or to the north in the Maryborough district. Being an inland basin we do not know at what level the basin was, but the probability is that it was not far from sea level. Nor do we know when the change took place from sedimentation to denudation.

What we do know from the geological structure is that there has been an enormous amount of denudation of the mesozoic sediments amounting to several thousands of feet in those parts where the lower beds are now exposed. We also know from the volcanic rocks, particularly the trachyte plugs which are generally accepted as being the pipes or cores of former volcanoes, that several thousands of feet of surrounding strata or volcanic debris have been denuded away even from above the Jurassic strata now exposed. That there has been uplift to expose these rocks to denudation is abundantly clear, apart from the improbability of their being deposited in an elevated basin. That of course applies to any sediments now above sea level. What we do not know is to what extent denudation may have been taking place in some part of our area while sedimentation was in progress elsewhere, nor to what extent in post-Jurassic time denudation was concurrent with the earth movements indicated now by the faulting and folding of the strata. That is to say that while we may reasonably presume that the sediments having now the highest elevation were raised at least to that amount, we do not know how much higher at any time their surface had been—that would depend on the rate of denudation compared with the rate of movement, which may or may not have been very slow.

Volcanic rocks such as constitute a large part of the greater elevations are themselves no indication of elevation as they may have been extruded on the surface at any level.

The greatest heights at which sedimentary rocks occur are of the following order :—

Brisbane Schists	in the D'Aguilar Range	2,400	feet.
,, ,,	near Tambourine Mt.	1,600	,,
Carboniferous	—Mt. Barney	2,000	,,
Mesozoic	Tambourine Mountain	1,000	,,
Mesozoic near	Mount Lindesay ..	1,850	feet
,, near	Wilson's Peak ..	2,200	,,
,,	Ma Ma	1,700	,,
,,	Mount Joyce ..	1,500	,,
,,	Mount Hallen ..	1,270	,,
,,	Crow's Nest	2,400	,,

Apart from the general question of uplift and the period at which it occurred some writers have maintained that a relative movement or block faulting occurred which has left its mark on the present topography in the Main Range in the region of Cunningham's Gap. This view was first put forward by Wearne and Woolnough in 1911 who considered there had been a peneplain in Cainozoic times which suffered two distinct faulting movements, the first of 2,000 feet and the second of 2,700 feet. The first resulted in the Lockyer Block and the second produced the Fassifern Block. The Main Range at Cunningham's Gap was held to be a fault-scarp, a view with which Richards expressed general agreement and seems to have been widely accepted until Reid examined the solid geology of the district and disagreed entirely with the evidence of any serious block-faulting. His view was based largely on the levels of the bases of the lava flows, particularly in the part which Wearne had termed the Lockyer Block. His sections seem incontrovertible, and this part not having the marked appearance of faulting, it is doubtful if any one now would maintain its existence. Reid's evidence in regard to Cunningham's Gap region seems to the writer equally inescapable, but here there is the picture-book appearance of a fault-scarp and many physiographers seem inclined to believe the appearance rather than the evidence of solid geology provided by Reid, evidence which one would have otherwise expected to render further discussion unnecessary. It is therefore necessary to refer to it to make the position clear for the purpose of this paper. The Main Range here forms a bold escarpment, on the very edge of which the divide is situated. It runs at elevations of 4,000 feet and more on the peaks and 2,000 feet or more in the gaps, looking out over the low Fassifern district of about 500 feet. Above a certain height the Main Range is composed of basalt and other volcanic rocks. Below that are the Mesozoic strata, mainly sandstone, which also constitute largely the Fassifern district. There are also extensive occurrences of basic volcanic rocks in the lower country as well as numerous upstanding trachytic plugs of which Mount Edwards and Mount Greville are good examples and occur only a few miles in front of the escarpment.

Over the sandstone in the Main Range there is a thickness of some 3,000 feet of volcanic rock. Reid pointed out that quite apart from not being able in the field to find any section showing the fault it was clear that the volcanic rocks had not been faulted down for the sandstones underlying them are exposed on the eastern or downthrow side of the alleged fault. This is of course a simple problem in stratigraphical geology of which the elementary test has always been the ability to draw an intelligible section. We must also remember that the fault-scarp alleged is of the order of 3,000 feet. It is not a little curious that Richards who in his text agreed with the faulting hypothesis published a section which does not show the fault. It is plainly necessary for anyone upholding the hypothesis to draw a section showing what has happened to the 3,000 feet of volcanic material on the eastern side of the 3,000 feet fault.

In addition to this very definite geological evidence against the fault interpretation there is also physiographical evidence, little less definite. Reynolds Creek, rising in the Main Range runs a very consistent course throughout its journey to join Warril Creek and the Bremer River. After about 12 miles in moderately hilly country it comes to Mount Edwards, a trachyte mass situated right in its path. This it cuts through in a narrow gorge. So little effect does a trachyte mountain 2,300 feet high have on the course of the creek that one could not pick out the position of the gorge on a map which did not indicate the mountain.

It is plain that the mountain is a residual and owes its present contrast with the surrounding country to differential weathering for it could scarcely be seriously suggested that it was thrust up through the strata so slowly as not to divert the creek. It is I think accepted that these trachyte plugs were the cores, if not the pipes of some sort of volcano, and we know that the hard trachyte is very resistant to weathering. Whether as a volcano, or as subsequently denuded, we can quite confidently say that the trachyte would not form a valley, but a prominence. Yet we know that when Reynolds Creek started its career it must have started in a depression of some sort. For it to have started its regular course in the position it has it is clear that the trachyte, be it volcano or core, must have been covered by some subsequent deposit. We are not aware of any sedimentary deposits that could have done this, but we do know that basalts cover the acidic rocks in the Main Range and other places. If physiographic reasoning has any value, we are in a position to say with considerable confidence that Reynolds Creek started its career on the top of the basalt flows, which extended (as would be expected from their thickness) much further east than their present limit. As denudation proceeded the trachyte became exposed.

The present level of Mount Edwards is comparable with that of the gaps in the Main Range. Reynolds Creek has certainly lowered itself by this amount, and probably much more, merely by denudation, so that faulting would require that originally Reynolds Creek was higher than the present western drainage by at least the amount of the fault.

The most important evidence put forward by its advocates in favour of the fault hypothesis has been the appearance of the scarp and the air gaps. In regard to the first, if we follow the range to the south towards Wilson's Peak there are high mountains to the east of it, and the appearance is very much less like faulting than ordinary denudational effects. Indeed we get mountains approaching or exceeding 4,000 feet east to the National Park. If we follow the Main Range north we find Mount Castle standing out somewhat in front of the line. From this on everyone seems to have regarded the Little Liverpool Range as the continuation of the scarp, but to the west of it, separated by the narrow Laidley Creek valley, Mount Mistake tableland is much higher than the Little Liverpool and from the east looks as if it is the Main Range, for which it was at one time mistaken.

From Mount Mistake one looks across the narrow ridge of the Little Liverpool and sees further out a similar but much lower divide from which rises the Mount Walker residual and which also radiates from Mount Castle. They give the impression of being, and are most simply interpreted as the result of different stages of denudation.

Certainly the alleged fault-scarp is straight, but other causes than faulting can produce a straight scarp, and one of these is a straight divide. When as in the present case the streams on one side have a much lower base level than on the other, a level below the base of the volcanic rocks there is not wanting a physical reason for the great difference in the amount of denudation on the two sides of the divide.

Besides the appearance of a scarp, the " air gaps " have greatly influenced physiographers in favour of the fault hypothesis. Text book descriptions of air gaps with inferences as to former stream courses through them seem part of the orthodox physiographical teaching and appear to have influenced the physiographers so that they have not really discussed these particular gaps on their own merits. One would not of course suggest that air gaps are not often disused river valleys, but there are other explanations possible in many cases as in the present instance.

We have a series of parallel streams flowing westward from the edge of the divide scarp. These have cut down their valleys leaving high ridges between them, ridges which run up to the scarp and around the heads of the valleys. As denudation progresses the ridges also get lowered, according to the slope of the valley sides and the branch gullies joining from the sides of the intervening ridges. The slope depends on the depth to which the stream is cut and this on the power of the stream. In other words the depth to which the valley is cut depends on the area draining into the stream at that point and on the nature of the rock. The area depends again on the width of the valley.

These factors must decide whether the intervening ridges or the ridge round the head of the stream, that is the main divide, will first be lowered and the extent of the difference. When we remember that the main divide in this instance is such a high escarpment on the other side of it the reduction of the divide into " gaps " at the heads of some of the streams is only what would be expected. There does not seem to be the slightest ground for " postulating " a former river.

Coastal Movements.

In the coastal part of the area we get some evidence of changes in elevation relative to the sea. Moreton and Stradbroke Islands, consisting almost entirely of wonderful ranges of sand dunes, up to 900 feet in height, only have a bearing on the question by virtue of the few small occurrences of solid rock, at Cape Moreton, Dunwich, Point Lookout and Canaipa. These with the other islands inside the Bay indicate that Moreton Bay is the result of a drowning of a former valley. The great distance from their mouths to which the tidal waters extends also suggests a sinking. The Bremer, for instance, is tidal at Ipswich some 60 miles by water from the sea, and the foundations of the new bridge in Brisbane showed rock bottom to be about 100 feet below water level. This would hardly be expected in the ordinary development of a river out of solid rock, whatever might happen in alluvium.

A well-marked terrace occurs along most of the stream suggesting that the most recent movement has been a slight uplift, of about 20 feet. One would however have expected this to show up around the shores of the Bay in the form of wave-cut platforms. Not doing so, the meaning of the terraces must still remain in doubt.

Conclusions.

These observations are inadequate to piece together into any sort of connected story what seems to have been a very complicated physiographical history. We may however summarise the little that is ascertainable while hoping that further work will elucidate more.

The present drainage system, or the present "cycle" of erosion appears to have originated, at least in the south, west and north-east on the surface of basaltic flows which probably covered the greater part of the area. This surface may have been a peneplain, reduced thereto by denudation, or it may have been a lava plain, the latter being the more probable. That it was probably a fairly even surface is shown by the regularity of the streams in maintaining their general directions in certain groups away from the divides. Whether this regularity of the streams and divides is due to volcanic action or to subsequent tectonic warping is not clear but the latter seems more likely in the Main Range and in the D'Aguilar Range is almost certain

In the southern and western part of the area there is no evidence at all of the alleged Tertiary peneplain, in fact any evidence we have is against its existence.

The Blackall Range and Mount Mee appear to be remnants of a peneplain formed after the lava flow. Mount Glorious and other summits of the D'Aguilar Range may also be remnants of the same old land surface, raised to different elevations. The age and former extension of this is quite unknown, or the elevation at which it was formed and the reason for its survival. Much information is required before any opinion can be formed.

The D'Aguilar-Blackall divide formed the axis of an anticlinal or monoclinal warp down the eastern slope of which a well-marked group of streams resulted.

The upper Brisbane River appears to have had its course determined by a new movement along an old fault line, for it is the depression into which the streams flow at right angles from the straight ridge on the basalt forming the Main Divide.

The lower Brisbane also seems to have had some relationship with the structural geology, namely the boundary of the schists and Ipswich formations. The nature of it is not clear and may be a mere coincidence.

All the other streams and the divides seem to have no relationship to the pre-volcanic geology.

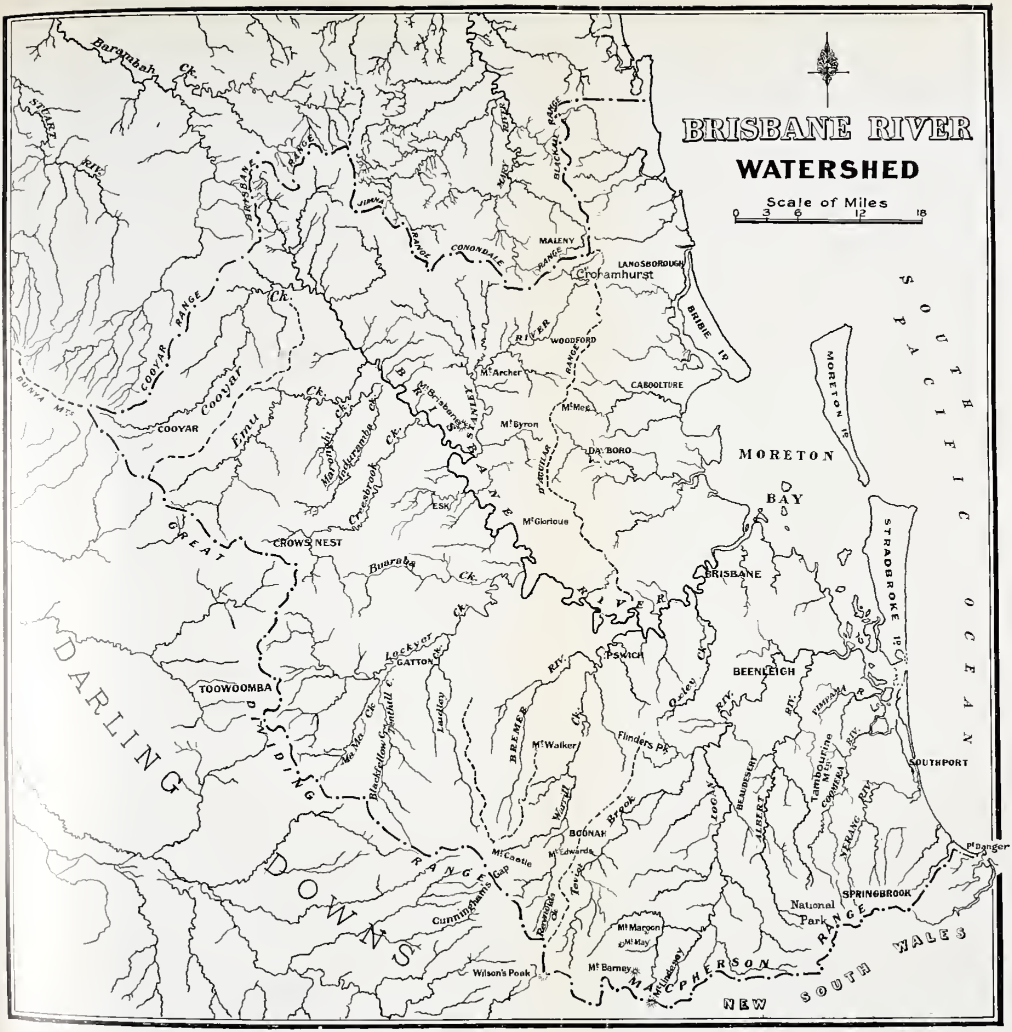
Differential denudation is very marked throughout the area and entirely over-rides any suggestions of relative movement except of a minor nature. It accounts for, or can account for, all the major differences. The alleged block-faulting at the Main Range is definitely discounted.

That elevation has taken place is indicated by the present heights at which sedimentary rocks are found. There is nothing to indicate what the height was at any time in the complicated history of faulting, folding, vulcanism and denudation prior to the effusion of the upper basalts, nor indication of subsequent elevation for that reason.

On the other hand there has been a depression at least in the coastal region, apart from the significance (not yet clearly understood) of the occurrence of basalts in two bores to a depth of 800 feet below sea level.

In trying to collect together in one purview the results of incomplete and scattered observations and ideas, full and free use has been made of previous publications other than those referred to in the text.

The writer desires to thank Professor H. C. Richards and Dr. W. H. Bryan for their interest and suggested modifications.


BRISBANE RIVER
WATERSHED
Scale of Miles
0 3 6 12 18
SOUTH PACIFIC OCEAN
MORETON BAY
MORETON Is.
STRADBROKE Is.
BRIBIE Is.
DARLING DOWNS
GREAT DIVIDING RANGE
MACPHERSON RANGE
NEW SOUTH WALES
BRISBANE
IPSWICH
TOOWOOMBA
CROWS NEST
GATTON
ESK
COOYAR
CABOOLTURE
DAYBORO
WOODFORD
MALENY
LANDSBOROUGH
Crohamhurst
BEENLEIGH
SOUTHPORT
BOONAH
SPRINGBROOK
National Park
Cunningham's Gap
Wilson's Peak
Pt. Danger
Mt. Archer
Mt. Brisbane
Mt. Byron
Mt. Mee
Mt. Glorious
Mt. Walker
Mt. Castle
Mt. Edwards
Mt. Maroon
Mt. May
Mt. Barney
Mt. Lindesay
Flinders Pk.
Tambourine Mtn.
BRISBANE RIVER
STANLEY
BREMER RIV.
LOGAN
ALBERT
COOMERA
NERANG
PIMPAMA R.
BARAMBAH Ck.
STUART RIV.
BUNYA Mts.
COOYAR RANGE
Cooyar Ck.
Emu Ck.
Cressbrook Ck.
Buaraba Ck.
Lockyer Ck.
Oxley Ck.
Warrill Ck.
Teviot Brook
Reynolds Ck.
Laidley
Ma Ma Ck.
Blackfellow Ck.
Tenthill C.
BRISBANE RANGE
JIMNA RANGE
CONONDALE RANGE
BLACKALL RANGE
MARY RIVER
D'AGUILAR RANGE
BEAUDESERT

Essential Oils from the Queensland Flora.

PART V.—ERIOSTEMON GLASSHOUSIENSIS.

By T. G. H. JONES, D.Sc., A.A.C.I.

(*Tabled before the Royal Society of Queensland, 28th November*, 1932).

Eriostemon glasshousiensis is a small rutaceous shrub growing on some of the higher parts of the Glasshouse Mountains, South-eastern Queensland, and so far has not been collected in any other locality. Though first collected many years ago by F. M. Bailey it was not referred to by him in his Queensland Flora as it was included there under the widely distributed and rather variable *E. myoporoides* DC.

It was first described by the Czecho-Slovakian botanist Dr. K. Domin in his general work on the flora and plant geography of Australia in the Bibliotheca Botanica Vol. 89, Part III., page 840 (1926). It has sessile, oblong or oblong-lanceolate, rather thick leaves averaging about 5 cm. long and 8 cm. broad. The flowers are borne singly in the axil on peduncles about 5 mm. long. The flowers themselves are about 1 cm. in diameter.

Of previously described Australian species it comes closest to *E. intermedius* Hook., a species found in Queensland in the neighbourhood of Stanthorpe.

A small plant collected and transferred to the author's garden in Brisbane has during two years grown exceedingly well, and compares very favourably with shrubs growing in the more favoured spots on the Glasshouse Mountains.

Owing to the somewhat limited distribution of the plant and its general inaccessibility, supplies of leaves were difficult to obtain and the amount of oil, necessarily small, has not permitted of its complete examination. As, however, it is unlikely that larger supplies can be procured from the area it has been thought advisable to place on record the results obtained from examination of the small amount of oil available.

Supplies were collected mainly on Ngun Ngun Mountain, 28lbs. on 29th September, 1929, yielding 21 ccs. of oil, while 70lbs. collected on 27th April, 1930, yielded only 30 ccs. of oil. In the latter case the leaves were stripped from all the shrubs that could be found on mountain. The oil had a pleasant odour and was slightly fluorescent. The contents for both samples showed little variation and for the mixed sample were recorded as follows :—

$d_{15.5}$	.8676
n^{D}_{20}	1.4682
$[\alpha]_D$	+40
Ester Value	Nil
Acetyl Value	6

Aldehydes, phenols, and acids were absent. Forty ccs. of oil were submitted to fractional distillation at 7mms. pressure, but the greater portion of the oil (35 ccs.) distilled between 35° and 37°C. and this fraction possessed the following constants :—

$d_{15.5}$	..	..	..	..	.8646
n_{20}^{D}	..	..	..	..	1.465
$[\alpha]_D$	..	..	..	..	+45
b.p.	..	..	..	..	155-157°C.

Identity with dextro rotatory α-pinene was established by oxidation to pinonic acid (semicarbazone M.P. 204 C.) and there is no doubt that this terpene comprises from 80-90% of the oil. A small percentage of ocimene, however, appeared also to be present, although the isolation of this constituent in sufficient amount for characterisation was impossible.

The faint fluorescence of the original oil suggested the presence of methyl anthranilate, a minor constituent of the oil of *E. myoporoides*[1].

The small residue (5 ccs.) left after removal of the pinene fraction possessed a variable boiling point and no doubt contained other constituents, presumably alcoholic, in small amount.

It appears, therefore, that the essential oil of *E. glasshousiensis* consists primarily of α-pinene with minor constituents unidentified amongst which ocimene and methyl anthranilate seem very probable. There is thus resemblance to the oil of *E. myoporoides.*

The author is much indebted to Mr. M. White, M.Sc. for assistance in collecting the leaves and to Mr. C. T. White for botanical assistance.

REFERENCE.

1. Penfold, A. R., Royal Society of N.S.W., 1925, LIX., p. 206.

On the Presence of Glendonites in the Dawson Valley

By Dr. F. W. Whitehouse (Department of Geology, University of Queensland).

Plate VI., and one Text Figure.

(*Read before the Royal Society of Queensland, 28th November,* 1932).

Introduction.

In 1849 J. D. Dana[1] described from the village of Glendon in New South Wales some peculiar mineral forms that subsequently have attracted considerable attention among Australian geologists. These interesting objects later were named " Glendonites " by David and Taylor; and evidence then was advanced by David, Taylor, Woolnough and Foxall[2] to show that they were carbonate pseudomorphs after glauberite.

Glendonites now have been found on many horizons of the Permo-Carboniferous (Kamilaroi) sequence in New South Wales, and also have been described from similar beds in Tasmania. Hitherto they have not been found in Queensland; but the present record of an abundant development of glendonites in the Dawson Valley of Queensland extends considerably the geographical range of these forms.

Previous Work on Glendonites.

The very thorough work of David, Taylor, Woolnough and Foxall already quoted gives a *resume* of all literature and all views upon the subject until that date (1905). Two subsequent papers, one by Walkom[3] and the other by Brown[4], summarise later records.

Glendonites now have been obtained from many horizons and from many localities in New South Wales, all of them from beds of Permo-Carboniferous age. Always they have been found in soft, marine mudstones (usually richly fossiliferous) and almost invariably evidence has been forthcoming (by growth around shell fragments and pebbles) to show that the original mineral of the glendonites has grown in the muds and has not merely been laid down on successive bedding planes in the process of deposition.

All known glendonites are calcareous pseudomorphs, usually now in the form of calcite with a considerable quantity of iron carbonate. Crystallographic work has shown them to be pseudomorphs of a monoclinic mineral agreeing perfectly with glauberite ($Na_2SO_4.CaSO_4$). As David, Taylor, Woolnough and Foxall have pointed out the mineral glauberite has not yet been prepared by a wet process so that their occurrence in marine muds suggests some special process of formation. Many of the glendonite beds in the southern States have been shown to have been laid down under glacial or sub-glacial conditions. Thus the theory was advanced that their growth in the muds has been controlled by very cold temperature. So far no experimental work has been done and no observations have been made upon muds forming at present in polar latitudes to check this suggestion.

The Queensland Record.

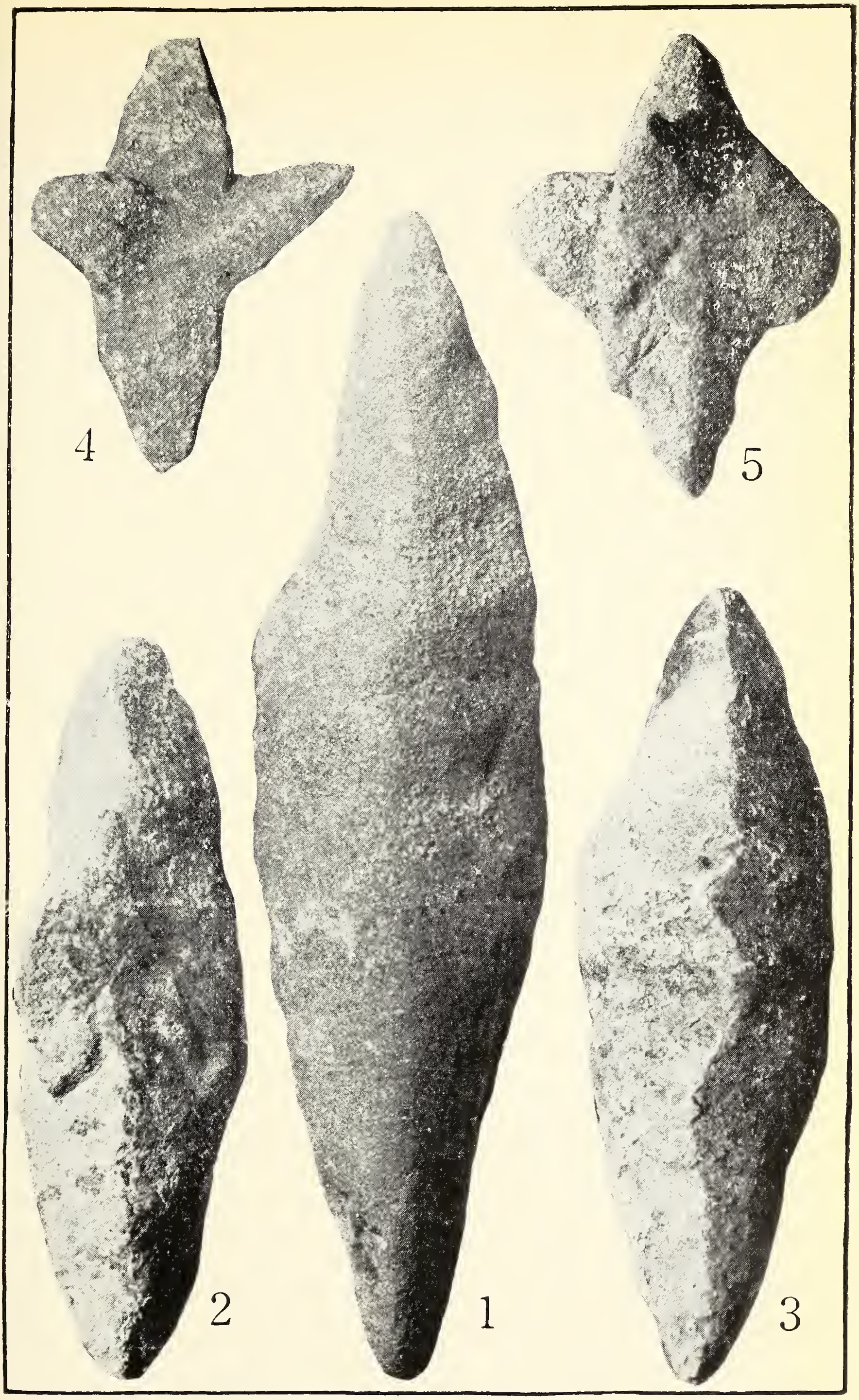
i. *Locality*: The specimens now described from Queensland were collected on the western portion of Walloon Station in the Dawson Valley, at a point nine miles N.N.E. of the centre of the township of Theodore and about one mile east of the western boundary fence of the station property. There they occur in a soft, yellowish mudstone through which the glendonites are abundantly scattered. My attention was drawn to this occurrence by Mr. J. R. May, manager of Walloon Station, and Messrs. R. and M. Sollitt, stockmen on the property.

ii. *Geology*: The rocks of Walloon Station consist of members of the Bowen Formation of Permo-Carboniferous age. The lower members form a thick series of volcanic rocks (the Lower Bowen Volcanics), consisting mainly of andesites and rhyolites, both flows and tuffs being developed. These beds strike north and south and dip at a slight but unestimated angle to the west. The latest flow was a trachyte, perhaps 300 feet in thickness, forming a very prominent ridge beside the station homestead and extending for several miles north. The eastern and lower members of this volcanic suite are intruded by granites and granodiorites.

Above the volcanic rocks lie marine fossiliferous sediments—mainly sandstone and shale of a dominantly yellowish or brownish colour. It is in the lower portion of this marine stage that the glendonites occur. With them in the bed were found species of *Trachypora*, *Spirifer* (three species) and *Plerophyllum* (?), all of the forms being species not yet described. The general aspect of this fauna rather suggests a high horizon in what recently has been called the Lower Bowen Series[5] (the *Monilopora-Taeniothaerus* faunal stage.) More fossils are needed to establish this point.

iii. *The Glendonites*: The glendonites, which are preserved in the condition of crystalline, ferruginous calcite, occur with their long axes sub-parallel or slightly inclined to the bedding planes in a bed of soft yellowish mudstone. The largest specimen collected (plate VI., fig. 1) is six inches long. The majority of the specimens are pseudomorphs of individual crystals of the usual cigar-shape. Inter-

Text-Figure 1.—Glendonites *in situ*, Walloon Station.



GLENDONITES FROM WALLOON STATION, DAWSON VALLEY.
(Figures natural size.)

penetrated groups, however, are very common (plate VI., figs. 4, 5) while parallel growths also are found (plate VI., fig. 2). They are very abundant at this locality, the concentration being approximately of the order of one or two individuals per square yard.

Some forms still retain fairly sharp angles ; but in the majority of forms these angles are rather rounded and the surface is finely pitted suggesting that a certain amount of corrosion has affected the crystals since they were formed. None of the Queensland specimens has such very sharp angles and regular faces as shown, for example, on the Husskison specimens described by David and others. Some forms, *e.g.* the specimen shown on plate VI., fig 3, develop shallow transverse flutings on the sides, in the position of the striations described by Walkom (op. cit. p. 166) on the New South Wales forms. Because of these flutings on adjacent sides the edges of such forms frequently are crenulated.

A few forms were noticed in which during growth the crystal had enveloped fragments of brachiopod shells.

iv. *General*: No evidence is available to determine the climatic conditions under which the glendonites were formed. No erratics, such as occur in many of the glendonite beds of New South Wales, were noticed in the bed. The occurrence of the glendonites at a considerable distance below the top of the marine shales agrees with the observations made by Dr. Brown (loc. cit. p. 31) upon the Ulladulla forms, and is an exception to the generalisation of David, Taylor, Woolnough and Foxall that glendonites occur usually near the top of a series of marine beds.

REFERENCES.

1. Dana, J. D. " Geology of the United States Exploring Expedition during the years 1838-1842 under the command of Charles Wilkes, U.S.N.," Quarto, New York 1849.

2. David, Taylor, Woolnough and Foxall: " Occurrence of the Pseudomorph Glendonite in New South Wales." Recs. Geol. Surv. N.S. Wales. vol. 8, 1905, pp. 161-179.

3. Walkom, A. B. " Notes on some recently discovered Occurrences of the Pseudomorph Glendonite." Proc. Linn. Soc. N.S. Wales, vol. 38, 1913, pp. 160-168.

4. Brown, Ida A. " Notes on the Occurrence of Glendonites and Glacial Erratics in Upper Marine Beds at Ulladulla, N.S.W." Proc. Linn. Soc. N.S.W. vol. 50, Pt. 2. 1925, pp. 25-31.

5. There is considerable variation in the usage of the term " Lower Bowen Series." Originally the name was intended for the volcanic rocks and interbedded sediments that form the basal members of the Permo-Carboniferous succession in the eastern limb of the great Bowen-Dawson syncline. Recently, however, there has been a tendency to make it equivalent to the beds in this basin with elements of the *Monilopora-Taenio-thaerus* fauna, some of which, as at Cracow, Theodore and Mt. Britton, occur above the volcanic stage, *i.e.*, in part of the original " Middle Bowen Series."

The Royal Society of Queensland

REPORT OF THE COUNCIL FOR 1931.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its Report for the year 1931.

Fourteen original papers were read before the Society, and published during the year. On the 25th May, Dr. T. G. H. Jones delivered a short lecture on "Essential Oils"; on the 29th June, Mr. F. W. Moorhouse gave an address on "Recent Marine Biological Work on the Barrier Reef"; on the 31st August the evening was devoted to the celebration of the Michael Faraday centenary, addresses being given by Mr. H. A. Longman, Prof. T. Parnell, Prof. L. S. Bagster, and Mr. J. S. Just; on the 26th October, a lecture was given by Dr. F. W. Whitehouse on "Some Problems of Queensland Palaeo-botany."

The Council wishes to express its appreciation to the University of Queensland for housing the library and providing accommodation for meetings.

Again the Council reminds members that the Government subsidy has been withdrawn, and that the only source of income is from subscriptions. Practically the whole of this income is utilised in the publication and distribution of the Proceedings. At a time like this there is a tendency for members to meet a dwindling private income by dropping their subscription. Fortunately, so far, only a few have felt this course to be necessary, and we trust that few others will follow suit. There are many people in Queensland, who, if they knew of the need for help towards publishing in Queensland the scientific work of Queenslanders, would readily assist by giving the small annual subsidy which we ask for membership. Your Council trusts that all members, realising the difficult position the Society is in, will strive during this 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.

During the year the Soil Investigation Committee held a number of meetings, and decided upon a plan of action. In accordance with this plan, the Committee is endeavouring, in the first place, to collate the data already existant on Queensland soils. To facilitate this, a deputation waited on the Under Secretary of the Department of Agriculture and Stock, and brought before his notice a scheme drawn up by the Committee of converting the present departmental records into a more readily available form. After due consideration, the Minister for Agriculture and Stock has given his general approval to the scheme, which should prove mutually advantageous to the Department concerned and the Soil Investigation Committee.

The work of arranging the Library was continued during the year. The progress made in this direction is due to the labours of Dr. Bryan, Mr. Hitchcock, Mr. Perkins, Dr. Herbert and Mr. Hines, each of whom devoted a considerable amount of time to a section of the Library. Dr. Bryan has in hand the American publications, and it is pleasing to report that the very large number of these publications is now almost in order. This has entailed a large amount of concentrated work on Dr. Bryan's part. In the Asiatic section, Mr. Hitchcock's work is evident from the large number of periodicals which he has arranged. Mr. Perkins and Dr. Herbert have the Australian portion well in hand, and Mr. Hines has arranged the English periodicals.

It is to be hoped that these gentlemen can be prevailed upon to continue their valuable work in the present year, although it is recognised that it entails the sacrifice of much time on their part.

Among the acquisitions during the year is a complete set of the Reports of the Princeton University Expeditions to Patagonia. These were obtained in exchange for a set of our Proceedings. Numerous requests from libraries abroad for missing numbers of our Proceedings have been attended to.

The Society is indebted to the Assistant Librarian of the University, Miss McIver, for superintending the lending of periodicals from the Library.

The membership roll consists of 4 corresponding members, 7 life members, 172 ordinary members, and 2 associate members. During the year there were 6 resignations, four names were removed from the list under Rule 13, and sixteen new members were elected. It is with deep regret that the death is reported of Prof. H. J. Priestley, M.A., a past president of the Society, and Hon. Auditor for many years ; and of Mr. C. W. Bundock, B.A., one of the oldest members of the Society.

There were ten meetings of the Council during the year, the attendance being as follows :—E. W. Bick, 10 ; W. H. Bryan, 8 ; R. W. Cilento, 0 ; W. D. Francis, 6 ; J. B. Henderson, 4 ; D. A. Herbert, 10 ; T. G. H. Jones, 7 ; J. S. Just, 2 ; H. A. Longman, 2 ; E. O. Marks, 9 ; F. A. Perkins, 9 ; H. C. Richards, 7 ; and C. T. White, 8.

D. A. HERBERT, President.

F. A. PERKINS, Hon. Secretary.

THE ROYAL SOCIETY OF QUEENSLAND

Cr. STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDING 31st DECEMBER, 1931. Dr.

Receipts	£	s.	d.	Expenditure	£	s.	d.
Balance at 31st December, 1930	55	19	4	H. Pole & Co., Printing Volume, Part Cost	75	2	7
Subscriptions	131	5	0	H. Pole & Co., Printing Abstracts and Cost of Blocks	5	12	5
Sales, Reprints, Volumes, Etc.	31	12	4	Government Printer, Annual Report and Abstracts	3	3	11
Bank Interest at 30th June, 1931	2	3	3	Briggs & Co., Printing 1,000 Circulars	1	13	0
Exchanges	0	5	2	Hon. Secretary, Postages	12	0	0
				Hon. Librarian, Postages	2	0	0
				Hon. Treasurer, Postages	1	0	0
				State Government Insurance	0	13	0
				Exchanges and Stamps	0	2	2
				Cash in Hand	2	2	0
				Balance in Commonwealth Bank, 31st December, 1931	117	16	0
	£221	5	1		£221	5	1

NOTE.—£15 of Balance is allotted to Bookbinding Account of Library, also a further payment has to be made for Volume of Proceedings, 1931.

Checked with books and found correct.

JOHN S. JUST,
Acting Hon. Auditor.

E. W. BICK,
Hon. Treasurer.

1st March, 1932.

Abstract of Proceedings, 29th March, 1932.

The Annual Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Tuesday, 29th March, 1932. The President, Dr. D. A. Herbert, occupied the chair and about thirty members and visitors were present. Apologies for absence were received from His Excellency the Governor, Professors Goddard and Lowson, and Mr. Kyle. The minutes of the previous meeting were read and confirmed. The following were proposed for ordinary membership :—Mr. E. L. D. White, B.E., by Messrs. Hines and Perkins ; and Dr. J. Vickery, M.Sc., by Professor Richards and Dr. Herbert. The Annual Report and Balance Sheet were adopted.

The following officers were elected for 1932 :—President, Dr. T. G. H. Jones ; Vice-Presidents, Dr. D. A. Herbert (*ex officio*), and Dr. R. W. Cilento ; Hon. Secretary, Mr. F. A. Perkins, B.Sc.Agr. ; Hon. Treasurer, Mr. E. W. Bick ; Hon. Librarian, Mr. W. D. Francis ; Hon. Editors, Dr. W. H. Bryan, M.C., and Mr. L. F. Hitchcock, M.Sc. ; Hon. Auditor, Mr. J. S. Just, M.I.M.E. ; Members of Council, Mr. J. B. Henderson, F.I.C., Mr. J. S. Just, M.I.M.E., Dr. E. O. Marks, Professor H. C. Richards, D.Sc., and Mr. C. T. White.

Dr. D. A. Herbert delivered his Presidential Address entitled, "The Relationships of the Queensland Flora."

Any study of the relationships of the Queensland Flora must commence by the recognition of two facts revealed by the fossil record, the existence of angiospermous types at least as early as the Triassic, and the existence of well differentiated modern types, undoubtedly referable to living genera, in the early Tertiary. The leaf impressions from Eastern Australia are of types found in both open and rain forest, and of types of sub-antarctic palaeotropic and autochthonian affinity, so that already in Eocene or Miocene times the flora was one of considerable complexity. The present distribution of these types indicates that geological and climatic changes have modified considerably their original geographical distribution.

A detailed examination of the main associations shows that the Queensland plant populations of to-day are strictly controlled by climatic and geographical factors. In general, types whose affinities are with those at present dominant in Malaysia, occupy the warmer parts of the continent where rainfall exceeds about 35 inches. Types of sub-antarctic affinity, common in Tasmania, are found in Queensland in the higher mountains, often, but not necessarily, in characteristic associations. The ecological conditions are, or have been, widespread over sufficiently continuous land masses, and both elements may be regarded as the ancient occupants of their own type of habitat in palaeotropic and sub-antarctic countries respectively.

The palaeotropic element in Queensland is part of the original widespread palaeotropic flora which, differentiated by geological and climatic isolation, has developed along somewhat different lines in Western Malaysia, Eastern Malaysia, North Queensland, South Queensland, Polynesia, and other centres. Here, as elsewhere, it has been enriched by the incorporation of certain plants characteristic of palaeotropic communities generally, *e.g.*, *Grevillea*.

The sub-antarctic element is also portion of the great sub-antarctic flora, but here the area with ecological conditions suitable for its development is relatively small. We find, however, as with the palaeotropic element, a floristic backbone of types widespread from South America to Australia, some of them apparently South American, others apparently Australian, and yet others apparently Zelandic, but now widespread. With them, however, are interwoven local types in all the countries concerned, as must be expected in a widespread flora where homogeneity is impossible.

The autochthonous element is more localised in its distribution than the palaeotropic or the sub-arctic. It is for the most part a flora of open formations and is not well adapted to cold conditions; nor does it reach its best development in the tropics even where open formations are the natural type of vegetation. Such types as *Dracophyllum* and *Lomatia* have been successful in sub-antarctic countries, and such types as *Stackhousia* and *Pimelea* occupy suitable territory in Malaysia, but for the great majority circumscription by unsuitable territory has resulted in isolation and consequent marked localised development. It is a quantitative and not a qualitative distinction which has led to the designation of this type as the Australian element.

A vote of thanks to the retiring President, moved by Mr. White and Professor Bagster, was carried by acclamation.

Abstract of Proceedings, 26th April, 1932.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on Tuesday, 26th April, 1932. The President, Dr. T. G. H. Jones, occupied the chair, and about seventy members and visitors were present. Apologies for absence were received from Messrs. Kemp and Kyle. The minutes of the previous meeting were read and confirmed. Dr. E. F. Simonds was proposed for ordinary membership by Messrs. Perkins and Hines. Dr. J. Vickery, M.Sc., and Mr. E. L. D. White, B.E., were unanimously elected ordinary members of the Society.

The main business of the evening was a lecture by Mr. W. Davies, M.Sc., entitled "Pasture Studies."

The importance of grassland is emphasised by the fact that of Australia's total exports of all kinds 60% approximately are direct products from grassland, and these include meat, wool and dairy produce. The comparable figure for New Zealand is 94%, for South Africa about 45% and for Canada nearly 20%.

Agrostology is the study of grassland problems, particularly as they effect economic production from pasture lands. Until recently pastures have not been given the study and investigation which has been afforded to fodder crops and cereal crops. It may be said that whereas the 19th century was marked by big progressive strides in respect of improvement in breeds of live stock and in producing varieties of cereals, the 20th century is likely to be equally important in regard to improvements brought about in our grasslands. The whole world has at last realised the importance of pastures to the economic life of every nation and it is in the interests of every nation to keep abreast of the times and to know not only how to improve its grasslands but also how to produce that grass at the lowest possible cost. The primary producer who can the better withstand periods of low prices is he that knows how to produce cheaply, and so it is with nations.

The modern study of grassland is young and therefore a vast number of big problems confront us. These problems require careful observation and research before they can be solved.

The fundamental principles underlying modern grassland technique may be divided into four major groups, namely :—

(*a*) Those problems connected with the introduction and trial of new pasture plants. The importance of this section is emphasised by the fact that the Commonwealth Council for Scientific and Industrial Research has a whole division which deals with plants introduced into Australia for trial.

(*b*) Problems connected with strain in pasture plants. Plants vary within their own groups just as animals show variation from one individual to another. It is the aim of the plant breeder to select the best forms and to use them as a basis for providing even better and more desirable forms which can be used by the practical grazier for improving the carrying capacity of his grasslands. This line of investigation is being given particular prominence at the Welsh Plant Breeding Station at Aberystwyth (Wales) and, in so far as the grasslands of Britain and New Zealand are concerned, promises to be one of the most important developments connected with our pastures.

(*c*) Problems concerning the use of artificial manures on our grasslands. The grass crop, just as any other form of crop, requires to be manured. The main elements of plant food required, and which are often deficient in soils, are phosphoric acid, nitrogen, lime and potash. Each are essential elements and every crop tends to deplete the soil of these valuable food substances, to quite an appreciable extent. The soil, therefore, has to be replenished by the fertiliser ingredients so depleted. The upkeep of soil fertility is an important principle in grassland investigational work.

(*d*) Problems connected with the proper management of our grasslands. This involves the utilisation of the grass that grows at the stages when the product is at its most nutritious stage and when the grazing animal can make the most of it. It is found by experiment that young leafy grass is more valuable than old overmatured grass. This finding has caused us to look for a sound, practical method of grazing our stock on short grass. The system involves the use of relatively small paddocks, changing the stock around from paddock to paddock in rotation so that as the grass in one paddock is grazed down the stock go in on to fresh grass in the next paddock, and so on.

The mechanical cultivation of our grasslands is an important section of pasture management. This includes the renovation of Paspalum pastures, which is of paramount importance to the east coast of Australia.

Finally, conservation of grass (grown at periods of the year when feed is over-abundant) is very important and probably fundamental in areas of periodic drought such as Australia. Conservation of fodder for use in dry periods is probably the very best form of insurance against drought on pastures.

Messrs. Gurney, Bennett, and Henderson took part in the discussion which ensued. A vote of thanks moved by Professor Richards and Mr. W. Bryan, was carried by acclamation.

Abstract of Proceedings, 30th May, 1932.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 30th May, 1932. The President, Dr. T. G. H. Jones, occupied the chair, and about forty members and visitors were present. Apologies were received from Dr. Herbert and Mr. Hines. The minutes of the previous meeting were read and confirmed. Dr. E. F. Simonds was unanimously elected a member of the Society.

Mr. C. A. Sussmilch delivered a very interesting lecture entitled "The Evolution of the Highlands of Eastern Australia." The lecture was illustrated by a very fine set of lantern slides.

A vote of thanks to the lecturer, moved by Professor Richards, supported by Dr. Marks, Dr. Bryan, and Mr. Inigo Jones, was carried by acclamation.

Abstract of Proceedings, 27th June, 1932.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 27th June, 1932. The President, Dr. T. G. H. Jones, occupied the chair, and about thirty-five members and visitors were present. Apologies for absence were received from Messrs. Kyle, Lewcock, and Longman. The Minutes of the previous meeting were read and confirmed. Messrs. E. R. Gross and C. Elliott, and Dr. W. N. Robertson were proposed for ordinary membership by Prof. Richards and Dr. Bryan.

Professor H. C. Richards exhibited the following :—

(i) Pink granodiorite from Upper Cedar Creek, on the south western flanks of Mt. Samson, showing small rosette-shaped masses of molybdenite developed along a joint plane. The granite rock is at present being worked to provide stone for the A.M.P. building in Brisbane. Both pink and grey phases occur in the Cedar Creek granitic mass as in the Enoggera mass, and it is interesting to note that from the pink marginal phase of the latter near the Summit, on Taylor Range, molybdenite has been found frequently.

The Samford granitic mass occurs between the above two bosses, and near its margin at Camp Mountain, has yielded molybdenite from the quarry which supplied the grey granitic stone for the base of the Brisbane City Hall.

(ii) Additional specimens showing the pseudograptolitic character of the hydrated and oxidised marcasite crystals on the joint planes and bedding planes of the country rock associated with the Rio Grande silver lead lode at Mt. Isa. A specimen of a bore core from depth showed the original pyritic character of the long, slender, and occasionally plate-like crystals very well, and serves to explain more clearly the true nature of the graptolite-like markings.

(iii) Specimens of a thick series of highly tilted sedimentary rocks from the eastern flanks of Mt. Barney. Associated with these were marine fossils of Carboniferous age as determined by Dr. Whitehouse.

Dr. F. W. Whitehouse commented on this exhibit.

Mr. W. D. Francis read a paper entitled "The Production of Protein from Inorganic Material: Evidence suggestive of the Generation of Life." Iron, mostly in the form of wire, was suspended in a very dilute solution containing ammonium sulphate, potassium chloride, magnesium sulphate, potassium phosphate and calcium nitrate. After the lapse of several days the ferruginous material adhering to the iron wire was found to contain protein bodies of microscopic size. Precautions were taken to ensure sterilisation. The protein bodies were not produced when the air was freed of carbon dioxide. It is suggested that life may be generated from mineral compounds in a reduced state in the rocks and soils of the earth. The oxidation and hydration of ferrous hydroxide, on account of the special properties of this compound, are particularly mentioned as a possible starting point for the evolution of life.

Dr. T. G. H. Jones and Prof. Bagster, who took part in the discussion following the reading of the paper, expressed doubt as to the correctness of the conclusions drawn by Mr. Francis. They considered that the results were exceedingly unlikely on theoretical grounds, while the experimental procedure seemed to offer many possibilities for mistake and uncertainty.

Dr. Vickery, Dr. Marks and Mr. Hines also took part in the discussion.

A paper by Mr. G. H. Hardy entitled "Notes on Australian Stratiomyiidae," was laid on the table.

This paper gives the relationship of certain genera, some of which had been misallied. A key to subfamilies and to the species in certain genera are given, seven new species being described. Two names are reduced to synonmy, one being generic, the other specific. Other notes are also given.

Mr. O. A. Jones, M.Sc., read a paper entitled "A Revision of the Australian Species of the Coral Genera *Spongophyllum* E. and H., and *Endophyllum* E. and H., with a note on *Aphrophyllum* Smith.

This paper was commented on by Dr. Bryan and Dr. Whitehouse.

Abstract of Proceedings, 25th July, 1932.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 25th July, 1932. The President, Dr. T. G. H. Jones, occupied the chair, and about forty members and visitors were present. Apologies for absence were received from Professor Bagster, Dr. Herbert, and Mr. Hines. The minutes of the previous meeting were read and confirmed. Mr. E. R. Gross, Dr. W. N. Robertson, and Mr. C. Elliott were unanimously elected ordinary members of the Society.

The main business of the evening was a symposium on the history, botany, and geology of Mt. Barney.

Professor Cumbrae-Stewart said that Mt. Barney was first ascended by Captain Logan, 57th Foot, the Commandant at Moreton Bay, the discoverer of the Logan River. Captain Logan, Allan Cunningham and Charles Fraser were on the mountain on 3rd August, 1828, but Captain Logan alone succeeded in reaching the summit. There were two accounts of this, one, Allan Cunningham's official report to Governor Darling, extracts from which, together with his map, were published in Ida Lee's "Early Explorers in Australia," and Fraser's journal of a two month's residence, published in Hooker's Botanical Miscellany (1830) Vol. I., pp. 239-599. This is in the library of the Curator of the Botanic Gardens, Brisbane. Mt. Barney was originally named Mt. Lindesay, after Colonel Patrick Lindesay, commanding the 39th Foot, stationed at the time in Sydney. As such it appears on Allan Cunningham's map. On this, however, is shown a Mt. Barney considerably to the eastward. Mr. R. Dixon, the chief of the first survey at Moreton Bay, published a map in 1845, now at Camden (Port), N.S.W. in which the name of Mt. Barney is attached to the original Mt. Lindesay, and this error has been perpetuated. What Cunningham named Mt. Hooker now figures as Mt. Lindesay and the original Mt. Barney is probably the modern Mt. Gipps. Mt. Barney was called after Colonel Barney, R.E., afterwards Surveyor General of New South Wales. Cunningham's map shows the Richmond River (discovered a few days afterwards from the sea by Captain Rous, H.M.S. Rainbow), as seen by Captain Logan from the top of Mt. Lindesay. It was certain that he saw the country through which the Clarence flowed in the plains to the south-west, described by Fraser as "the Shoal Bay Country."

Near Mt. Lindesay W. G. Chetwynd Stapylton was murdered by blacks in June, 1840, when engaged in tracing the Richmond down to the sea. Captain Logan should not be forgotten. He was the earliest land explorer of Moreton Bay. He too was murdered by blacks. This took place on the upper Brisbane in October, 1830. Captain Logan's son, Colonel R. A. Logan, C.B., commanded the 57th about 60 years ago. Colonel Barney's brother, Captain Barney, 97th Foot, was buried in the old Milton Cemetery. His tombstone is still to be seen.

Mr. C. T. White exhibited a collection of plants from Mt. Barney made by Dr. D. A. Herbert and himself in August, 1931. Among the plants collected was *Hibbertia sericea* Benth., a new record for the State. It was found as a shrub or subshrub 1 foot high, the stems procumbent or scrambling over rocks at an altitude of about 4,000 feet. Other very interesting finds were *Syncarpia Hillii* F. M. Bailey found growing in a rocky gorge at about 2,000 feet altitude, *Leptospermum microcarpum* Cheel and *Leptospermum citratum* Challinor, Cheel and Penfold, both common in rock crevices at about 2,000 feet altitude, *Keraudrenia Hillii* F. v. M. common at from 2,000 to 4,000 feet altitude. Two forms were present, one with white, the other with purple flowers. *Leucopogon melaleucoides*, an upright bush covered with white flowers and found on rocky cliffs at about 3,000 feet altitude, and *Casuarina distyla* Vent., a She Oak forming shrubs of upright growth about 2m. high on cliff faces at about 3,000 feet altitude. The flora of the mountain was found interesting as having a mixture of some coastal and some inland species.

Professor Richards and Drs. Bryan and Whitehouse read a paper entitled "A Preliminary Note on the Geology of Mount Barney." The paper was the result of an excursion made to Mount Barney for the purpose of investigating the possible occurrence of late Palaeozoic rocks reported from the area by the late Mr. R. A. Wearne. As a result of several traverses made on the eastern flanks of Mount Barney the presence of a considerable mass of Carboniferous sediments was proved. These sediments were largely marine in nature and contained fossil remains of Bryozoa, Brachiopods, Gastropods, Lamellibranchs and Crinoids. The Carboniferous beds were traced to a height of 2,000 feet up the mountain. They are disposed almost vertically and are separated by a strongly marked fault from fossiliferous fresh water strata of the Walloon Series on the east. Two vertical sills were noted within the Carboniferous series, the larger of which, measuring 200 feet in thickness, was closely adjacent to the fault. Microscopical examination of specimens from these sills showed that they were composed of an acid rhyolitic material with a micrographic base and were similar to small dykes found invading the Walloon strata and to the granophyric rock which forms the upper part of Mt. Barney and which is supposed to be of Tertiary age.

Messrs. F. Bennett and Salmon, Prof. Richards, and Dr. E. O. Marks took part in the discussion which ensued.

Abstract of Proceedings, 29th August, 1932.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 29th August, 1932. The President, Dr. T. G. H. Jones, occupied the chair, and about forty members and visitors were present. An apology was received from the Minister for Agriculture, Mr. F. W. Bulcock. The minutes of the previous meeting were read and confirmed.

A paper by Dr. W. H. Bryan entitled "A Note on the Stratigraphical Significance of *Monilopora nicholsoni* " was laid on the table.

This paper purported to show that: (1) The stratigraphical position of *M. nicholsoni* in the type area is not known with certainty, (2) The fossil corals in Eastern Australia referred to *M, nicholsoni* embrace several distinct forms, none of which may be specifically identical with the type. (3) That the comprehensive group formed of those Eastern Australian fossils assigned to *M. nicholsoni* covers such a great vertical range that the stratigraphical value of the group as such is negligible.

In view of these facts the author is of the opinion that at present. the genus *Monilopora* appears to be of little value for the purpose of the precise correlation of our late Palaeozoic strata.

The main business of the evening was a lecture by Dr. J. Vickery entitled "The Application of Scientific Methods to the Preservation and Transport of Meat."

Australia has lost her frozen beef trade. It was restricted more and more to naval and military contracts and supplies to institutions, and if it was not to stagnate entirely means of chilling would have to be devised.

There had been a lot of loose talk lately about chilled and frozen meat, said the lecturer. Many of the optimistic reports probably were only 10 per cent. correct. It served nevertheless to bring to notice the scientific aspects of the control of the wastage in meat. The happy co-operation of scientific and industrial interests averted that time lag between the success of the scientific experiment and its application to industry. It was his privilege, said Dr. Vickery, to study the changes in dead tissue. The saying "as dead as last week's mutton," brought up visions of chops and steaks; but meat was far from being the uninteresting thing that it appeared. It was only 50 years since the regular shipment of frozen meat had commenced from the Southern Hemisphere, and it had become increasingly apparent that the aid of science must be sought. So far the engineer had controlled the process, but the era of the biologist was definitely coming. On the biological side the industry was yet in its infancy. Cold storage science would be complete only when the biologist was able to state the condition of the meat for the guidance of the engineer.

Dr. Vickery discussed the nature of meat, aided by lantern slides, the post mortem immediate changes in meat—which was not yet understood; the immediate increase in temperature after killing, bone taint, desiccation, and loss of "bloom" or change in colour after cold storage, brought about by the activity of micro-organisms. There was no known case of a micro-organism growing below a temperature of 19 degrees Fahr. It was, therefore, apparent that the growth of micro-organisms might be controlled by sufficiently low temperature. Preservatives such as formalin might be used, but they were looked upon by health officers as injurious to human beings. Chilled beef should resemble as closely as possible freshly-killed meat, but the chief difficulty to be encountered by Australia was the long voyage. Even with the shorter voyage from South America to Great Britain there was little margin of safety. If there was a delay of a week the engineers had to freeze the beef. Throughout the voyage they maintained a temperature of from 28 degrees to 35.5 degrees Fahr., and 60 or 70 per cent. of the so-called chilled beef arrived partly frozen. The engineers on the South American boats had to steer a course between attack by organisms and freezing.

A vote of thanks to the lecturer by Prof. Goddard and seconded by Mr. J. B. Henderson, was carried by acclamation.

Abstract of Proceedings, 26th September, 1932.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 26th September 1932. The President, Dr. T. G. H. Jones, occupied the chair, and about forty members and visitors were present. The minutes of the previous meeting were read and confirmed.

Mr. H. A. Longman, Director of the Queensland Museum, exhibited the following specimens :—(1) *Astrotia stokesii* Gray. Giant sea snake, caught at Morey Reef, Port Douglas, and presented to the Queensland Museum by Mr. E. J. Whelan, Harbour Master, Port Douglas. This very bulky species, which was named after Captain Stokes, of H.M.S. "Beagle," ranges from Chinese and Indian seas to Australia. The specimen exhibited was seventy-three inches in length, with a maximum girth of twelve inches, and appeared to be the largest on record. The colour was uniform olive brown. (2) *Voluta Bednalli* Brazier. A fine specimenof this rare shell, found by a diver in deep water near Thursday Island, which had been received on loan from Mr. R. W. Millard.

Professor L. S. Bagster, D.Sc., exhibited some very interesting lantern slides illustrating the modern applications of the X-Ray.

Mr. S. B. Watkins exhibited specimens of grits and conglomerates taken from outcrop behind the Moogerah State School. The outcrop occurs as a narrow belt of coarse sandstone, grit and conglomerate running north-east—south-west and standing vertically. It can be seen from the main Moogerah Road at a point north of the State School and occupies the top of a crest at the rear of the State School. The strata close to the road hereabouts are gently dipping Walloon coal shales of a grey to dark colour, dipping about 8 degrees south-west. The strata were examined in a newly sunken well adjacent to the road. On approaching the outcrop, typically Walloon, ferruginous concretionary material and clay shales are crossed. Through these beds a number of acid dykes intrude and run in parallel lines of outcrop across the country. These acid dykes strike in the same direction as the outcrop in question. On close examination pieces of volcanic material are found included in the sandstone and in the grits.

Dr. D. A. Herbert exhibited—(1) Specimens of *Myrtus Hillii* which had grown over a liana coiled round its trunk so that the liana was at one point embedded in wood half an inch below the surface. (2) Specimens of *Cordyceps Gunnii*, the Vegetable Caterpillar from Roberts Plateau, National Park, collected by Mr. J. E. Young, and of the same species collected in the neighbourhood of Sydney by Dr. J. McLuckie.

Mr. C. T. White exhibited—(1) Specimens of some undescribed or little known plants from North Queensland collected by Mr. S. F. Kajewski on behalf of the Arnold Arboretum (Harvard University). (2) Specimens of *Sterculia foetida* collected at Port Douglas by Mr. C. Allen. Only the one tree was known in the district. This was growing a little above the tide mark but it was not clear as to whether the tree had been planted or was growing wild.

Mr. F. A. Perkins exhibited two boxes of beetles belonging to the families *Buprestidae* and *Cerambycidae*. These specimens form part of a collection made by the late Mr. Rowland Illidge, which has been presented to the University by his sons.

Miss N. M. Holdsworth exhibited a specimen of Coralline Algae, cf. *Lithothamnion sp.*, from Muckadilla, Queensland, presented to the Queensland Museum by Mr. F. W. Hacker. This is, apparently, the first record for this plant from Queensland Cretaceous rocks. *Archaeolithothamnion* has been recorded from Cretaceous beds in Southern India (*see* Nature, Vol. 128, 1931, p. 225).

Dr. J. V. Duhig exhibited a Malignant Newgrowth growing from the Skin of a Fish. The tumor growing from the lower lip of a sea bream is generally rounded in form and resembles a large wart. To the touch it is very firm and is cartilaginous in appearance, being of a faint translucency. Its long and short axes measure 3.5 c.m. and 2.0 c.m. respectively. Microscopic section shows the growth to be a squamous epithelioma, of a spindle cell type. It is infiltrating in broad columns through the centre of which run a loose vascular core of connective tissue. The fibro-cartilaginous substance of the lower jaw of the fish has been eroded diffusely, though it is this tissue which forms the marrix of the growth and has been stimulated to proliferation as the parasitic stroma of the growth. It is this which give solidity and translucency to the mass. Tumors are not uncommon in domestic animals though they are said to be rare in wild animals. Though bony growths are very common in fish in the natural state, my knowledge does not allow me to state whether a tumor of this kind has been reported before. I should think it would be very rare.

Professor H. C. Richards, D.Sc., showed a number of microphotographs of rock specimens from typical geological formations in Southern Queensland.

Messrs. Bennett and Longman, Dr. Duhig and Professor Richards commented on the exhibits.

Abstract of Proceedings, 31st October, 1932.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 31st October, 1932. Dr. D. A. Herbert occupied the chair, and about twelve members and visitors were present. Apologies were received from Prof. Richards, Dr. Jones and Messrs. Longman and Bick. The minutes of the previous meeting were read and confirmed. Mr. E. C. Barton was proposed for Corresponding membership by the Council.

On behalf of the delegates from the Society, Dr. W. H. Bryan gave a verbal report of the main features of the recent Science Congress in Sydney.

Mr. Perkins exhibited a case of insects belonging to the order Neuroptera, and gave a short account of the habits and life history of some of the more interesting families.

Dr. Herbert exhibited a section of a branch of a tree of *Ficus hispida*, sixty years old, showing 284 rings in the wood.

Dr. F. W. Whitehouse exhibited a number of palaeczoic fossil plants fron various localities in Queensland, each being a new locality record and most of them new generic or specific records for the State. They were :—

(1) A collection of fossil plants apparently of Middle Devonian age, sent by Mr. F. G. de V. Gipps from Gilberton. In this were some excellently preserved specimens of *Leptophloeum aff australe* (McCoy) in all states and with the root (stigmarian) processes also present. Associated with them were *Cyclostigma* (?) *sp.* and impressions of psilophytalids of various types. One of these has all the features of *Hostimella* but is very much larger than any described species of that genus.

(2) *Stigmaria* (?) *sp.* from beds at the top of the lower Carboniferous (Neerkol Stage) at Mt. Barney.

(3) *Rhacopteris sp.* from a new series at Mt. Barney.

(4) Permo-Carboniferous plants making new records for the State. These were: *Taeniopteris sp.* from Galah Gorge; *Schizoneura gondwanensis* Feist, from Mt. Mulligan; *Thinnfeldia hughesi* (Feist.) and *T. feistmanteli* Johnst. from Jericho; *Emplectopteris sp.* from Theodore. The last named form was represented by specimens including one fertile frond. It is probably identical with the widely distributed *Sphenopteris lobifolia* Morris.

Dr. Marks, Dr. Bryan and Mr. Bennett commented on this exhibit.

Abstract of Proceedings, 28th November, 1932.

The Ordinary Monthly meeting of the Society was held in the Geology Lecture Theatre of the University at 8.15 p.m., on Monday, 28th November, 1932. Dr. Jones occupied the chair, and about thirty members and visitors were present. Apologies were received from Messrs. Henderson, Bailey, Miss Holdsworth, and Dr. Bagster. The minutes of the previous meeting were read and confirmed. Mr. E. C. Barton was unanimously elected a Corresponding Member of the Society.

Prof. H. C. Richards communicated a paper by Mr. C. A. Sussmilch on "The Geomorphology of the Moreton District, Queensland."

Dr. E. O. Marks read a paper entitled "Some Observations on the Physiography of the Brisbane River and Neighbouring Watersheds."

A paper by Dr. T. G. H. Jones on "Essentail Oils from the Queensland Flora, Part V. : *Eriostemon glasshousiensis*" was laid on the table.

Dr. F. W. Whitehouse read a paper on "The Presence of Glendonites in the Dawson Valley."

Dr. D. A. Herbert exhibited specimens of *Albugo bliti* a white rust on *Amaranthus viridis* collected in Brisbane, November, 1932.

A Special Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 28th November, 1932.

The business of the meeting was the alteration of Rule 2, and the addition of two rules. These amendments were proposed by the Council and were carried unanimously. They were as follows :—

Rule 2. The insertion of the words "*Honorary Life Members*" **after the word** "*of.*"

The addition of the following Rules—*Honorary Life Members are those who, having performed valuable scientific work, or meritorious work in the interests of the Society, have been elected by ballot at an Ordinary Meeting on the nomination of the Council;* **and**

Donations and Life Members' subscriptions shall be treated as capital funds.

Publications have been received from the following Institutions, Societies, etc., and are hereby gratefully acknowledged :—

ALGERIA—

Societie de Geographie et d'Archaeologia 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.

Field 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 Janerio.

Ministerio de Agricultura Industria y Commercio, Rio de Janerio.

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.

CUBA—

Sociedad Geografica de Cuba, Habana

DENMARK—

The University, Copenhagen.

FRANCE—

Station Zoologique de Cette.

Societe des Sciences Naturelles de l'Ouest.

Museum d'Historie Natural, Paris

Societe Botanique de France

Societe Geologique et Mineralogique de Bretagne

Societe de Geographie de Rochefort.

GERMANY—

Zoologische Museum, Berlin.

Gesellschaft fur Erdkunde Berlin.

Deutsche Geologische Gesellschaft, Berlin.

Naturhistorischer Verein der preus Rheinland und Westfalens, Bonn.

Naturwissenschaftlichen Verein zu Bremen.

Senckenbergischen Bibliothek, Frankfurt a. Main

Kaiserlich Deutsche Akademie der Naturforscher, Halle.

Zoologischen Museum, Hamburg.

Naturhistorisch-Medizinischen 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—

Imperial University, Kyoto.

Imperial University, Tokyo.

National Research Council of Japan, Tokyo.

JAVA—

Koninklijk Naturkundige Vereinginig, Weltvrenden.

Department van Landbouw, Buitenzorg.

MEXICO—

Instituto Geologico de Mexico.

Sociedad Cientifica "Anatonio Alzate," Mexico.

Secretario de Agriculture y fomento, Mexico.

Observatorio Meterorologico Central, Tacaibaya.

NEW ZEALAND—

Dominion Museum, Wellington.

New Zealand Institute, Wellington.

Auckland Institute and Museum.

Dominion Laboratory, Wellington.

Council for Scientific and Industrial Research, Wellington.

Geological Survey of New Zealand.

PERU—

Sociedad Geologica del Peru, Lima.

PHILIPPINES—

Bureau of Science, Manila.

POLAND—

Polskie Towarzystwo Przyrodnikow im Kopernika, Lwow.

University of Poland.

Societes Savantes Polonaises.

PORTUGAL—

Academia Polytechnicada, Oporto.

Sociedade Broteriana, Coimbra.

Institute Botanico, Coimbra.

RUSSIA—

Akademie des Sciences Russie, Leningrad.

Bureau of Applied Entomology, Leningrad

SPAIN—

Real Academia de Ciencias y Artes de Barcelona.

Real Academia de Ciencias, Madrid.

Museo de Historia Natural, Valencia.

Academia de Ciencias de Zaragoza.

SWEDEN—

Geological Institute of Upsala.

SWITZERLAND—

Societe de Physique et d'Historie Natural, Geneve.

Naturforschenden Gesellschaft, Zurich.

The League of Nations, Geneva.

SOUTH AFRICA—

Geological Society of South Africa, Johannesburg.

South African Museum, Capetown.

Durban Museum, Natal.

Transvaal Museum, Pretoria.

United States of America—

United States Geological Survey, Washington.

Natural History Survey, Illinois.

Lloyd Library, Cincinnati.

Wisconsin Academy of Arts, Science and Letters, Madison.

California Academy of Sciences.

Cornell University, Ithaca, New York.

University of Minnesota.

University of California.

Library of Congress, Washington.

Field Museum of Natural History, Chicago.

American Museum of Natural History, New York.

Buffalo Society of Natural History.

Boston Society of Natural History.

American Philosophical Society, Philadelphia.

American Geographical Society, New York.

Smithsonian Institute, Washington.

Carnegie Institute, Washington.

United States Department of Agriculture, Washington.

Oberlin College, Ohio.

National Academy of Science, Washington.

Rochester Academy of Sciences.

Academy of Natural Sciences. Philadelphia.

New York Academy of Science.

Indiana Academy of Science.

American Academy of Science and Arts, Boston.

Institute of Biological Research, Baltimore.

John Crerar Library, Chicago.

Ohio Academy of Science, Columbus.

Arnold Arboretum, Jamaica Plains.

Michigan Academy of Arts, Science, and Letters.

University of Michigan.

Minnesota Geological Survey.

New York Zoological Society.

Wistar Institute of Anatomy and Biology, Philadelphia.

Portland Society of Natural History.

San Diego Society of Natural History.

Puget Sound Biological Station, Seattle

Missouri Botanic Gardens, St. Louis.

University of Illinois, Urbana.

State College of Washington, Pullman.

Bureau of Standards, Washington.

National Research Council, Washington.

United States National Museum, Washington.

Public Health Service, Washington.

Peabody Museum of Natural History, Yale.

Lawde Observatory, Arizona.

List of Members.

Corresponding Members.

Barton, E. C., A.M.I.C.E.	c/o Decimal Assoc., Finsbury Pavement House, Moorgate, London, E.C. 2.
David, Professor, Sir T. W. E., F.R.S.	The University, Sydney, N.S.W.
*Domin, Dr. K.	Czech University, Prague
*Maitland, A. Gibb, F.G.S.	Melville Place, S. Perth, W.A.
*Skeats, Professor E. W.	The University, Melbourne, Vic.

Ordinary Members, Etc.

Atherton, D. O., B.Sc.Agr.	Department of Agriculture and Stock, Court House, Cairns.
Bage, Miss F., M.Sc.	Women's College, Kangaroo Point, Brisbane
†Bagster, L. S., Prof., D.Sc.	The University, Brisbane.
*†Bailey, J. F.	Maynard Street, Woolloongabba, S. Brisbane
Ball, L. C., B.E.	Geological Survey Office, Brisbane
*†Bancroft, T. L., M.B.	Walla Villa, *via* Bundaberg
Barker, Miss E., B.A.	Infants' School, Fortitude Valley, Brisbane
Barker, F.	Railway Audit Office, Brisbane
Barr, L. L. S., B.Sc.Agr.	Edgecliffe, River Terrace, Kangaroo Point, Brisbane
Beckman, G. H., B.Sc.	Crook Street, Northgate, Brisbane
*Bennett, F., B.Sc.	State School, Toowong, Brisbane
Bennett, F. C., B.Sc.	Pharmacy College, Brisbane
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VOLUME XLIV.

PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

QUEENSLAND

FOR 1933.

VOL XLV.

The authors of the several papers are individually responsible for the statements made therein.

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VOLUME XLV.

PRESIDENTIAL ADDRESS

By T. G. H. Jones, D.Sc., A.A.C.I., Department of Chemistry, University of Queensland.

(*Delivered before the Royal Society of Queensland, 27th March,* 1933).

The report of the Council of the Society as presented this evening has placed the present position before you and it is scarcely necessary for me to enlarge upon it. The number of papers published has been well up to standard and the proceedings to be issued will not suffer by comparison with previous years. I must confess, however, to some little anxiety regarding the finances of the Society as our balance sheet shows only a small surplus ; considerably less than that of last year. The effect of the withdrawal of the Government subsidy is probably beginning to show itself and it will be necessary for the incoming Council to keep a careful eye on expenditure. There is also the obligation upon members of meeting their annual subscription at an early date and also of introducing new members, while at the same time persuading those who may be contemplating severing their connection with the Society to refrain from doing so. It is only by the loyal co-operation of all those who have the welfare of our Society at heart that we can overcome our difficulties and not lower our standard.

During the period under review the Society has sustained the loss of two members in the deaths of Mr. G. J. Saunders and Dr. Wilton Love. Mr. Saunders, a graduate of our University, at the time of his death was Principal of the Ipswich Technical College and was well known in scientific circles in Queensland.

Dr. Wilton Love laboured long and well at his profession and during his many years of association with the Royal Society had shown a close interest in scientific work and contributed to our proceedings.

We deeply regret the deaths of these two and the Society is the poorer by their passing.

* * * * * * *

The Elements and their Relationship

A former President of this Society whose interests are chemical expressed the view that some later President might find it convenient to discuss in his address the progress that has been made in Chemical Science during the twentieth century. The magnitude of such a task is self evident to any one who has followed the development of chemical science during the last thirty years and I have selected, in consequence, a subject which, while conforming to the idea of a review of progress made, nevertheless narrows down that review to a reasonable scope. The endeavour will be made not only to focus attention on fundamental advances affecting the subject as a whole rather than those of specific sections, but also to present those advances in simple and, I trust, readily understandable language, unobscured by the symbols which are apt to deter the non-chemist.

It can no doubt be said with some truth that the ultimate aim of scientific thought has always been the reduction of physical relationships to a purely mathematical basis. This purpose manifested itself even in remote times in the answer given by the school of Pythagoras to the fundamental problem—the nature of the primordial substance. One school of Greek thought claimed to recognize the elementary principle in empirically known substances, such as earth, fire, air and water. Another school identified it with abstract metaphysical conceptions such as the Infinite Being. The Pythagoreans, however, regarded Number as the Universal basis and thus foreshadowed in a curious way the development which has led to the present day theory of the elements. The crowning point of this development may be seen in the enormous advances in atomic theory between 1920 and the present day, which reduce the system of the chemical elements to a series of comparatively simple arithmetical relationships.

The earlier history of this great discovery dates back to the year 1869 when it was independently established by Lothar Meyer and by Mendeléeff that the elements, when arranged in increasing order of atomic weights, showed a regular recurring periodicity in their characteristic chemical and physical properties. Mendeléeff gave us the periodic system of classification of the chemical elements, which has since remained as the only rational basis for their chemical study.

Most of the scientists of the present day have grown up in a science wherein radioactivity, X-rays, electrons, etc., are taken for granted. If asked to name the most important scientific discovery of modern times most of us would no doubt at once reply "the discovery of radium." It is certain that the discovery of radium and the almost simultaneous discovery of X-rays have exercised a very profound, almost revolutionary influence on most branches of science, chemistry and physics in particular, and it may not be uninteresting to go back prior to that time and glance at the ideas then in evidence.

The conception of the atom held by the chemist of a generation or so ago was that of a homogeneous, incompressible particle, probably spherical in form and certainly indivisible into anything finer. This particle was assumed to have existed unchanged throughout the past and it was believed that it would persist in the same unaltered state through all time to be. Chemical compounds might crumble and decay but the atomic particles were endowed with eternal permanence. The atom, too, was a purely hypothetical thing ; no direct proof of the existence of the atoms could be produced although the evidence in favour of the atomic theory was sufficiently convincing for most chemists.

The original definition of an element due to Boyle was a purely empirical one. An element was something impossible to break up by any available means. This definition did not remain unqualified, any "available means" being translated into any chemical means. Chemical analysis became the ultimate court of appeal in the problem of the elements, and the term "element" came to suggest a material endowed with chemical character which differentiated it from all other elemental matter and permitted of its isolation from other elements by purely chemical methods.

There was likewise the further idea that the relative weights of atoms could be determined by purely chemical methods and hence the conception of the chemical element became associated with that of its atomic weight.

With the coming of Dalton's atomic theory, the older conception of the element was re-stated in atomic terms and it became an accepted theory that the chemical element could only be a material composed of atoms, all of which had the same chemical character.

From the time of Newlands (1863) up to 1913 the periodic system of classification of the elements rested upon the basis of chemical atomic weights. The places in the periodic system of classification clearly represented a series of detached forms of matter. Certain anomalies there were, which were well known, namely, the positions of argon and potassium, iodine and tellurium, cobalt and nickel, in which cases the chemical sequence was different from that inferred from the atmoic weight.

The discovery of the inert gases of the atmosphere by Rayleigh and Ramsay in the years 1894-1905 not only gave to the periodic system a symmetry which it previously lacked but, in addition, disclosed a novel form of matter with no chemical properties.

In 1888 Crookes predicted that "an absence of absolute homogeneity may possibly yet be traced in many of the elements" so that under the name element it would be necessary to include a mixed material.

The periodic system of classification as devised by Mendeléeff and subsequently amended by the insertion of the rare gases and the discovery of new elements could be accurately described before 1910, at all events, as "a completely unsolved riddle, the meaning of which seems scarcely hidden beneath the surface and yet perpetually eludes the grasp."

I have already referred to the discovery of radium and the X-rays as being the most notable discoveries during comparatively recent times and it is to them that we owe the remarkable advances that have materially helped to solve the "unsolved riddle of the periodic system of classification."

In 1913 a fresh time of research was opened up which threw light upon the problem of the elements from a new angle.

Moseley in his investigation of the X-ray spectra of the elements brought out a direct relationship between this physical property and the sequence of the elements in the periodic system and further work proved that all forms of matter which could be represented by a single place in the table emitted the same X-ray spectrum. This gave an entirely new criterion wherewith to judge the claim of a form of matter to a place in the table.

Moseley found that the X-ray spectra discovered by him contained line series which, while differing in wave-lengths for the various lines, were all of the same type. He further made the surprising discovery that the chemical elements could be arranged in a numerical series in such a way that the lines shifted with great regularity from element to element as the series was traversed. The displacement occurs with such precision that any gap in the series is immediately indicated by an excessive displacement.

If we construct the so called "natural sequence of the elements" on the basis of the X-ray spectra we find that it is in essential agreement with the series arranged in increasing order of atomic weights, but nevertheless Moseley's discovery first made possible an accurate representation of the periodic system and enabled apparent anomalies to be understood. Moseley was able to assign to every element its atomic number, that is to say, its number in direct "sequence" commencing with hydrogen as 1 and ending with uranium which was 92. This definitely fixed the number of elements below uranium and indicated how many unknown elements were to be expected.

Before Moseley's work had been carried out it had already been pointed out by Soddy in 1910 that certain members of the radioactive group of elements exhibited a complete identity of chemical behaviour and were thus entitled to be placed in the same position in the periodic system of classification and in order to express the idea Soddy coined the word "isotopes," that is to say, a group of two or more elements occupying the same place in the periodic system of classification; chemically identical and non-separable.

It was soon recognised that isotopic forms might not however, belong exclusively to the radioactive elements and as a matter of fact the first discovery of isotopes was made by means of positive ray analysis in the case of two forms of neon but the meaning of the experimental result was not then grasped. It became clear that Crookes' general idea of the absence of complete homogeneity was true.

The work of Sir J. J. Thomson on positive rays followed by Aston with the mass spectrograph has placed the existence of the isotopes beyond all doubt and has substantially altered our views regarding "chemical atomic weights."

A very large number of the elements has been shown by Aston to be heterogeneous, atoms chemically inseparable, but of different weights and with the aid of the mass spectrograph Aston was able to analyse different elements and not only produce information regarding the existence of the isotopes, but also to measure their masses as well. In an incredibly short space of time Aston determined more atomic weights than all the other workers on the subject combined.

The atomic weights as determined by ordinary methods thus represent an average value of the various isotopic atoms making up the heterogeneous element.

If we may quote from Aston's work, element neon consists of three isotopes of masses 20, 22, and 21. Zinc consists of seven isotopes of masses 64, 66, 68, 67, 65, 70 and 69. Tin consists of no less than eleven isotopes of masses 120, 118, 116, 124, 119, 117, 122, 121, 112, 114, 115. Xenon consists of nine. Mercury of seven and lead four of masses 208, 206, 207, 209. (The masses in these cases are quoted in order of intensities). Other examples are numerous and complete lists for the first forty examples are now available. In most cases the numbers determined are whole numbers without fractional parts, thus vindicating to some extent Prout's idea of one hundred years ago that the elements were built up by the combination of hydrogen atoms, their atomic weights in consequence being integers.

The accuracy with which Aston could work with the mass spectrograph was limited to about 1 part in 10,000 so that, if the proportion of one isotope fell below that ratio it could not be detected by the mass spectrograph. Certain elements which in his results appeared to be homogeneous have, however, during the last year or two, been shown to be heterogeneous by entirely different methods.

It was originally suggested by R. S. Mulliken that new isotopes might be detected by examining isotopic lines in band spectra and the study resulted in the discovery of two new isotopes of oxygen, one of carbon, one of nitrogen and possibly one of beryllium. In the case of oxygen, isotopes of atomic weights 17 and 18 additional to the ordinary 16 have been discovered and the proportions in the ratio 16 : 18 : 17 are 10,000, 8 and 1. An isotype of carbon with atomic weight 13 additional to the ordinary 12 has also been discovered but the proportion is very small and impossible of detection by the mass spectrograph. An isotope of nitrogen with an atomic weight of 15 additional to the ordinary 14 has been discovered, the proportions being about 1 to 800.

Thus elements such as carbon and oxygen formerly considered quite homogeneous have now been shown to consist of mixtures of atoms of different masses. There is the added interest in the case of oxygen that the mass 16 has been chosen as the standard for atomic weights but actually the mass is a little greater than the mass of its main constituent O^{16} by about 1.25 parts per 10,000. This quantity is of little significance to chemists partly because it is very small and partly because the ratio of the isotopes is probably invariable but physicists aiming at an accuracy in the masses of atoms of 1 part in 100,000 must find the chemical unit unsuitable.

In the light of these results it is therefore clear that the spaces in the periodic system of classification do not represent the positions of homogeneous material but in most cases mixtures of atoms of different masses which are chemically indistinguishable. The border line between the elements must therefore definitely remain for the present at any rate as one of chemical analysis.

We will next proceed to deal with the relationship of the elements with each other. That the elements are related to one another in some way must have been assumed even if unconsciously by the alchemists as otherwise there could have been little basis for their work in attempting transmutation and the very fact of the existence of the periodic system of classification further suggests some relationship.

Little progress was possible in connection with this problem until the knowledge of radioactive changes and transformations was made as complete as possible and the spontaneous change of one element into another such as occurs in these series recognised as being something which required a definite scheme of atomic structures.

Many hypothetical structures have been proposed from time to time but practically none have survived apart from what is known as the Rutherford atom. The present day view of the atom postulates a nucleus wherein the whole mass of the atom is concentrated and experiments suggest a diameter for this mucleus in heavy atoms of 4×10^{-12}cms. or about $\frac{1}{5000}$ of the whole of the atom diameter. This nucleus probably contains protons (hydrogen nuclei) equal in number to the mass number of the element and as each of these protons carries one positive charge the total number of positive charges in the nucleus is equal to the mass number of the atom under consideration. Closely associated with these protons is a group of electrons and the number of these electrons is found by subtracting the atomic number of the element from the mass number of the element in question.

This arrangement yields a nucleus having a surplus positive charge numerically equal to the atomic number of the element. The atomic number of an element corresponds to the positive charge on the nucleus of an atom and it was this charge which Moseley actually determined in his work on atomic numbers.

We may take the element lithium as an example. Its atomic number is 3 and Aston has determined masses of 6 and 7 for the element. In the nucleus therefore of one lithium atom there must be 6 protons and 3 electrons, while in another (the isotope) 7 protons and 4 electrons, leaving in both cases a surplus charge of 3.

This gives us a clear idea of the meaning of isotopes, merely atoms with the same charge on the nucleus irrespective of their mass. Theoretically an infinite number of isotopes is possible for any element —we may take uranium as an example with a nuclear charge of 92. If by some means we could introduce 91 more electrons into its nucleus, thus reducing its charge to 1, we would have an isotype of hydrogen with the mass of uranium.

Since an atom is electrically neutral, surrounding the nucleus there must be a series of electrons corresponding in number to the atomic number of the element. Thus, as we progress through the periodic table we increase the nuclear charge by one as we move from element to element and therefore the electrons surrounding the nucleus commences with 1 for hydrogen, 2 for helium and so on up to 92 for uranium.

The individuality of an atom resides in the nucleus, and since chemical analysis has in no case changed one element into another, it is clear that no chemical reaction has any effect on the nucleus. Spontaneous change in the nucleus of certain radioactive atoms is continually going on but it is as yet beyond our control and not subject to chemical influence. Although it is clear that the nucleus of an atom must have a special structure, that particular structure appears as yet to be of little concern to the chemist, but it is a problem of major interest to physicists. Recent theories regarding the structure of the nucleus may be found discussed by Rutherford (1932). Papers dealing with the existence of what is known as a neutron have also appeared, Chadwick (1932). Some work has been carried out also, in the actual transformation of certain elements into others.

Thus using the α-particle from radioactive sources as a projectile (and this projectile mass for mass has an energy 400 millions times as great as a rifle bullet), Rutherford and others have succeeded in shattering a very small proportion of the nuclei of certain atoms with the production of others. In this way bombardment of the nitrogen atom by the α-particle has resulted in the elimination of a proton from the nitrogen nucleus, while the α-particle is captured. The result is an atom with a mass of $14 + 4 - 1 = 17$, while the nuclear charge has increased by 1, that is an isotope of oxygen with mass 17. As already mentioned an isotope of mass 17 has been discovered for oxygen and it may have been produced in this way in nature. Many other elements, such as neon, magnesium, silicon, sulphur, chlorine, aluminium, argon and potassium behave in the same way ; the nucleus suffers disruption if a favourable collision with the powerful α-particle projectile takes place and in most cases one proton is ejected. This must constitute a transmutation of the elements on an infinitesimal scale.

More recently interesting new experiments have been made particularly in the Cavendish Laboratory with an apparatus designed to give 600-800 thousand volts.

Protons produced in an auxiliary discharge tube were accelerated by this high potential in a discharge tube and this steady stream of swift protons used to bombard a number of elements. Lithium was the first element examined and it is believed that the lithium atom of mass 7 captures one proton making the total mass 8 and the resulting nucleus breaks up into two α-particles. Other elements such as boron, flourine, aluminium, carbon and nitrogen appear to behave similarly and give rise to α-particles.

It is obvious that much further work is needed in this field and it is being undertaken by Rutherford and his co-workers.

It is probable as we proceed from element to element in the periodic system some change in structure in the nucleus of a regular character occurs and the real relationship of the elements to each other would be found in this particular change. But to the chemist the change in chemical character as we pass from element to element is of fundamental concern, and it is the arrangement of electrons around the nucleus which interests him most. For chemical change seems to be the result of the removal or utilisations of these outer electrons by forces such as one can regulate in the laboratory. Much attention has therefore been given to the particular arrangement of what are known as the planetary electrons around the atomic nucleus. We have 92 such electrons starting with one for hydrogen and progressively increasing by one as we climb the table. How are these arranged around the nucleus ? The answer has been supplied during recent years and enables us to understand—if not entirely, the periodic system of classification from a new angle.

It is here as stated in the earlier portion of this address that reduction to a purely arithmetical basis has been effected.

It has been found that four (so called quantum) numbers are necessary to afford a complete picture of the electronic motions. This is readily understandable from the fact that the movement of an electron requires 3 degrees of freedom while a fourth arises from the spin of the electron on its own axis. These four numbers have been called the principal, subordinate, magnetic and spin quantum numbers and are all expressed by simple arithmetical terms.

Thus the principal quantum called large N runs from 1 upwards, each corresponding to a period in the periodic system. Thus there are 7 such numbers required 1, 2, 3, 4, 5, 6, 7. The subordinate quantum number l possesses N values for each particular value of N and is numbered from 0 upwards 0, 1, 2, 3, 4, etc. The magnetic quantum number m possesses $2l + 1$ values for each value of the subordinate number and may thus be any integer from $-l$ to $+ l$. Thus if l is 3 the values for m are -3, -2, -1, 0, $+1$, $+2$, $+3$, *i.e.*, $2l + 1$ or 7 values. The fourth spin quantum number can only have two values corresponding to its spin and these are given values of $+\frac{1}{2}$ and $-\frac{1}{2}$.

Thus we arrive at the following table :—

Combination of the principal, subordinate and magnetic quantum numbers.

$N = 1$	$l = 0$	$m =$	0
$N = 2$	$l = 0$	$m =$	0
$N = 2$	$l = 1$	$m =$	—1, 0, +1
$N = 3$	$l = 0$	$m =$	0
$N = 3$	$l = 1$	$m =$	—1, 0, +1
$N = 3$	$l = 2$	$m =$	—2, —1, 0, +1, +2
$N = 4$	$l = 0$	$m =$	0
$N = 4$	$l = 1$	$m =$	—1, 0, +1
$N = 4$	$l = 2$	$m =$	—2, —1, 0, +1, +2
$N = 4$	$l = 3$	$m =$	—3, —2, —1, 0, +1, +2, +3

In 1925 the key to the understanding of the periodic system was discovered by Pauli in the principle according to which two electrons in a single atom can never coincide in all four quantum numbers. Thus according to this so called Exclusion Principle each of the combinations given in the table can be realised by two electrons at most in the same atom.

Thus when $N = 1$ we have the two following possibilities only :—

1, 0, 0 + $\frac{1}{2}$ 1, 0, 0 —$\frac{1}{2}$

When $N = 2$ we have the following possibilities :—

2, 0, 0, +$\frac{1}{2}$ 2, 0, 0 —$\frac{1}{2}$
2, 1, —1, +$\frac{1}{2}$ 2, 1, —1, —$\frac{1}{2}$
2, 1, 0 +$\frac{1}{2}$ 2, 1, 0, —$\frac{1}{2}$
2, 1, +1, +$\frac{1}{2}$ 2, 1, +1, —$\frac{1}{2}$

making 8 altogether or 4 pairs.

When $N = 3$ the number is obviously in the same way 16 and when N = 4 the number is obviously 32.

When there is agreement in the first three numbers and difference only in the fourth (or spin quantum number) the electrons are said to be paired.

From these considerations it follows that the first quantum group can only hold 2 electrons, the second quantum group 8, the third 16, the fourth 32 and so on.

Now in considering the relationships of the elements we are struck by the unique position of the rare gases. In their electronic arrangements conditions of great stability obtain as is obvious from their chemical inertness which means that the electrons are not easily removable. It is clear too that when a rare gas is reached as we proceed along the table, it coincides with the completion of an addition of 8 electrons to the outermost group and with the rare gases the outermost group of electrons is always 8 (excepting helium).

Thus we have the development :—

He	2
Ne	2, 8
Ar	2, 8, 8
Kr	2, 8, 18, 8
Xe	2, 8, 18, 18, 8
Nt	2, 8, 18, 32, 18, 8

Krypton is not 2, 8, 8, 18 as we might at first sight suppose.

We are now in a position to understand the reason why there is a recurrence of chemical properties as we proceed along the periodic system. Take the alkalies as an example :—

Li	is	2, 1
Na	is	2, 8, 1
K	is	2, 8, 8, 1
Rb	is	2, 8, 18, 8, 1
Cs	is	2, 8, 18, 18, 8, 1

In every case there is one electron over the stable arrangement of the inert gas and this accounts for the resemblance of the alkalies as this 1 electron is available for chemical reactions. A similar state of affairs will be found with the halogens.

We have,

F	2, 7
Cl	2, 8, 7
Br	2, 8, 18, 7
I	2, 8, 18, 18, 7

In the outermost group we have 7 electrons—one less than the stable arrangement 8 and the great resemblance of the halogens follows from this resemblance in electronic groupings.

We may quote one more example—an interesting one, the rare earth elements.

Lanthanum with an atomic number 57 has the arrangement—

$$2, 8, 18, 18, 8 + 1, 2$$

The next rare earth cerium has the arrangement—

$$2, 8, 18, 18, + 1, 8 + 1, 2$$

and we proceed through the series of rare earth elements by adding one electron at a time to the fourth group, thus,

$$2, 8, 18, 18 + 2, 8 + 1, 2$$
$$2, 8, 18, 18 + 3, 8 + 1, 2$$
$$. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad .$$
$$2, 8, 18, 18 + 14, 8 + 1, 2$$

When 14 electrons have been added to this group the total number is 32 and reference to the table indicates that that is the maximum number possible for the group.

The next element hafnium then has the arrangement—

$$2, 8, 18, 32, 8 + 2, 2$$

and is obviously not a rare earth element.

The great similarity of the rare earths is to be found in the identity of the two outermost shells 8 + 1, and 2.

The relationship of all the elements to one another, at all events chemical relationship, can be seen by examining the particular arrangement of the electrons for each element in a similar fashion to those examples just quoted.

It must however be pointed out that these structures are those of "normal" atoms, that is, an isolated atom of the element at a temperature low enough for it not to radiate energy and to have its electrons in the most stable orbits possible. In most cases these "normal atoms" are highly unstable but a knowledge of the structures gives us valuable information as to the chemical behaviour of the element.

In the table previously mentioned it has been shown that the electrons may be paired, that is to say have the same numbers for the first three quantum numbers, but have different spins. Now in any atom, say hydrogen with only one electron, there cannot be a fellow with which to pair, it is only with helium that the second one is introduced. With lithium 2, 1, unpairing is again introduced, but with the inert gases pairing of electrons is complete.

In this pairing of electrons we have a possible explanation of chemical reaction. London, in 1927, suggested that chemical combination was to be regarded as the pairing of unpaired electrons in different atoms. Thus the hydrogen molecule is formed by the pairing of electrons of opposite spins from two hydrogen atoms. The inert gases are inert because in their electron groupings all the electrons are paired.

Time does not permit me to do any other than mention this interesting theory and to add that a similar state of affairs may be possible with the protons of the atomic nucleus. In the hydrogen molecule, apart from the paired electrons we have just discussed, it is possible that the two protons of the nuclei may have opposite or identical spins. In 1927, Dennison arrived at the conclusion that hydrogen must consist of a mixture of two different kinds of molecule. In one kind known as ortho hydrogen, the two nuclei rotate in the same direction, in the other known as para hydrogen, the two nuclei rotate in the reverse sense.

This conclusion has since been verified by experiment and practically pure para hydrogen has been obtained.

It has been demonstrated that at the absolute zero, hydrogen would revert completely but very slowly to the symmetrical form, the change being accelerated by the use of wood charcoal as a catalyst and by the application of high pressure.

It is believed also that nitrogen and iodine molecules also exist in symmetrical and anti-symmetrical modes and also the compound acetylene.

The last word does not appear to have been said with regard to hydrogen in so far as the existence of an isotope is concerned.

Recent issues of Nature (1932), make reference to the detection of an isotope of mass 2. Evaporation of liquid hydrogen would result in the relative enrichment in the remaining liquid of this isotope and evidence of the existence of the isotope has been obtained by means of the mass spectrograph.

The mass found was 2.01351 ± .00018 [$0^{16} = 16$].

Examination of ordinary hydrogen chloride showed that H^2Cl was present to the extent of 1 part in 35,000. Further results will be awaited with interest, especially as it is highly desirable that we should know all that is to be known regarding the first element hydrogen of atomic number 1, rightly or wrongly suggested by Prout over a century ago as the primitive material from which all elements are built up and therefore probably holding a unique position in the relationship of the elements.

REFERENCES.

Rutherford, Sir E. (1932) Proc. Roy. Soc. Lond. A, Vol. 136, No. 830, p. 735.
Chadwick, J. (1932) Ibid, p. 692.
Nature (1932) December 3rd.

Notes on Australian Syrphinae (Diptera)

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The majority of the Syrphidae that are of economic importance, come within the subfamily Syrphinae which was not incorporated in the revision of the family given by the late E. W. Ferguson. There is, however, an incomplete manuscript in the hands of Dr. I. M. Mackerras which I have not seen and there, will be found the descriptions of a number of manuscript names applied to specimens in various collections. A study of the material named, leads me to the conclusion that Ferguson intended to revise the genus on the plan found in Brunetti's paper; inserting the Australian genera that are foreign to the Indian element. I cannot see how he intended to treat *Emmyia*, *Chilosia* and *Hemilampria*, for he evidently did not recognise and name these; nor can I see any improvement contemplated in regard to the treatment of species that had been placed under *Melanostoma*; nevertheless, I credit to the effort of Ferguson, the identity of most species whether they be obvious or not. Some of the names were applied before Ferguson began his revision.

I am indebted for the loan of some exotic genera to Dr. W. Horn, Director of the "Deutscher Entomologisches Institut," these genera being somewhat akin to the *Psilota* element. It would seem that Brunetti, Ferguson, Klocker and myself, were all a little confused in regard to the limits of *Psilota*, but the study of the typical form and other genera has now allowed me to suggest an improvement in its treatment, making two subgenera, of which one could be raised to generic rank if desired. As at present constituted, the genus *Psilota* forms the largest unit represented in Australia, for there are many undescribed species.

Besides my own, other collections which I have seen when compiling these notes, are those of the Queensland and Australian Museums, the Ferguson collection in the School of Tropical Medicine, Sydney, and that of Mr. F. A. Perkins. All of these contain specimens identified under manuscript names and doubtless will be found as species described in the Ferguson manuscripts.

KEY TO THE GENERA OF SYRPHINAE.

1.	Face with a central knob in both sexes	2
	Face with a central knob on male only	11
	Face without a central knob in either sex	9
2.	Seen in profile, face with a conspicuous concave line between the antennae and tubercle, or if only slightly concave, then a bright yellow and black species	3
	Face hardly concave between the antennae and tubercle. Dark species, at most with yellow on only part of the face and scutellum	*Paragus*
3.	Abdomen very long and slender, usually clubformed, and the second segment reaching to about one third of the abdomen	*Baccha*
	Abdomen not so formed, and if slender the second segment reaching not beyond one quarter of the length of the abdomen	4
4.	Face and scutellum black	*Melanostoma*
	Face or scutellum at least partly yellow	5

5.	Thorax with conspicuous yellow lateral margins on the dorsum, and also the pleura with yellow parts	6
	Thorax without, or at least with inconspicuous yellow lateral margins and the pleurae never with yellow parts	8
6.	Hind trochanter with a conspicuous spine-like process, a character that is unique to the genus	*Ischiodon*
	Hind trochanters simple	7
7.	Abdomen rounded at the lateral border and without a depression marking it off	*Sphaerophoria*
	Abdomen very flattened, the sides having an edge marked off by a depression	*Xanthogramma*
8.	Ocellar triangle placed well back on the head so that it is no further than its own length, away from a line joining the posterior border of the two eyes	*Syrphus*
	Ocellar triangle placed well forward so that it is further away by twice its own length, from a line joining the posterior border of the two eyes	*Asarkina*
9.	Abdomen with the third and second segments longer than wide, and other segments inconspicuous by comparison. The enlargement of this region is unique to the genus	*Triglyphus*
	Abdomen with the second, third and fourth segments subequal in size	10
10.	Head produced so that seen in profile, the antennae are as far away from the eye as the width of the eye ; thence the face is very concave to the oral margin which again reaches as far from the eye	*Cyphipelta*
	Head normal. Typically with the face long and straight and the mouth border more or less produced forwardly ; the face, however, may be short with a much enlarged prominence at the mouth border, making the face concave apparently for its whole length. All grades are found in these face characters	*Psilota*
11.	Median vein meeting the fifth radial at an acute angle, and running parallel with the wing margin. (Besides the form placed here, the male of which has hairy eyes, *Plesia analis* Macq. runs here, too, but it can hardly be congeneric) ..	*Chilosia*
	Median vein running into the fifth radial at right angles and remote from the wing border	*Hemilampra* and *Chrysogaster*

The following notes on the species gives the original generic name applied by the author to the species, but are arranged under the generic name in which they are now placed.

Genus *Paragus* Latrielle.

Mulio serratus Fabricius 1805, is a widely distributed form recorded from New Guinea, but not hitherto from Australia. It is rather plentiful in northern Queensland and two females are from Palm Island, May 1925, these bearing Ferguson's identification label. It is readily recognised by the apical half of the abdomen being yellow with serrations along its border.

Pipiza tibialis Fall. 1817, is a species of the northern hemisphere, but Ferguson identified one in the Queensland Museum (Brisbane, 3.ii.1914, H. Hacker) under a synonym, *P. rufiventris* Brunetti. This form has the third and subsequent abdominal segments red. Except for the face and legs which are partly yellow, there is an entirely black specimen in my collection from Brisbane, April 1928. The species is evidently introduced.

Genus *Melanostoma* Schiner.

Syrphus agrolas Walker 1849, *S. expositus* Walker 1852, and possibly *S. propinquus* Macquart 1849, all described from Tasmania, are names belonging to the species to which Ferguson attached Walker's first specific name. It is very abundant in Tasmania and the four large spots of the abdomen, together with the black face and scutellum, makes the species readily determined. There is a close ally with an entirely black abdomen, in the Queensland Museum.

Syrphus univittatum Wiedemann 1824, is the name applied to a species formerly known as *Syrphus planifacies* Macquart 1848, in Australia. It is the small species abundant in swamps during spring and is represented in most collections. The tubercle of the face is sometimes difficult to make out and at other times appears like an obscure pair of adjacent tubercles.

Klocker's determination of *Melanostoma apicale* Bigot, does not belong here, but is referred below under *Plesia analis* Macquart, which may belong to a new genus.

Genus *Ischiodon* Sack.

Scaeva scutellare Fabricius 1805, has many synonyms and it may have been described from Australia under a name not yet recognised. It is not uncommon in northern Queensland where it has been bred by Mr. W. A. McDougal who found it infesting sugar cane aphides, it also occurs in Brisbane. Under the name *Xanthogramma scutellaris*, Ferguson has labelled specimens that may be this species, but they miss the spine on the trochanters, whilst another specimen is queried as belonging to this genus and is given the same specific name. It requires Ferguson's manuscripts to disentangle this matter, for he does not seem to be consistent in applying the name.

Genus *Sphaerophoria* St. Farg. & Serv.

Syrphus javana Wiedemann 1824, is a species with a wide range and reaches Australia ; *Melithreptus australensis* Schiner 1868, is a synonym and there may be others not recognised as belonging here.

Sphaerophoria kerteszi Klocker 1924, has more recently been described, but Ferguson has labelled it as being *S. menthastri* Linnaeus 1758, the typical form of the genus. The specimens I have seen do not agree with the description of the latter, which however, is said to be very variable.

Genus *Xanthogramma* Schiner.

Syrphus grandicorne Macquart 1842, described from Port Jackson, is perhaps the most abuntant fly of the family in Australia, occurs abundantly in all States and has been reared from aphides in most of them. It is also considered to be capable of feeding on scale insects but I have seen none reared in this manner. It is the most dominant species, and its wide range suggests it could be introduced into most parts of the world.

In the manuscripts of Arthur White, it was suggested that *Syrphus pusilla* Macquart 1847, is a synonym. *Syrphus sydneyensis* Macquart 1846, *S. pallidus* Bigot 1884, and *S. macrogaster* Thomson 1868, none of which have been recognised in Australia, may also be synonyms.

Genus *Syrphus* Fabricius.

Six species belonging to this genus and commonly met with in collections, may be distinguished by the following key :—

Key to species of genus Syrphus.

1.	Face entirely yellow ; abdomen with broad yellow bands, that on the second segment being interrupted	2
	Face not entirely yellow	5

2. Abdomen very broad and flat, the lateral margins being marked off by a depression	*confrater* Wied.
Abdomen less broad and the lateral margins not marked off by a depression	3
3. Third abdominal segment with a narrow discal black band ..	4
Third abdominal segment with bands only along the segmentations, none on the discal area	*sellenyi* Sch.
4. Fourth abdominal segment with a discal band	*balteatus* Deg.
Fourth abdominal segment without a discal band	*sp.*
5. Face yellow with the tubercle and oral margins black. All yellow bands of the abdomen interrupted	*viridiceps* Macq.
Face entirely black, at most with a grey pulverulent covering over part of the area	6
6. Abdomen black with narrow light bands	*serarius* Wied.
Abdomen black with interrupted light bands that appear as semilunar spots	*ortas* Walk

Syrphus confrater Wiedemann 1830, is recorded from Asia to New Guinea and is also a well known Australian species.

Syrphus sellenyi Schiner 1868, has a slender abdomen with simple black bands somewhat like those of the prior species. Two males from Brisbane are before me.

Musca balteatus Degeer 1776, is the name usually applied to a form recorded from Australia by Macquart as *Syrphus alternans* Macquart 1842, from India. Brunetti elucidated the position for India for that variable form, but in Australia the species which goes under this name varies very little. I do not know if the species in Australia is truely *S. balteatus* ; the matter requires investigation.

Syrphus sp. I have no name for this form which is somewhat like *S. balteatus* in markings, but has the face covered by a light pulverulent overlay ; the abdominal bands especially on the apical segments are much wider.

Syrphus viridiceps Macquart 1847, has the central area of the face black and the scutellum may be largely black, whilst the bands of the abdomen may be broken up into six large yellow spots with traces of another pair at the apex. This very common species may have been described under two other names, *S. collatus* Walker, 1852, and *S. jacksoni* Bigot 1884.

Syrphus ortas Walker 1849, was originally described from New Zealand, and this species would seem to be identical with a common Tasmanian form that is very dark ; the yellow bands of the abdomen being often obscure, each being interrupted and reduced to two semilunate spots ; also these spots may be covered with an overlay that shines yellow or grey in accordance with the incidence of the light reflected. *Syrphus ambusta* Walker 1852, may belong here.

Syrphus serarius Wiedemann 1830, is a name applied by Ferguson to a black species with three linear pulverulent covered bands that traverse the abdomen. The form is apparently not previously recorded from Australia but is to be met with in Brisbane and perhaps more frequently in scrub areas.

Two species placed here have not been recognised. *Syrphus rufiventris* Macquart 1849, and *Scaeva damastor* Walker 1849. It is not yet possible to suggest their generic position.

Genus *Asarkina* Macquart.

Two species are known to me in this genus, but Ferguson has labelled specimens with two other names attributing them to Bezzi.

As I have failed to trace these in literature, I suspect them of being manuscript names and so omit them here.

Eristalis aegrota Fabricius 1805, has a black area across the central part of the wing, occupying about a third of the length.

Syrphus ericetorum Fabricius 1781, has hyaline wings. Both of these species are common in the northern parts of Queensland and the former reaches Brisbane ; some years being rather plentiful at Sunnybank.

Genus *Triglyphus* Loew.

Triglyphus fulvicornis Bigot 1884, is known from Stanthorpe in Queensland, to Tasmania.

Genus *Baccha* Fabricius.

This well known genus is well represented in Australia, several species being bred from aphides. Two species are described, *B monobia* Terry, and *B. siphanticida* Terry 1905 ; both are from north Queensland. Ferguson does not seem to have identified either.

Genus *Cyphipelta* Bigot.

Brachyopa rufocyanea Walker 1835, a species to which the names *Eristalis vesicularis* Erichson 1842, and *Cyphipelta conifrons* Bitgo 1859, also apply. It is not common but Mr. F. A. Perkins took a series at Stanthorpe, and I have one from Brisbane (August 1920). It is also known from Sydney and Bigot's record from Tasmania needs confirmation.

Genus *Chrysogaster* Meig.

There are several groups that are placed under the generic name *Chrysogaster* and it seems advisable to incorporate *Hemilampra australis* Macquart 1849, in this position, as it is probably congeneric with the other forms already placed here. *Chrysogaster cuproeus* Macquart 1849, and *C. australis* Macquart 1854, are not recognised. *Chrysogaster rectinervis* deMeijere 1908, and *C. rufonasus* Curran & Bryan 1926, are not certainly recognised as there seems to be a series of species which comes near each of them.

Genus *Chilosia* Meigen.

Chilosia australis Macquart is a common Brisbane species having rather dissimilar sexes. I have not seen any illustration that has such a small area forming the eye-margins, on which character it might be excluded from the genus, but on the other hand all the other characters seem to indicate its alliance with the genus *Chilosia* in which position it is retained.

Genus *Psilota* Meigen.

Numerously represented in Australia, but poorly so in other parts of the world ; this genus has had no defined limits. Quite a number of subsidiary groups could be made out of it but it would appear that only two are at present worthy of recognition, the typical group having the posterior femora without the flange, the other with it. The genus *Emmyia* Klocker 1924, is but little different from the typical form, *P. anthracina* of Europe and hence it is regarded as being congeneric. Two species have not been recognised in Australian collections, but enough is given in their descriptions to indicate their probable position and hence are incorporated in the key.

Key to species of Psilota.

1.	Hind femora, on the posterior side, indented and with a ventral flange just before the apex	6
	Hind femora simple and without a flange	2
2.	Entirely black and blue-black species (hairs excepted) ..	3
	Species with the abdomen red or mainly so	*rubra* Klock
3.	With a golden-red pile over the apical portion of the abdomen	*auricaudata* C. & B.
	Without such pile	4
4.	Crossvein at apex of wing practically straight	5
	Crossvein at apex of wing conspicuously bent. Large species with the crossvein sinuous	*queenslandica* Klock
5.	Abdomen hairy	*hirta* Klock.
	Abdomen practically bare	*tristis* Klock.

Key to species of Parapsilota.

6.	Dark blue-black and steel-blue species	7
	Vivid blue-green species	8
7.	Abdomen blue-black	*femoralis* Schin.
	Abdomen reddish (? discoloured)	*erethrogaster* C. & B.
8.	Hair on face bright yellow and longer than usual	*coerulea* Macq.
	Hair on face whitish	9
9.	In profile the line of the face from antennae to oral margin is approximately the same in both sexes, the oral protuberance being of equal prominence	*viridis* Macq.
	Face dissimilar in the sexes, the female having the oral margin more protruding and the face apparently concave	*victoria* Curran

Subgenus *Psilota*.

Psilota rubra Klocker 1924, has the abdomen genuinely red, and not discoloured as sometimes happens with species that are normally black. The flies belonging to this series (for there seem to be several) fly along logs in company with a bee which also has a red abdomen I have seen this in Queensland and Tasmania. The male is not known

Psilota auricaudata Curran & Bryan 1926, is commonly found flying around dead upstanding trees, but the male has not yet been discovered.

Psilota tristis Klocker, is also only known from the female, but there is a species very closely allied in which both sexes are before me. This second form is more strongly metallic, having a green thorax and violet abdomen instead of blue-black and black respectively.

Psilota queenslandica Klocker, the typical form of genus *Emmyia*, is only known from the male, several being in various collections. Klocker's figure is very faulty, judging from the specimen he identified under the name and which fits the description exactly.

Psilota hirta Klocker, is perhaps the commonest species in Brisbane, the male being specially noticeable, sometimes hovering around trees in countless numbers. There is only one female before me, and some specimens from Tasmania seem to be conspecific though larger in size.

Subgenus *Parapsilota* n. subg.

Psilota victoria Curran 1925, was a name given to replace *Psilota cyanea* Hill (nec. Brunetti 1921). The specimens identified by Curran under the name, however, probably belong to another species, perhaps *P. viridis* Macquart. Hill's figures are very accurate, but he gave the lateral view of only the female head.

Psilota viridis Macquart 1847, is evidently the common Victorian species which I have selected to be the type of the subgenus.

Psilota coerulea Macquart 1846, is another form that seems easily identified but less common.

Psilota femoralis Schiner 1868, undoubtedly comes into this position as the author mentions the femoral character, but *Psilota erethrogaster* C. & B. does not have the character mentioned, nevertheless it would seem to belong here.

All of the above species under *Parapsilota* and others, have in common an indentation on the posterior side of the hind femora, below which is a ventral flange situated just before the apex. The character is very consistent and no apparent grades exist between this and the simple femora of species placed under the subgenus *Psilota*. In addition to this it seems strikingly obvious that all the forms that deviate away from the typical form to any extent, belong to this subgenus, but all the characters yet studied seem to show gradations in *Parapsilota* to that of *Psilota*. There are some very apparent smaller divisions existing under both subgenera but material does not permit me to make the necessary groups to illustrate this. Most of the species have yet to be described and presumably many more are to be found. *Psilota* and its allies occur during the spring and in Brisbane at least their occurrence is irregular, some years they occur in abundance and in others are very difficult to find.

Species not relegated to a generic position.

Plesia analis Macquart 1849, and *Melanostoma apicale* Bigot 1884 (Klocker in 1924, identified it under the latter name), refer to the male of a very abundant species. The female, however, has a concave face without a knob and does not conform to genus *Melanostoma*. The characters bring this species in the key given above to *Chilosia* but it does not belong there and it is not congeneric with *C. australis*, nor is it related to the *Chrysogaster* group. There is another but smaller species that is congeneric with this one and is found on tea-tree (*Melaleuca*) and on marshes in association with it. The two species are liable to be confused.

List of Works.

The following list contains those works which record species of Syrphinae from Australia and the original descriptions of such species; the list being limited to those of taxonomic value. In economic literature there are many references, the species not always being identified, or sometimes faultily so.

Austen. .. .. .. Proc. Zool. Soc. Lond. i. 1893, 163.
Bigot. .. .. .. Rev. Mag. Zool. ii. 1859, 307.
Bull. Soc. Ent. France, 1882, lxviii.
Ann. Soc. Ent. France (6) iv. 1884.
Brunetti. .. .. Faun. Brit. Ind. iii. 1923.
Curran. Amer. .. .. Mus. Novitates, No. 176, 1925, 7.
(In same periodical No. 200, is *Cerioides victoria*, a description overlooked by Ferguson).
Curran & Bryan. .. Proc. Lin. Soc. N.S. Wales, li. 1926, 129-133.
Degeer. .. .. .. Mem. pour serv. l'Hist. d. Ins. vi. 1776.
de Meijere. .. .. Tidj. v. Ent. li. 1908, 191-332.
Erischson. .. .. Arch. f. Naturg. viii. 1842.
Fabricius. .. .. Spec. Ins. 1781.
.. .. Syst. Ant. 1805.
Fallen. .. .. .. Dipt. Sueciae, 1817.
Ferguson. .. .. Proc. Lin. Soc. N.S. Wales, li. 1926, 137-183, 515-544.
(Partial revision of the Syrphidae).

GRIMSHAW. .. .. Fauna Hawaiiensis iii. 1901.
HILL. .. .. .. Proc. Lin. Soc. N.S. Wales, xlvi. 1921, 216-220.
KLOCKER. .. .. Mem. Queensland Mus. viii. 1924, 53-60.
LINNAEUS. .. .. Syst. Nat. Ed. x. 1758.
MACQUART .. .. Dipt. Exot. 1838-55.
RODER. . .. .. Wien Ent. Zeit. i. 1882, 61-2.
SCHINER. .. .. Reise Novara Dipt. 1868.
SHIRAKI. .. .. Mem. Fac. Sci. Agr. Taikoku Univ. Formosa. 1930.
TERRY. .. .. .. Bull. Exp. Stat. Hawaii, i. 1905, 177-9.
THOMSON. .. Eugenies Resa 1868, 501.
WALKER .. Ent. Mag. ii. 1835, 472.
List Dipt. B.Mus. iii. 1849.
Ins. Saund. Dipt. i. 1852.
WIEDEMANN .. .. Dipt. Exot. 1824.
Auss. Zweifl. Ins. 1830.

Serum Inhibition of Haemolysis.

By J. V. DUHIG, M.B.

(Two Text Figures)

(*Read before the Royal Society of Queensland, 31st July,* 1933).

In a previous paper (Duhig and Jones, 1928), I concluded from observations of the haemolytic action of a certain fish venom, that the protective action of serum against haemolysis was to some extent species-specific. It was found, for example, that guinea-pig serum was more potent in inhibiting haemolysis of guinea-pig red cells than was human serum and, *vice-versa*, guinea-pig serum did not protect human cells from the action of the haemolytic agent as well as did human serum.

In the experiments described, I have proceeded to test these findings by the use of a haemolytic substance of known activity: a solution of pure white saponin in 0.85 per cent sodium chloride solution.

To obtain strictly comparable results when working with the cells of different animal species, cell suspensions of as nearly equal surface area as possible were used. The casual use of the percentage suspensions commonly employed in serology is obviously fallacious when we remember that the surface area of an average red cell of any given species is different from that of an average cell of another species. The surface area of the red cells of the human, guinea-pig and sheep was calculated according to the formula of Ponder (1927),

$$\Delta = 2\pi A^2 + 2\pi AB\ (0.6)$$

where A and B are the major and minor axes of the cells respectively and 0.6 a factor which Ponder finds to be "remarkably constant for all cells of mammalia." I estimated by the camera lucida method at a magnification of about x800 the major and minor axes of 100 cells suspended in plasma of three animal species.

The results were,

human	cells,	$\Delta = 61.0\mu^2$,	ratio 1.0
guinea-pig	,,	$\Delta = 48.8\mu^2$,	,, 0.8
sheep	,,	$\Delta = 41.5\mu^2$,	,, 0.68

These figures agree well with those given by Ponder (loc. cit.).

In work of this kind, account must be also taken of the difference which may exist in the total red cell counts of the species studied. I worked with human and guinea-pig cells in the final tests, and since the total counts of these species are the same, this factor was negligible.

In accordance with the ratios of cell surface determined, 5 per cent. cell suspensions of as nearly equal surface area as possible were prepared and mixed with equal volumes of serial dilutions of a primary dilution of 1 in 1000 of pure white saponin in 0.85 per cent. saline.

Owing to the rapidity of action of the saponin in the lower dilutions, the mixtures were made in separate operations for each tube, quickly mixed by inversion and placed in a water bath at 37°C. The time for complete haemolysis to occur was taken by a stop watch and read in whole seconds. For each species, three sets of observations were made, namely :—

(1), human cells plus saponin ; (2), human cells plus saponin plus human serum ; (3), human cells plus saponin plus guinea-pig serum ; (4), guinea-pig cells plus saponin ; (5), guinea-pig cells plus saponin plus guinea-pig serum ; (6), guinea-pig cells plus saponin plus human serum.

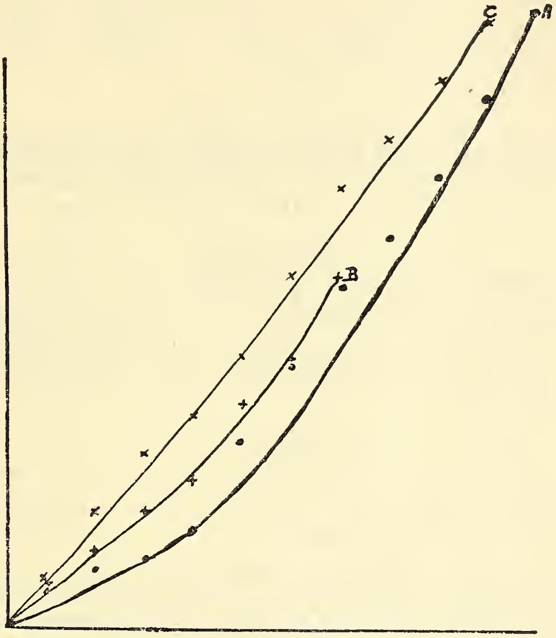


Fig. 1. Curves A, human cells alone ; B, with Guinea Pig serum ; C, with human serum.

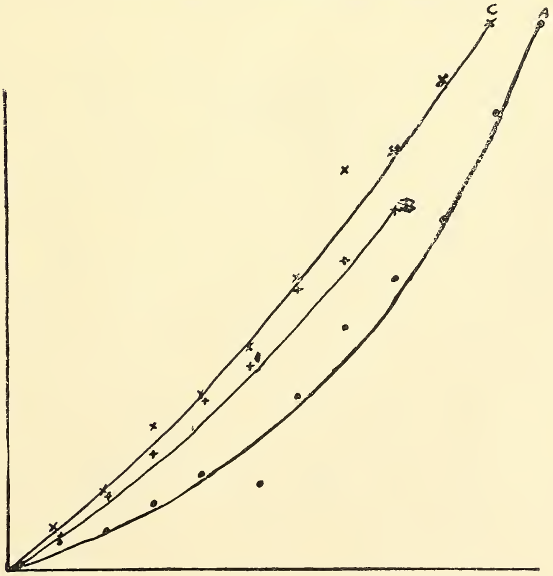


Fig. 2. Curves A, Guinea Pig cells alone ; B, with human serum ; C, with Guinea Pig serum.

The whole of the tests were repeated and the second set of results were found to be in substantial agreement with the first.

The sera, the protective action of which was being studied, were used in an arbitrary dilution of 1 in 10, which figure was arrived at as that most likely to show best in a graphic manner the kind of phenomenon studied. Outside that dilution, the effect of the saponin was progressively too fast or too slow for accurate observation.

The curves show the kind of result obtained ; the dilution of saponin being plotted along the abscissa and the times taken for complete haemolysis along the ordinate.

A glance at these curves shows that haemolysis of the cells of either species is more rapid in the absence of serum and slowest when the serum used is that of the same species as the cells, while a heterologous serum gives a time series intermediate between the two.

Conclusions.

1. Serum inhibits the action of haemolytic agents, "*in vitro.*"
2. The inhibitory power of serum in this respect is greater when the serum is of the same species as the cells protected.

I have to thank my assistant, Miss Gwen Jones, for her valuable technical aid.

REFERENCES.

Duhig, J. V., and Jones, Gwen., 1928, Aust. Jl. Exptl. Biol. and Med. Sci., 5, 173.

Ponder, E., 1927, Biochemical Journal, 21, 56.

(Note.—Just after this paper went to press, Kellaway and Williams reported serum inhibition of haemolysis by snake venom. Their paper in the Aust. Jl. Exptl. Biol. and Med. Sci., 1933, 11, 2, 81, gives a full discussion of the whole subject)

Two Australian Pandani

By Professor U. Martelli
Director Botanical Gardens, University of Pisa, Italy.

Plates I. and II.

(*Communicated by C. T. White, Government Botanist, Brisbane, to the Royal Society of Queensland,* 31*st July*, 1933).

Mr. C. T. White, Government Botanist, Brisbane, sent me for identification last autumn, some beautiful sheets of two Australian species of *Pandanus.* One proved to be *Pandanus Copelandii* Merr., very interesting from a geographical aspect. The second was a new form of the group of *Pandanus spiralis* R. Brown, of the subgenus *Keura.* It belongs to an Australian group not known elsewhere, because the *Pandanus fanningensis* Mart. (Univ. of Calif. Publ. Vol. 13, No. 7, page 145, plate 12), which I consider belonging to it, was found on the sandy shore of Fanning Island, but only a phalange washed up by the waves, probably conveyed by currents.

I think a few observations about these two species will not be without interest.

Pandanus spiralis Brown.

This plant was described by R. Brown in 1810, in his " Prodr. Florae Novae Holandiae," with this brief, but rather clear diagnosis : " Caudice stolonibus carente, phalangibus druparum 9-20 locularis, apice depresso, tesselato, basi obtusissima." A figure of the species I reproduced in my " Enumerazione delle Pandanaceae " Webbia, Vol. IV. Parte 1., tav. 13, fig. 1-2.

The specific name *spiralis* was used by other authors for a *Pandanus* quite different from the one described by R. Brown. We have a *P. spiralis* Blanco, Fl. Filippin, 1897, p. 777, growing in the Philippines ; I judge this, from the description, to be referable, *pro parte,* to *P. odoratissimus* variety, which I distinguish with the name var. *spiralis* (Martelli, Philip. species of *Pandanus,* in Webbia, tav. 8 fig. 1-2 ; tav. 9 fig. 1 ; tav. 12 fig. 8), and, *pro parte,* to a not identifiable species. Ouden, in Sieb. et de Vriese, Fl. Jard. Pays Bas. V. 1862, p. 81, fig. A.B. used the name *spiralis* for a *Pandanus* which should be ascribed to *P. utilis* Bory, of Reunion. At last, the name *spiralis* was also noted by Wendland, Index Palm. 1854, p. 47 without any description, it is then a "*nomen nudum*" of an unknown species.

Robert Brown indicates, very vaguely, the native country of his *P. spiralis* ; " Nova Hollandia, intra circulos tropicos," and the specimen at the British Museum bears no more precise indication. Bentham, Flora Australiensis VII, page 148, sub *P. odoratissimo,* describes Brown's species and indicates some localities, all in north Australia ; *e.g.,* Port Darwin, Arnhem's Land, Islands of Gulf of Carpentaria, Escape Cliff, King's Sound. In the carpological collection of the Museum de Paris I saw two phalanges of this species sent by

Baron F. von Mueller in 1874, collected at Escape Cliff, probably by Mr. Hulse. In the carpological collection at the British Museum there are beautiful phalanges of this species from Escape Cliff. I have tried more than once to get people living in Australia to search for the species, but without any result. I was more fortunate when I addressed myself to Mr. C. T. White, of Brisbane, who eagerly interested himself in the matter and succeeded in obtaining from one of his acquaintances some specimens of it. He was so kind as to forward them to me and I here express my gratitude to him, not only for these, but also for many other Australian specimens of *Pandanus* he has had the kindness to send me for my studies.

Pandanus spiralis R. Br. seems to be an inhabitant of the northern Australian lands only, though some forms like it have been found here and there elsewhere.

Some years ago, in 1922, an analogous form, but specifically different, was discovered by Mr. White in low savannah forest country near Townsville, and I called it *P. Whitei* ; and had the pleasure of publishing a description in the Proceedings of the Roy. Soc. of Queensland Vol. XXXVI n. 9. Mr. Allen in 1927 collected the same species near Darwin, Northern Territory. In 1928 Mr. Tandy collected on the Western side of South Brooke Island in Whitsunday Passage, another form belonging to the same group of *Pandanus spiralis* and *Whitei*, but specifically different from them. I was able to observe the specimen by the kindness of Mr. White and I distinguished the form with the name of *P. Brookei*, but never described it. Last autumn Mr. White forwarded to me again a syncarp and its photograph, the same reproduced here, of *P. Brookei*, collected by him in August, 1931, in coastal savannah forests at Farnborough near Yeppoon, Queensland (White No. 8195). Specifically they are distinct forms, but all of what I may call the regional type. I observed the same thing in *P. pedunculatus* and even in *P. Cookii* and *P. Damannii*. Are these forms the result of hybridisation ? I doubt it, but I cannot say anything on this question.

Pandanus (*Acrostigma*) *Copelandii* Merrill.

This plant was first described by Dr. E. D. Merrill in his paper "New or noteworthy Philippine plants, P. 11," published in Govt. Labor. (Philip.) Publ. No. 17 (1904) p. 7. and is the other species forwarded to me by Mr. C. T. White. It belongs to the subgenus *Acrostigma* and not to *Rykia* as says Prof. Merrill in the description *l.c.*—of which in Australia previously only *Pandanus monticola* Mueller was known. *Pandanus Copelandii* was originally described by Dr. Merrill on a specimen gathered at Gimagon River, Negros Island, one of the Philippines, and nowhere else. It was then a great surprise for me when I received the Australian sheets from Mr. White with a fine photograph of a portion of the spadix accompanied by information on the locality and on the appearance of the plant : "It is there comparatively rare, the trees attain 4-5 m. in height and are surrounded by dense clumps of young trees, these latter bearing syncarps when only about 1m. high. The Filipino boatmen, who were with Mr. Hockings, the collector, stated that they recognised the species as one that grew in their own country and the leaves of which they used to make baskets." (C. T. White, *in litteris*). The presence of this Philippine species on the Australian continent, in its most northern regions, is an important fact that I am not able to explain nor to give a plausible hypothesis; it is interesting on account of geographic botany.

The species of *Pandanus* are circumscribed in a limited territory, and it is a very rare case that the same species be diffused at such a great distance. I ascertained once that a microspecies of *Pandanus odoratissimus* (type), also of the Philippines (which is important), was found by Mr. C. Hedley in 1924 and communicated to me by Mr. C. T. White, growing on Northwest Island, one of the Capricorn group. It is true that the microspecies belongs to the subgenus *Keura* which species have more or less large phalanges that may float easily for a long time. However, I ask myself, if it is possible for phalanges to be conveyed by currents from the Philippines to coastal Queensland, along an ocean spread with such numerous islands. *Pandanus Copelandii* does not belong to the subgenus *Keura* but to *Acrostigma*, the species of which have not phalanges but small drupes which easily separate from the axis, so that I can admit, with great reserve, the possibility of their buoyancy for a long time. The drupes, when ripe, commonly remain assembled in the syncarp for a short time, and very soon fall down, sooner still if the syncarp is plunged in water. Once separated, the drupes, I think, may remain buoyant only for a relatively short time, after which they sink, because full of water.

On account of the hard spinescent character of the drupes I exclude the spreading by migratory birds. I do not know, after all, whether this migration, between the Philippines and Australia, does take place; it does not seem probable to me. I cannot admit, on account of the great distance and numerous islands between the Philippines and Australia, the possibility of living trees or portions of them being carried along waves from the Philippines and succeeding in landing on Australian shores. The only supposition remaining to my mind is the introduction by man. The species being rather scarce on the banks of the Jardine River, as Mr. Hockings informs us would show that the species is there not "*ab antiquo*," and we may suppose a comparatively recent introduction. An ethnographer on the place should be more able to examine the question and find a satisfactory answer.

Pandanus Copelandii Merrill, "New or noteworthy Philippine plants 11" in Govt. Labor. (Philip.) Publ. No. 17 (1904). An erect, unbranched plant of about 2m. high. Leaves 1 to 1.5m.long, 5.5 to 6cm. wide, glabrous, shining above, glabrous beneath, the margins and the midrib beneath spinously toothed, the teeth pale, coarse below, 3 to 4mm. long, the marginal teeth antrorse throughout, those on the midrib retrorse below, antrorse above, at a point 6 or 7cm. from the apex of the leaf the leaf is 3.5cm. wide, and from this point it tapers abruptly to the acute, not acuminate, apex, the midnerve and margins of the apex finely and densely serrate. Flowers unknown. Rachis triangular, 1.5cm. thick, 50cm. long. Fruits solitary or racemed, nearly sessile, elliptical or subspherical, 7 to 9cm. long, 5 to 6cm. in diameter, red when mature. Drupes very numerous, 14mm. long, 3 to 4mm. in diameter, the apex conical, 10mm. long, the slender style proper, 5 to 6mm. long, entire curved upward; endocarp 8 mm. long.

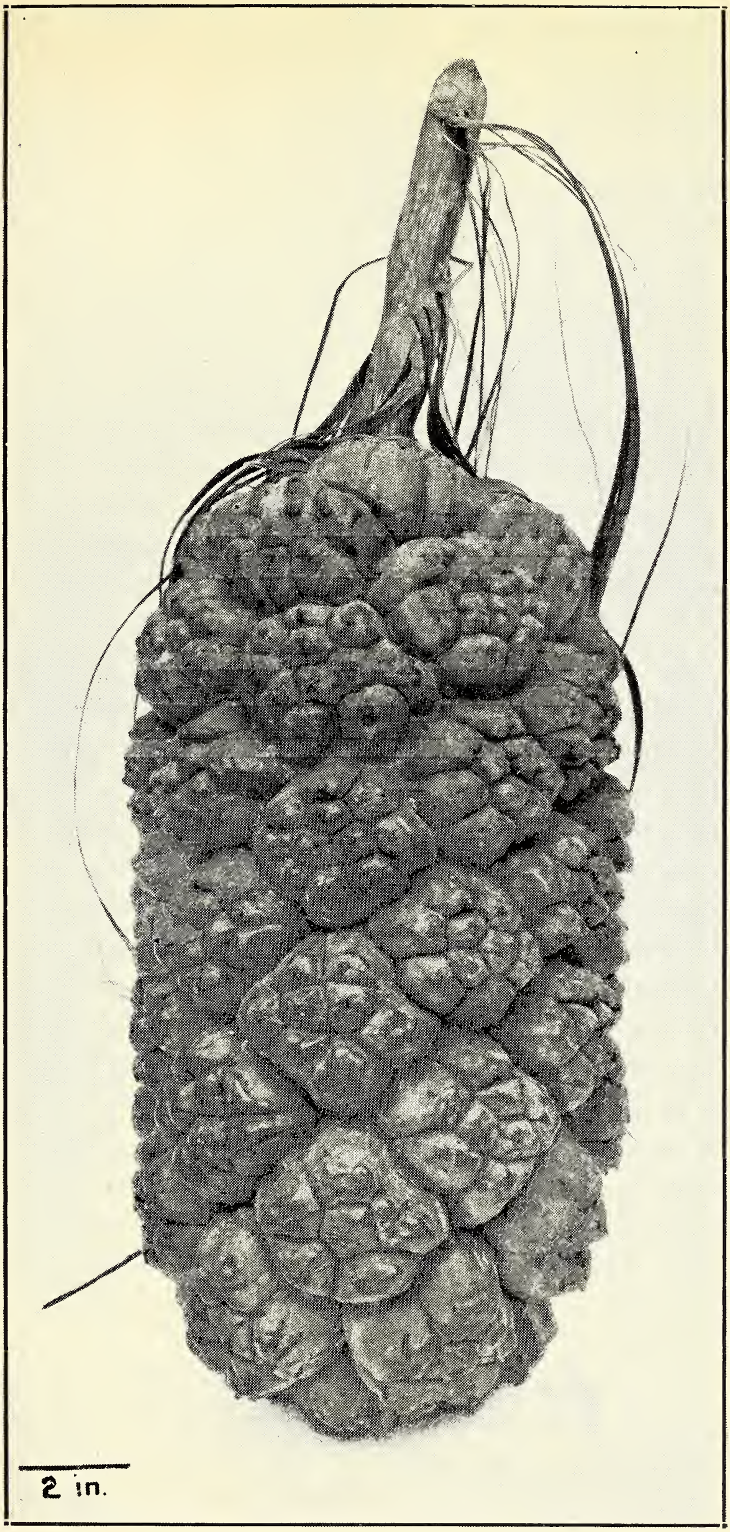
Habitat: Philippines; on Gimagon River, Negros, January 1904, Copeland. Growing in forests at an elevation (Merrill, *l.c.*)

Pandanus (*Keura*) *Brookei* Martelli.

Syncarpium solitarium, cernuum, oblongum, subrectangulare, ad vertices rotundatum, circiter 20 *cent. longum,* 11 *cent. diam., a plurimis phalangibus constitutum. Phalanges subponderosae, sub globoso-angulosae,* 4½-6 *cent.* (*in medio*) *latae,* 4-4½ *cent. longae, fere in dimidia inferiori parte inter se connatae et* (*in sicco*) *fibrosae, cuneatae, sed in basi lata vel latiuscula terminatae ; in fere dimidia superiori parte liberae, rotundatae, superne plano-convexsiusculae ; lateribus latis, plus minusve angulosis et sinuosis, secuus suturas loculorum anguste sulcatis non rugoso-costulatis ; loculis* 6-13, *subaequalibus, latis, interdum plus-quam pollicem, subirregularibus, convexis vel rotundatis, vel in pyramidem elevatis, a sulcis plusminusve profunde separatis, angulosis, laeviter costulatis. Stigma ad verticem loculorum, prominente et robustum. Endocarpium osseum, infra medio situm, totam latitudinem phalangis occupans, in sectione longitudinali, fasciform-lenticulare,* 1½ *cent. circiter spissum. Mesocarpium superum dense fibroso-medullosum, cum cavernis elongatis ; inferum fibrosum, breve circiter* 1 *cent.*

Habitat: Australia ; Central Queensland ; Western side of South Brooke Island in Whitsunday Passage ; *legit* Tandy 1928.—Keppel Bay at Farnborough near Yeppoon ; *legit* C. T. White Aug. 1932 (No. 8195).

This *Pandanus* is of the same type as *P. spiralis* R. Br. (*non alior*) and *P. Whitei* Mart. I think it a southern form of them. From *P. spiralis*, it differs in the smaller size of its phalanges, in the locules always more prominent, which does not all correspond to the character "apice tessellato" as Brown rightly indicates for *P. spiralis*. *P. Brookei* looks like *P. Whitei* Mart., but, although similar in type, it differs in its locules, not so prominent and not being at all "rugoso costulatis" along its sides. *P. Whitei* by this character is rather like *P. Damannii* Warb. Another peculiarity in *P. Brookei* is the shape of its syncarp, which in other *Keura* is generally globose or oblong, more seldom pyriform ; here instead the syncarp is very elongated and almost rectangular, rounded at the bottom. Mr. White informed me that all syncarps he saw on different plants of that species have the same shape. It is not then an occasional shape but a characteristic one ; the syncarps of *P. spiralis* and *P. Whitei* are globose, as I may judge by a photograph kindly forwarded to me by Mr. C. E. F. Allen collected near Darwin, Northern Territory of Australia.



Pandanus Brookei Martelli (from Farmborough near Yeppoon)

Photo Department Agriculture and Stock, Brisbane

Pandanus Copelandii Merrill (from Jardine River)

Photo Department Agriculture and Stock,
Brisbane

The Genus Pleiogynium in Papua

By C. T. White
Government Botanist, Brisbane.

Plate III

(*Read before the Royal Society of Queensland, 28th August*, 1933).

In his "Forest Resources of the Territories of Papua and New Guinea" (Government Printer, Melbourne, 1925) C. E. Lane-Poole records *Pleiogynium Solandri* Engl., the "Burdekin Plum" of Queensland, as growing at Aroa, Papua. These specimens were listed in the systematic account of Lane-Poole's collections by White and Francis (these Proceedings Vol. XXXVIII, p. 237). They consisted of a few leafy branches with female inflorescences and detached seeds. They agree well with Queensland material, except that the seeds are markedly smaller than in any Queensland specimens observed by me.

Early this year the Rev. A. H. Lambton brought me specimens of a *Pleiogynium* from the mountains near Goodenough Bay, Territory of Papua. These, unfortunately, in addition to timber and bark, consisted only of leafy branches bearing male inflorescences with the flowers in bud only.

Whether the specimen from Aroa and those from Goodenough Bay represent the same species or not, can only be told from more complete material, *e.g.*, male flowers in the former, and female flowers and fruit in the latter case. Personally, I regard the tree growing at Aroa as identical with the Queensland one, and the one growing at Goodenough Bay as distinct from it. Aroa in the west and Goodenough Bay in the east are opposite ends of the Territory of Papua, and though the material is fragmentary, the Rev. Lambton's specimens show distinct differences from Queensland ones ; and as the flora of the south and west of the Territory of Papua is more Australian than that of the east, I have decided to name his specimens as a new species and offer a description herewith.

Pleiogynium papuanum sp. nov.

Arbor mediocris, partibus novellis pubescentibus mox glabris, cortice atro ca. 1.5*cm. crasso, ligno atro-castaneo. Folia imparipinnata,* 3-4-*juga, rhachide* 8-20*cm. longo, interstitiis inter jugalibus* 2-3.5*cm. longis* ; *foliola petiolulo* 2*mm. suffulta, oblonga, breviter acuminata* 6-8*cm. longa,* 2.5-4*cm. lata, saepe latere superiore quam inferius paullum latiore, nervis lateralibus* 9-11 *in utroque latere, subtus prominulis. Paniculae masculae axillares, densiflorae, ad.* 15*cm. longae, ramulis secundariis horizontaler patentibus, infimis ca.*3*cm. longis, tertiariis* 0.5*cm. longis, rhachide ramulis albo-furfuraceis pedicellis robustis brevis, cum calyce* 1.5*mm. longis. Calyx* 5-*lobatus. Petala oblonga,* 1.5*mm. longa, alba* ; *stamina* 10 ; *filamentis* 1*mm. longis, levtier applanatis. Ovarium abortivum pyramidatum* ; *stylis liberis* 2-4 (*plerumque* 3). *Flores feminei ignoti. Drupa ignota.*

In mountains near Goodenough Bay, altitude 500 feet, Territory of Papua. Rev. A. H. Lambton.

Native names :—Wedan Language—Daraia. Daga Language—Kwa-ma-ma-tua.

Type :—Herbarium, Brisbane. Co-type material at Royal Botanic Gardens, Kew; Botanic Gardens and Museum, Berlin ; Arnold Arboretum, Boston ; Botanic Gardens, Buitenzorg.

Differs from *P. Solandri* Engl., the only previously known species, in possessing smaller male flowers, all pedicellate, more numerous in the panicle and in the rhachis and branches being covered with a grey scurfy tomentum. When female flowers and fruits are known probably other differences will be shown. The wood is softer than that of *P. Solandri* Engl., but like it, turns with a beautiful figure as shown by some examples of turnery made by Mr. Lambton.

Pleiogynium pup anum (Sp. Nov.)

Photo Department Agriculture and Stock,
Brisbane

A Note on Some Preliminary Experiments with Ammonia as a Lure for the Queensland Fruit Fly (Chaetodacus tryoni Frogg.)

By F. A. PERKINS, B.Sc. Agr., and H. J. HINES, B.Sc.,
(Of the University of Queensland)

(*Read before the Royal Society of Queensland, 30th October*, 1933).

Examination of a number of lures in use for the attraction of the Queensland Fruit Fly (*C. tryoni* Frogg.) showed that without exception they were composed of a dilute solution of ammonia plus some odoriferous substance or substances. An open formula was published by Jarvis (1931), synthetic essence of vanilla (vanillin) being the added odorant. Some preliminary experiments with glass traps showed that ammonia alone was attractive to fruit flies, and that the addition of other odorous substances appeared to have little or no effect.

In a number of trials, ammonia only, ammonia plus vanillin, and vanillin only, were tested in citrus trees during September, October, and November, 1932. The solutions were frequently and regularly renewed, and precautions were taken to eliminate effects due to variation in the position of the traps.

The results indicated that there was no marked difference between the attractiveness of ammonia only and ammonia plus vanillin. Vanillin alone did not attract.

It is interesting to note that Ripley and Hepburn (1931) state that ammonia is a repellent to the Natal Fruit Fly (*Pterandrus rosa*).

As a result of the above experiments a modified form of the ordinary fly trap was constructed and tested in the field. The trap is modified by attaching to the upper opening a small bottle containing solid ammonium carbonate. A clear solution of soap and water is poured into the trap in the space usually occupied by the lure, in order to catch and retain the flies attracted by the ammonia. By the thermal dissociation of the ammonium carbonate, ammonia gas is continuously liberated and the only charging necessary is that of replacing the soapy water. In so far as these experiments went this device proved effective. It is proposed to repeat these experiments on a larger scale during the spring of 1933.

REFERENCES.

JARVIS, H., 1931, Queensland Agricultural Journal, 485

RIPLEY, L. B. and HEPBURN, G. A., 1931, Dept. of Agric., South Africa. Entomology Memoirs, No. 7.

Notes on Australian Muscoidea (Calyptrata).

By G. H. HARDY.

(Walter and Eliza Hall Fellow in Economic Biology, University of Queensland).

(*Tabled before the Royal Society of Queensland, 27th November,* 1933).

As the *Muscoidea Calyptrata* is an important section of the economic *Diptera,* it is essential to have a sound classification of its various constituent parts. In the "Insects of Australia and New Zealand," R. J. Tillyard has incorporated the view that the *Sarcophagidae* are true *Tachinids* morphologically (p. 373), and the *Calliphorinae* are true *Muscids* (p. 374). This is certainly disputable, nevertheless it is typical of the confusion of thought concerning the value of the various characters responsible for such views ; it also entirely ignores biological considerations. In the present notes the value of families and subfamilies is arbitrary but it is essential to use the terms in order to give some relative value to the groups as they are defined and found to be biological units. Moreover, the main consideration given in this treatment lies fundamentally in a study of the genital complex of the male, which hitherto seems to have been neglected but is now found to yield values of real phylogenetic significance. Special attention is drawn to this factor where it is inconsistent with accepted classifications.

The four families given below and the subfamilies of the *Calliphorinae* are all well recognised sections.

Key to the families of the *Muscoidea Calyptrata.*

1.	With mouth-parts vestigial..	*Oestridae*
	With mouth-parts functional and normally developed ..	2
2.	Lower squama always larger and longer than upper squama. Hypopleura with bristles. Sternopleural bristles, when three present, arranged 2 : 1 or 1 : 1 : 1	3
	Lower squama sometimes very small. Hypopleura never with bristles (or rarely so in exotic forms). Sternopleural bristles, when three present, arranged 1 : 2	*Muscidae*
3.	Postscutellum, in profile, showing a more or less sinuous line, the upper part being concave and without a protruding surface there. Or failing this, the upper concave part may be absent, the lower convex part being joined direct to the underside of the scutellum	*Calliphoridae*
	Postscutellum always with a protruding convex surface on upper part. This may be in the form of a small protuberance leaving much of the convex surface to view, or it may be any larger size until the whole of the convex area is occupied by it, thus showing two large convex areas below scutellum	*Tachinidae*

FAMILY MUSCIDAE.

Key to the subfamilies of *Muscidae.*

1.	Lower squama broad, the inner margin lying below the scutellum. The first median vein strongly bent upwards and usually reaching the costa well above the apex of the wing ..	*Muscinae*
	Lower squama narrower, the inner margin lying remote from the scutellum. The first median vein meeting the costa usually below the apex of the wing, rarely at apex ..	2

2.	Proboscis permanently projecting and long; blood-sucking flies	*Stomoxydinae*
	Proboscis retractile	3
3.	Palpi strongly expanding at apex	*Lispinae*
	Palpi normal	4
4.	Anal vein very short, reaching less than half way between anal cell and wing border	*Fanniinae*
	Anal vein longer, reaching over half way between anal cell and wing border	5
5.	Anal vein not traceable to wing border	*Phaoniinae*
	Anal vein traceable to wing border	*Anthomyiinae*

The *Coenosiinae*, a very small subfamily, has been too ill defined to permit its acceptance at present as a separate unit, and is best included under *Phaoniinae* which is a very large subfamily, well represented by numerous species in Australia, and capable of tribal subdivision.

Family CALLIPHORIDAE.

Key to subfamilies of the *Calliphoridae*.

1.	Postscutellum with the upper portion (normally indicated by a convex area) eliminated by reduction, the convex lower portion becoming adjacent to the scutellum. If not quite reaching this stage, then most sternites being hidden by the tergites meeting along the ventral line will indicate this group as all others have the sternites broadly visible	*Metopiinae*
	Postscutellum conspicuously concave on its upper part and normal	2
2.	Palpi flat and very broad, or if narrow and compressed (*Metallia*) then with abundant long bristles on thorax ..	*Rhiniinae*
	Palpi cylindrical, club-shaped, or if compressed provided with short, scanty and unnoticeable bristles on thorax ..	3
3.	External posthumeral bristle placed nearer the median line, or more or less in a line with the presutural bristle. Always grey species with tessellated abdomen	*Sarcophaginae*
	External posthumeral bristle placed very much further away from the median line than the presutural bristle	4
4.	Palpi flattened, and bristles of thorax scanty	*Chrysomyiinae*
	Palpi always cylindrical and more or less clubshaped. Bristles of thorax plentiful and long	*Calliphorinae*

It is customary to place the *Metopiinae* as part of the *Sarcophaginae*, but structurally and biologically they stand quite apart, hence are best separated. The *Calliphorinae*, *Chrysomyiinae* and genus *Metallea* of the *Rhyniinae* form another unit, perhaps of the same catagory, whilst the more typical *Rhiniini* form yet another unit, one having features approaching the *Muscidae* and found nowhere else in the *Calliphoridae*. Also, some of the males are found hovering in the air, a habit the group shares with certain *Muscidae* and is otherwise foreign to the *Calliphorine* element.

In no case have I found the absence of a large superstructure surrounding the gonopore in the subfamily *Sarcophaginae* and the nature seems to be limited to the group. In all other *Calliphoridae* examined, the gonopore lies at the end of a central tube which has a more or less funnel-shaped apex, and is supported by a pair of lateral struts. The nature of the tube and struts is confined to the basal section in *Sarcophaginae* and the superstructure has become the dominant feature of the aedeagus.

Family TACHINIDAE.

In Australia this family is usually divided roughly into three main sections, but it is essential to add a fourth in order to clarify the classification. Clear definitions of these divisions and those of tribal value have not been given, for the limits are not ascertained, nevertheless, the following will enable about 95 per cent. of those collected to be relegated to their correct position. Hitherto, no account has been given to show the part the genital complex can play in forming these divisions, although there are some very important phylogenetic considerations to be derived from their study. In this respect an advance has been made here by limiting one of these sub-families to genera in which a definite and outstanding form occurs.

Key to subfamilies of the *Tachinidae*.

1.	With sternites broadly visible	2
	With sternites much reduced, at least some being concealed by the tergites meeting ventrally	3
2.	Abdomen without bristles, usually rather broad and dull coloured, but if bright red, a carina may occur, never otherwise. Arista always bare. Small species	*Phasiinae*
	Abdomen with bristles. Carina present or absent. Arista bare to plumose. Mostly large and medium sized showy flies	*Ameniinae*
3.	Aedeagus in two parts, the apical section being hinged to and articulates with the basal part. Carina usually present, but if absent, the arista is usually plumose or pubescent, rarely bare	*Dexiinae*
	Aedeagus otherwise formed. Carina almost invariably absent, but if present the wings are heavily marked with a dark pattern. Arista usually bare but varies to long pubescent and some with plumosa arista (hitherto placed in Dexiini) may belong here too	*Tachininae*

Subfamily Dexiinae.*

This subfamily is to be restricted to all those genera that contain species with the aedeagus of a definite type. This consists of a stiff slender basal part and a well defined apical part that is hinged to the basal and articulates with it. This apical part may be short or long, and in the latter case very flexible, like a very supple cane. It occurs in a large number of genera of which *Rutilia* and *Prosena* form two, well represented in Australia. There are certain genera without a carina that may have to be removed and two are now definitely ascertained to be *Tachininae*, namely, *Sumpigaster* and *Zosteromyia*. These genera are dealt with in the following key:—

Key to genera hitherto incorporated under *Dexiini*, Section 2.

1.	With a large flat facial carina between antennae. Section 1. *Prosena* and allied genera.	
	Without a carina. Section 2	2
2.	First and fifth radial veins with a series of bristles on upper side	*Therairia* Desv.
	At most only the fifth radial vein with a series of bristles on upper side	3
3.	Abdomen stoutly conical, almost contiguous with hind coxae at base	4
	Abdomen slender and much more remote from hind coxae at base	6
4.	Arista long-plumose; parafacial and parafrontal region with hairs; palpi well developed and clubformed	*Apatemyia* Macq.
	Arista long-plumose; only parafrons hairy; palpi rather short, not clubformed	gen. ———
	Arista pubescent but may appear bare. Parafacial and parafrontal region without hairs; palpi well formed and clubform	5

*I do not know if genus *Dexia* has the character cited here, and if not the group will need another name.

5.	Propleura bare	.. *Heterometopia* Macq.
	Propleura hairy (a unique character in this section) ..	.. ? *Toxonemis* Macq.
6.	First abdominal segment without bristles	*Sumpigaster* Macq.
	First abdominal segment with a pair of long strong median marginal bristles	*Zosteromyia* B. & B.

Presumably genus *Hobartia* Malloch, also comes within this second section, but it is very indefinitely described.

Genus *Therairia* Desvoidy.

Three species are before me, one probably *T. australis* Walker. It may be a more primitive form than the usual *Dexiinae*, for it has been variously treated by authors, nevertheless, a specimen with the genitalia extracted shows that the aedeagus has the two hinged parts.

Genus *Apatemyia* Macquart.

Macquart, Dipt. Exot. suppl. 1, 197 ; Pl. 17, f. 4, 1846.

This was originally placed by Macquart amongst the *Calliphoridae*, but there can be no doubt that its affinities are with the *Tachinidae*, being one of perhaps five genera that have many characters in common. Its position amongst the *Dexiinae* requires confirmation. There is only one described species, but two others are known to me, all being rare in collections.

Apatemyia longipes Macquart.

Head : seen laterally, the line of the frons runs very straight to the base of the antennae, forming there a right angle with the line of the face ; the latter curves outwards to the oral margin. The carina is not developed and the first two segments of the antennae are about equal in length, very short, and the third is long, reaching nearly to the line joining the vibrissae. The arista is abundantly provided with long hairs, the proboscis is short, and when fully extended its apical part is about equal to its basal part, the whole being hardly longer than the depth of the head. The palpi are long, slender and club-shaped, about as long as the apical part of the proboscis. The cheeks are well pronounced and formed as in *Heterometopia*, but the whole outline of the head is more trapezoidal in shape than in that genus. There are no marked bristles on the yellow head other than those bordering the frontal stripe and those associated with the vibrissa, the two pair of verticles and the postoculars. Hairs are plentiful on the dark frons, down each side of the face to near the level of the lower margin of the eye, where there is a short bare space followed by more black hairs that give place to the yellow hairs that abound behind the eyes.

The whole dorsal area of the thorax is black with faint indications of striae ; the lateral border of the dorsum is thickly covered with a pulverulent grey that permeates the whole of the pleura, which is otherwise also black ; the dorsal hairs are rather long and most of the bristles are slender and hence some are not easily detected, those seen being :—3 presutural, 4 postsutural acrostichals, and a similar number of dorsocentrals ; 4 humeral, 3 posthumeral, 2 notopleural, the presutural not detected, 3 supra-alar, 4 intraalar and 2 postalar. Two pairs of scutellar bristles are widely separated along the margin, and between them one pair of slender submarginals, much weaker but nearly as long. On the pleura there are four strong bristles immediately above the anterior coxae and some weaker ones ; the mesopleura has the usual row near the base of the wing well developed and another bristle not far from the anterior spiracle; on the sternopleura the bristles are arranged 2 : 1; the hypopleural row is well developed and there are no bristles or hairs on the sclerite above the posterior spiracle.

The abdomen is yellow with a more or less interrupted uneven black stripe, broad at the base immediately behind the scutellum, the outline being concave to the apical margin of the first segment, the black occupying a third of the width there seen from above; on second segment a little narrowed at base, widening slightly to apex, very much narrower at base of third segment, but widening sharply to occupy the whole width visible from above at the apical margin; the fourth tergite almost wholely black, leaving an apical edge and the sides yellow, but this ground colour is overlaid by a pulverulent yellow. The sides of the tergites meet below so that only the basal sternite is exposed, but small, and all the abdominal hairs are black.

The abdominal bristles are :—3 pair of lateral bristles on apical margin of first segment, 1 median pair and 3 laterals on margin of second segment, third segment similar to second, but another pair placed half-way between median and laterals; fourth segment with a fringe of apicals. Also there are some long weak lateral bristles placed more basally amongst the long hairs of the two last segments, and these are repeated on two undescribed species and therefore may have some generic significance.

The legs are yellow with tarsi more or less black, the wings are hyaline, the venation being like that of *Heterometopia* but the fourth vein is well separated from the third which has three setae at its base on the upper side and one below. The anal vein is reduced to a very short stump.

Hab.—Tasmania: Hobart, 15th October, 1916, 1 male upon which the above description is based. Geeveston, 24th December, 1914, a male having a more slender stripe on abdomen. Allied to this are two more species, one from Victoria and one from Queensland.

Genus *Zosteromyia* B. & B.

Brauer & Bergamstamm, Denk. Akad. Wiss. Wien, lviii, 1891, pp. 376, 406 and 425; lx. 1903, 130.

This genus and *Sumpigaster* Macq. are clearly not *Dexiinae*, but should be relegated to the *Tachininae*. All the species described below are either black or black and brown forms that have silvery or golden transverse bars across thorax, one adjacent to the transverse suture and the other to the scutellum, making them readily picked out. Other species having this, contain also the first median vein running into the lowest radial vein before the wing margin, whereas in the present case these veins run separately to the wing margin or else the abdomen is almost contiguous with the hind coxae, not remote from them. These are well known bush and garden flies that frequent broad leaves over the surface of which they move quite actively and the peculiarity of their markings makes them especially noticeable.

Key to species of *Zosteromyia*.

1.	Arista long pubescent; abdomen black with silvery bars at segmentations	2
	Arista bare	3

2.	Summit of frons on male one-sixth head-width. On female, eye margins strongly bowed, the face being much narrower than the frons. Silver fascia of abdomen narrow, never reaching discal bristles	*cingulata* Macq.
	Summit of frons on male one-quarter head-width. On female, eye margins hardly bowed, the face being as wide or wider than frons. Silver fascia of abdomen wide, reaching discal bristles	*fasciata* n. sp.
3.	Face and antennae short, the third antennal segment being less than twice the length of the two basal segments. Female with eye margins diverging along frons, but contracting somewhat on face. Abdomen largely brown	*brevifacies* n. sp.
	Face and antennae long, the third segment being three or four times the length of the basal ones. Female not known ..	4
4.	Summit of frons on male broad, one-quarter head-width. Antennae inserted at half eye-depth	*longicornis* n. sp.
	Summit of frons on male narrow. Antennae inserted higher ..	5
5.	Abdomen black	*minor* n. sp.
	Abdomen largely brown	*morgani* n. sp.

Zosteromyia cingulata Macquart.

Myobia cingulata Macquart, Dipt. Exot. suppl. 4, 1849, 206; Pl. 19, fig. 1.

On male the summit of frons is one sixth the head-width and the arista long pubescent. The eye margins from summit to quarter the frons, somewhat converging, then diverging to base of antennae from where they still diverge down face but at a lesser angle. The antennae, inserted at two thirds eye depth, reach a little way beyond half the distance to the oral margin where the face width is equal to its length.

A black species with silvery white parafrons, face and occiput, a similarly coloured presutural bar that extends on to the pleura right round thorax, and a similar prescutellar bar. Narrow silvery basal bands occur on the second, third and fourth abdominal segments. Legs deep brown or black.

Female similar but eyes much wider apart at summit, thence bowed but coming nearer together across face where they are noticeably closer together than at the summit.

Hab:—Queensland and New South Wales. Although a very abundant well known fly, about a dozen specimens only are before me and are dated from August to December; it is, however, to be met with most months of the year.

Zosteromyia fasciata n.sp.

On the male the summit of the frons is one quarter the head-width and the arista long pubescent. Eye margins about parallel for about two thirds frons then diverging abruptly till level with antennae, thence diverging to a lesser degree. The antennae, inserted at two thirds the eye depth, reach to two-thirds the way towards the oral margin where the face is as broad as long.

Markings as in *Z. cingulata*, but the silvery bars on thorax are tinged with yellow, and those on the abdomen are much broader, covering half the second and third segments and almost the entire fourth.

The female is similar, but at the summit the eyes are very wide apart, the margins run parallel to near the oral margin where they tend to come closer together.

Hab.—Tasmania : Hobart, Mt. Wellington. Very abundant in the island, but only three males and one female are in the type series. Victoria : Melbourne, 1 female.

Zosteromyia brevifacies n.sp.

On male the summit of frons is one sixth the head width and the arista bare. The eye margins are as in *Z. cingulata* but the face is wider than long.

Markings as on *Z cingulata,* but those of the thorax dorsally are golden, and the pleura is covered with a pulverulent white so that the anterior bar does not stand conspicuous there. The abdomen and at least part of the legs are brown. On the former black markings occur dorsally, being in the form of a more or less triangular spot on each of the two basal segments and an apical black bar on the third, but these markings may be more or less diffused.

Female similar, but eye margins bowed similar to those of *Z. cingulata* and the width across the face is noticeably wider than the width at summit.

Hab.—Tasmania ; Mt. Wellington, 2 males, 1 female, January, 1924. New South Wales : Tooloom, January 1926, 1 female (F. A. Perkins) which seems to be identical.

Zosteromyia longicornis n.sp.

On male the summit of frons is one quarter the head width and the arista bare. The eye margins are parallel to half frons length, thence diverging without further alteration towards lower eye border. The antennae, inserted at half the eye depth are long and reach two thirds towards the oral margin where the face is as wide as long.

Markings on the thorax as on *Z. cingulata*, but the abdomen is brown with a broad uneven black stripe that extends on to the fourth segment. The legs are black and the wings rather heavily suffused with black.

Hab.—Queensland : Brisbane and Mt. Glorious, January to April, 1930, 1932. 3 males, two being in the collection of Mr. F. A. Perkins.

Note.—From Tasmania comes a similar form represented by a single specimen in rather poor condition, with a frons even wider than the present one and evidently related.

Zosteromyia minor n.sp.

A very small species, barely 5 mm. long (other species go up to 8 mm). and the male has its summit of frons only one seventh the head width. The arista is bare. The eye borders slightly diverge to one third the frons, thence diverge to a greater extent to lower eye border without further alteration. Antennae, inserted above half eye depth, are as long as half the head depth and reach practically to the oral margin where the face is less broad than long.

Markings as on *Z. cingulata*, but narrower and the pleura is more or less covered with a pulverulent grey.

Hab.—Tasmania : Strahan, February, 1924. 4 males.

Zosteromyia morgani n.sp.

On male the summit of frons is one fifth the head width, otherwise the head characters are as on *Z. minor.*

The markings and colours are also similar, except the abdomen is brown, not black, and with a narrow median black stripe on all segments, widening from a point at base towards apex and on the last two segments there is an apical black bar. The golden bands at base of the segments are lost in the general brown colour.

Hab.—New South Wales. Three males bear the following information on the label.—" bred from *Aulacophorus hilaris* adult, Coll. Binniguy, 22.2.30, W.L.M." Another male is similarly labelled but the latter part has substituted " Coll. Worara, 11.11.30, W. L. Morgan." Three of these contain the puparium and all were submitted for identification by the Department of Agriculture, Sydney.

It has long been suspected that *Z. fasciata*, on account of its habits and abundance, is parasitic on beetles of genus *Paropsis*, and the same may apply to *Z. cingulata.* The present record of a species being bred from another Chrysomellid beetle is therefore of special interest.

The Constitution of Campnospermonol.

By THOMAS GILBERT HENRY JONES, D.Sc., A.A.C.I.
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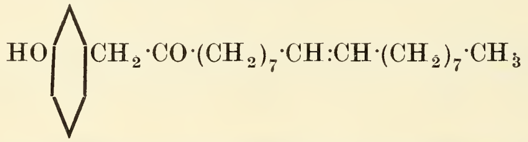
(*Tabled before the Royal Society of Queensland, 27th November,* 1933).

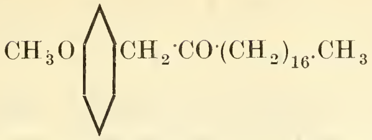
The examination of the oily exudate from *Campnospermum brevipetiolatum* a large tree endemic in the Sepik River district, Mandated Territory of New Guinea, was undertaken by Jones and Smith and the result of their investigation published in the Journal of the Chemical Society in 1928. It was shown, as a result of that investigation, that the principal constituent of the exudate was a ketonic phenol to which the name, campnospermonol, was given and a tentative formula was suggested for this substance. The investigation has now been continued by the present author, further supplies of the exudate having become available through the courtesy of Father Kirschbaum of the Sepik River Mission Station. It has been found possible to assign a definite constitution to the substance and it is to be represented as of molecular composition, $C_{25}H_{40}O_2$, with the following constitution—



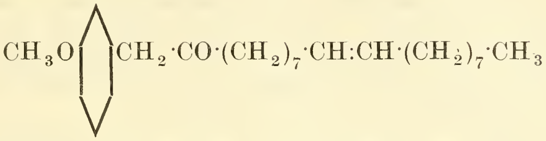
α—m—hydroxyphenyl—Δ^{κ}—nonadecen—β—one.

This constitution differs from that originally proposed by Jones and Smith from the incomplete data at their disposal, in containing only one double linkage and in molecular composition, $C_{27}H_{42}O_2$, or $C_{28}H_{44}O_2$, being originally proposed.

As recorded in the original paper, accidental loss of the nitrile portion resulting from the decomposition of oximinohydrocampnospermonyl methyl ether with phosphorus pentachloride, prevented determination of the constitution of this nitrile which, along with data already obtained, furnished the key to the structure of the phenolic ketone. This nitrile has now been obtained and proved to be m-methoxy phenyl cyanide, the acid derived from it on hydrolysis being m-methoxy benzoic acid. The products obtained from the above decomposition are m-methoxy phenyl cyanide and stearic acid whence it follows that hydrocampnospermonyl methyl ether is to be represented as ;



with campnospermonyl methyl ether represented by,



As a further confirmation, the oximino derivative of campnospermonyl methyl ether itself has been prepared and similarly decomposed with phosphorus pentachloride, the products in this case being m-methoxy phenyl cyanide and oleic acid.

A careful determination of the iodine value of campnospermonyl methyl ether and campnospermonyl acetate purified as far as possible, gave values 80 and 66 respectively. The theoretical values for one double bond are 65 and 60 and it is clear that the value 80 is somewhat high. No explanation of this inconsistency in the values of the methyl ether and acetate is apparent but it is probably to be found in the presence of some substance or substances occurring along with the campnospermonol in the oil, possibly the small amount of acid indicated by the acid number 17 of the original exudate.

Analyses of the methyl ether, the hydro-methyl ether and the alcohol obtained by reducing the ketone group in the hydro-methyl ether have been again carried out with results consistent with the respective formulae now suggested for these substances. The oxidation products of campnospermonyl methyl ether have been again examined and suberic acid isolated as a product additional to those already reported, namely, azelaic, nonoic and m-methoxy benzoic acids. It also seems clear that the oxidation product of hydrocampnospermonyl methyl ether previously described as margaric acid, is really a mixture of that acid with some stearic acid, a result in accordance with the constitution assigned.

It is hoped to publish an account of further derivatives of campnospermonol at a later date.

Experimental.

Combustion results.

Campnospermonyl methyl ether.
Found C = 80.6, H = 10.7.
($C_{26}H_{42}O_2$ requires C = 80.8. H = 10.8).

Hydrocampnospermonyl methyl ether.
Found C = 80.4. H = 11.4.
($C_{26}H_{44}O_2$ requires C = 80.4 H = 11.5).

Hydrocampnospermonyl methyl ether.
Found C = 79.9. H = 11.6.
($C_{26}H_{46}O_2$ requires C = 80.0. H = 11.8).

Reaction of oximino campnospermonyl methyl ether with phosphorus pentachloride.

Fifty grammes of campnospermonyl methyl ether were added to 200 ccs. absolute alcohol in which 3 grammes of sodium had been dissolved and after cooling to 0°C, 20 ccs. of amyl nitrite were slowly added and the mixture maintained at 0°C for 4 hours. The liquid was then diluted with water and extracted thoroughly with petroleum ether. The alkaline extract remaining, was acidified with dilute sulphuric acid and the oximino derivative which separated, isolated by ether extraction. It was then dissolved in dry chloroform, cooled to 0°C and finely powdered phosphorus pentachloride slowly added till no further reaction took place. Ice was then added and the chloroform solution removed. Evaporation of the chloroform gave a liquid which was separated into (*a*) a nitrile, (*b*) an acid, by treatment with dilute sodium hydroxide and ether extraction.

(*a*) The nitrile was distilled in vacuo and the distillate solidified on cooling. Hydrolysis gave a good yield of m-methoxy benzoic acid M.P. 106.5°C.

Found C = 62.9. H = 5.1.
($C_8H_8O_3$ requires C = 63.1. H = 5.2).

(*b*) The acid was converted into its methyl ester and fractionated. The iodine value for the distilled ester was 85. (Theor. for methyl oleate = 87).

Identity with methyl oleate was confirmed by oxidation with permanganate in acetone solution. Nonoic and azelaic acids being identified as the products.

In a similar reaction with hydrocampnospermonyl methyl ether, m-methoxy benzoic acid and stearic acid were obtained.

Oxidation of hydrocampnospermonyl methyl ether.

Examination of the ethyl esters obtained in this oxidation by methods already described (*loc. cit.*) resulted in the isolation of a small fraction of ethyl suberate as a fraction boiling a little below that of the main fraction, ethyl azelate, obtained on fractionation.

Hydrolysis gave suberic acid M.P. 132°C.

Found C = 54.8. H = 8.1.
Acid Number = 635.
($C_8H_{14}O_4$ requires C = 55.1. H = 8.1).

Oxidation of hydrocampnospermonyl methyl ether.

The fatty acid isolated in this oxidation and previously described as margaric acid was again examined. The acid number was carefully determined and the molecular weight calculated, the value 274 being obtained as a result of several determinations. The molecular weight of margaric acid is 270 and that of stearic acid 284 and it is clear that margaric acid is the principal product but mixed with about 30% stearic acid. The melting point of the sample was determined as 57.5°C.

REFERENCE

Jones, T. G. H., and Smith, T. B. (1928), J. C. S., pp. 65-70

New Australian Trypetidae with notes on Previously Described species

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(*Tabled before the Royal Society of Queensland, 27th November*, 1933).

In connection with experiments on the biology of Australian *Trypetidae*, several undescribed species have been discovered, and, as it will be necessary to refer to them in future reports, they have been named and the following descriptions prepared.

Chaetodacus gurneyi sp. nov.

Male and Female.—Length of body 6.5-7.5 mm. ; of wing 6.0-6.5 mm.

Head.—General colour brownish yellow. Frons nearly twice as long as wide, with a dark, slightly raised blunt tubercle covered with long black hairs situated just above the lunule ; black spots at the base of the *or.* bristles. Ocellar triangle and lunule shining black. Antennae longer than the face ; second segment bearing a short black dorsal bristle ; third segment nearly three times as long as second, and dark on the outer sides ; terminal part of arista black. Two top shaped facial spots. Genal spot present. Chaetotaxy *vt.* 2, *pvt.* (weak and divergent), *s. or.* 1, *i. or.* 2, genal bristle, and occipital row 7.

Thorax.—General colour dark yellowish brown (bred specimens much paler), punctulate, with short pale pubescence, and the following black markings :—two short central bands extending from the anterior margin to about the middle of the mesonotum, two lateral curved narrow bands extending from the humeral calli to the antero-lateral corners of the scutellum, a band in front of the mesopleural stripe, the posterior part of the pteropleurae, practically the whole of the sternopleurae, postscutellum, and mesophragma ; and with the following yellow markings :—humeral calli ; notopleural calli ; on each side a parallel sided mesopleural stripe equal to the notopleural callus in width, the anterior border straight and cutting the mesopleural suture at one quarter of its length from the sternopleural suture, the lower border extending on to the sternopleuron ; two short lateral stripes commencing at the suture and ending well before the upper *p. sa.* bristle ; practically the whole of the upper and the anterior four-fifths of the lower hypopleural calli. Scutellum yellow with a large brown triangular patch occupying nearly the whole of the dorsal surface. Halteres nearly white. Chaetotaxy *scp.* 4, *n.pl.* 2, *a. sa.* 1, *p.sa.* 2, *mpl.* 1, *pt.* 1, *prsc.* 2, *sct.* 2 (apical), all dark brown or black. Legs brownish yellow with the hind tibiae slightly darker. Wings very similar to those of *C. tryoni*, hyaline with a dark brown costal band extending a little past the end of the third longitudinal vein, and an anal streak ; costal cell pale brown ; wing veins dark brown, last portion of the fourth longitudinal distinctly curved, anterior cross vein oblique and a little beyond the centre of the discoidal cell; prolongation of the anal cell about twice as long in the male, and about as long in the female, as the last portion of the sixth longitudinal vein.

Abdomen.—General colour dark brown with the first and second tergites pale brownish yellow; a faint mid dorsal longitudinal dark line; two very distinct large shining black spots on the fifth tergite, one on either side of the mid dorsal line. Third segment of male ciliated. Described from 9 males and 10 females.

Host plants.

Acronychia laevis, Forst. (Cheesewood) Narara, N.S.W., 1910 (W. B. Gurney) and Tooloom, N.S.W., 1924 (F. A. Perkins).

Melodorum Leichhardtii, Benth. Acacia Ck., N.S.W., May, 1925 (F. A. Perkins).

Ficus glomerata, Wild. Brisbane, June, 1933 (F. A. Perkins).

This species is distinguished from other species of Australian *Dacinae* by the black spots on the fifth abdominal tergite, brown marking on the scutellum, and the shape of the mesopleural stripe and facial spots. It has been confused with *C. tryoni* in the past and many of the host records for *C. tryoni* really belong to this species. It has been named after Mr. W. B. Gurney, Government Entomologist of N.S.W., who was the first to breed it from native fruits.

Chaetodacus humeralis sp. nov.

Male and Female.—Length of body 6.5-7.5 mm; of wing 6.0-6.5 mm.

Head.—General colour reddish yellow. Frons nearly twice as long as wide, with a black central slightly raised tubercle, and black spots at the base of the *or.* bristles. Ocellar triangle and lunule shining black. Antennae longer than the face; second segment bearing a short black dorsal bristle; third segment nearly three times as long as the second, the outer sides black and the inner dark brown; arista pale at the base, the remainder being black. Face, palps, and proboscis orange yellow, the face with two irregularly shaped black spots. Genal spot very distinct. Chaetotaxy *vt.* 2, *s. or.* 1, *i. or.* 2, genal bristle and occipital row 7.

Thorax.—General colour dark reddish brown; punctulate, with short pale pubescence; a broad central greyish area, bordered on each side by two parallel narrow black lines which terminate about half-way between the suture and the scutellum; a triangular area in front of the suture, short bars on both sides of the posterior part of the lateral yellow stripes, and practically the whole of the ventral part of the thorax black. Humeral calli dark brown. Yellow marking as follows:—notopleural calli; on each side a sub triangular spot on the mesopleuron the base extending along the notopleural suture, and as long as the notopleural callus, and the apex terminating on the upper part of the sternopleuron; two short lateral stripes commencing at the suture and ending before the upper *p.sa.* bristle; practically the whole of the upper and the anterior four-fifths of the lower hypopleural calli. Post scutellum and mesophragma black. Scutellum bright yellow. Chaetotaxy *scp.* 4 (pale and weak), *n. pl.* 2, *a. sa.* 1, *p. sa.* 2, *mpl.* 1, *pt.* 1, *prsc.* 2, *sct.* 2 (apical), all dark brown or black. Halteres pale yellow. Legs pale yellow, with the distal portion of the femora, and the distal tarsal segments brown, and the coxae and hind tibiae very dark brown or black. Wings practically identical with *C. tryoni*. Costal band extending slightly beyond the end of the third longitudinal vein. Costal cell brown.

Abdomen.— General colour very dark brown or black. A short transverse pale yellow band on the anterior margin of the second tergite, and a larger pale yellow band occupying the posterior half of the same tergite ; the anterior margin of the larger yellow band sinuous. Third segment of male ciliated. Ovipositor yellowish brown. Described from 5 males and 10 females.

Host plants.

Mandarins, Cairns, July, 1933 (F. A. Perkins).

Passiflora suberosa Mackay, Q., June, 1933 (W. A. McDougall).

This species is closest to *C. tryoni* from which it can be distinguished by the brown humeral calli, and the thoracic and abdominal markings. Apparently it is of definite economic importance as a citrus pest in the northern part of the State.

Chaetodacus strigatus sp. nov.

Male and Female.—Length of body 6.5-7.5 mm. ; of wing 5-5.5mm.

Head.—General colour brownish yellow. Frons nearly twice as long as wide, with a dark central sub-rectangular spot, and black spots at the base of the *s. or.* bristles. Ocellar triangle and lunule shining black. Antennae longer than the face, second segment bearing a short black dorsal bristle, third segment more than twice as long as second. Face, palps, and proboscis paler than the rest of the head, face unspotted. Chaetotaxy *vt.* 2, *s. or.* 1, *i. or.* 3, all black.

Thorax.—General colour dark brown : punctulate ; with short pale pubescence ; two broad greyish parallel fascia, one on each side of the mid dorsal line of the mesonotum. Yellow markings as follows :— humeral calli ; on each side a sub-triangular spot on the mesopleuron the base extending along the notopleural suture, and the apex not reaching the sternopleuron ; two very short lateral stripes commencing at the suture, and ending well before the upper *p. sa.* bristle ; nearly all the anterior part of the upper, and the anterior two thirds of the lower hypopleural calli. Posterior part of the pteropleurae, and the lateral part of the post scutellum and mesophragma black. Scutellum yellow. Chaetotaxy *scp.* 4 (weak), *npl.* 2, *a. sa.* 1, *p. sa.* 2, *mpl.* 1, *pt.* 1, *prsc.* 2, *sct.* 2 (apical), all black. Halteres pale yellowish brown. Legs pale yellowish brown, hind tibiae dark brown. Wings hyaline with dark brown veins ; anterior cross vein oblique, and less than its own length from the posterior cross vein ; third longitudinal vein slightly sinuous near the outer margin ; costal cell hyaline ; stigma dark brown ; a narrow brown costal band terminating at the end of the fourth longitudinal vein ; a narrow transverse slightly angulated brown band leaving the costal band below the termination of the first longitudinal vein, then following the courses of the cross veins, and ending on the wing margin at the end of the fifth longitudinal vein ; anal streak present ; the first basal cell pale brown as far as the basal cross vein ; the coloured portion of the first basal cell is connected to the anal streak by a short narrow band which surrounds the basal cross gein.

Abdomen.—General colour dark brown ; punctulate ; with long golden pubescence ; short narrow median longitudinal black markings on the posterior part of the fourth and fifth segments. Third segment of male ciliated. Described from 1 male and 4 females.

Habitat.—Stanthorpe, Q., October, 1924 (caught in traps).

This species is distinguished from other species of Australian *Dacinae* by the approximation of the cross veins, the transverse brown band on the wings, and by the brown notopleural calli.

Rioxa pornia, Walker.

Synonymy

Trypeta pornia, Walker, 1849 (List. Dipt. Brit. Mus., iv., 1039).

Trypeta musae, Froggatt, 1899 (Agric. Gaz., N.S.W., 501).

Tephritis psidii, (Frogg.) Tryon, 1904-5 (An. Rep. Entom. 71).

Dacus musae, (Frogg.) Gurney, 1912 (Agric. Gaz. N.S.W., 75).

Rioxa musae, (Frogg.) Tryon, 1927 (Proc. Roy. Soc. Queens., xxxviii, 216).

As a result of a careful study of Walker's description of *Trypeta pornia* the above synonymy was suspected, and, in order to verify the suspicion, a typical specimen of the so-called *Rioxa musae* was sent to Sir Guy Marshall of the British Museum. He compared it with the type and reported as follows :—" I have compared *Trypeta pornia* with Walker's type, and there is no doubt that your specimen belongs to that species." I would like to take this opportunity of acknowledging the assistance rendered by Sir Guy Marshall.

Calantra aequalis Coq.

Synonymy.

Dacus aequalis, Coq., 1909 (Proc. Lin. Soc. N.S.W., xxxiii, 794).

Chaetodacus aequalis, (Coq.) Tryon, 1927 (Proc. Roy. Soc. Queens., xxxviii., 191).

In the original description and in subsequent descriptions by Froggatt and Tryon no mention has been made of the chaetotaxy which is as follows :—

Head.— *Vt.* 2, *pvt.* (divergent), *s. or.* 1, *i. or.* 2, genal bristle, and occipital row about 8 (very weak).

Thorax.—*Npl.* 2, *p. sa.* 2, *mpl.* 1, *pt.* 1, *sct.* (apical pair). There are no *a. sa.* nor *prsc.*

Abdomen.—Third segment of male ciliated.

Reactions of Tagetone. Part I.

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(*Tabled before the Royal Society of Queensland, 27th November,* 1933).

The essential oil of *Tagetes glandulifera* was shown by Jones and Smith to contain two ketones of the olefinic terpene class to which the following constitutions were assigned :—

$$(CH_3)_2{:}CH{\cdot}CH_2{\cdot}CO{\cdot}CH_2{\cdot}CH(CH_3){\cdot}CH{:}CH_2 \qquad \text{I.}$$

$$(CH_3)_2{:}CH{\cdot}CH_2{\cdot}CO{\cdot}CH_2{\cdot}C({:}CH_2){\cdot}CH{:}CH_2 \qquad \text{II.}$$

The name of tagetone was given to II. owing to its comparative abundance in the oil, while the more systematic name dimethyl $\triangle\alpha$ octen-ε-one was adopted for I.

Subsequently the formula for tagetone was slightly modified by Jones and the ketone was represented as comprising the tautomeric systems,

$$\cdot CO{\cdot}CH_2{\cdot}C({:}CH_2){\cdot}CH{:}CH_2 \rightleftarrows \cdot C(OH){:}CH{\cdot}C({:}CH_2){\cdot}CH{:}CH_2 \rightleftarrows$$
$$\rightleftarrows \cdot CO{\cdot}CH{:}C({\cdot}CH_3){\cdot}CH{:}CH_2,$$

in which case tagetone would be expected to act as an $\alpha\beta$ unsaturated ketone. The action of reducing agents on tagetone has therefore been examined and the expectation verified. Owing to the instability of tagetone, its isolation in a state of purity by fractional distillation is rendered difficult without undue loss of material and consequently some uncertainty must be attached to the purity of products obtained from it. This was the case in connection with experiments on the reduction of tagetone already described (*loc. cit.*) and it is now clear that the alcohol described as tagetol $C_{10}H_{18}O$, must be regarded as dihydro-tagetol $C_{10}H_{20}O$. This has been demonstrated by purification of this alcohol by means of its acid phthalate derivative. It has been found possible to prepare this alcohol in moderate yield by reduction of tagetone with sodium and alcohol provided the solution is maintained as cold as practicable during the reduction. The density of the alcohol .8464, shows it to be somewhat higher than that of dimethyl $\triangle\alpha$octen-ε-ol .8305, and the two cannot therefore be identical.

A convenient reducing agent for tagetone confirming its $\alpha\beta$ unsaturated character, has been found in zinc dust and ammonium chloride with alcohol as solvent—the principal product being a dihydro-tagetone $C_{10}H_{18}O$, resulting from the addition of two atoms of hydrogen to tagetone, together with smaller quantities of higher boiling substances containing twenty carbon atoms. The dihydro-tagetone obtained in this way is apparently not homogeneous, as its semicarbazone does not readily crystallise and invariably separates from solution as an oil which slowly crystallises. Examination of its oxidation products confirmed this view as there was obtained in addition to the expected isovaleric acid, a small quantity of the ketonic acid $C_9H_{16}O_3$. which is the characteristic oxidation product of I.

The constitution indicated for dihydro-tagetone in view of these results is to be represented as,

$$(CH_3)_2{:}CH{\cdot}CH_2{\cdot}CO{\cdot}CH_2{\cdot}C(CH_3){:}CH{\cdot}CH_3 \qquad \text{III.}$$

with some admixture with ketone I. with which it is isomeric, differing only in the position of the unsaturated linkage.

The density of dihydro-tagetone was determined as .8441, which is somewhat higher than that of ketone I. .8354.

As already stated the dihydro-tagetone was not the sole product of this reduction of tagetone with zinc dust and ammonium chloride. It was found possible to isolate two higher boiling substances of molecular compositions $C_{20}H_{32}O$ and $C_{20}H_{34}O_2$. Loss of water had evidently occurred in the formation of the first of these substances and some analogy with the behaviour of mesityl oxide on electrolytic reduction is apparent. While it is not as yet possible to assign a definite constitution, it is likely that a system analogous to desoxymesityl oxide is present in the first and that the second represents the usual type of pinacone.

The reduction products of tagetone with zinc dust and alcoholic sodium hydroxide have been further investigated and two products isolated, both apparently of molecular composition $C_{20}H_{34}O_2$. One however, appears to possess only one carbonyl group, as in reaction with hydroxylamine a mono-oxime results, the other giving a dioxime.

Consideration of the physical constants of these pinacone bodies suggests that neither is identical with that obtained in the ammonium chloride, zinc dust reduction.

Pinacol bodies are obtained from tagetone when sodium amalgam and alcohol or aluminium amalgam and moist ether, are used as reducing agents, but owing to the higher boiling points, separation is difficult and was not effected with the small amount of reduction product available.

Tagetone readily reacts when hydrogen sulphide is passed into a well cooled ammoniacal solution in alcohol and the solution becomes finally colorless. Fractional distillation indicated that primarily, complex substances of high boiling points, containing sulphur, had been formed but a small amount of an unpleasant smelling liquid containing sulphur, of boiling point 90°C at 4 mms. was obtained. This however, resinified before analysis, having become solid in a few days and insufficient material was available for further investigation.

In reaction with hydroxylamine, tagetone gave further evidence of $\alpha\beta$ unsaturated character. The normal oxime already described was, under the prescribed conditions, accompanied by an oximino ketone. The oximino ketone was separated by solution in acid and readily reduced Fehling's solution on warming.

Hydrolysis of tagetone with saturated methyl alcoholic barium hydroxide gave in addition to a small yield of isobutyl ketone, a ketone alcohol $C_{10}H_{18}O_2$, formed by addition of water to the unsaturated system.

Tagetone reacts vigorously with the Grignard reagent CH_3MgI, but considerable polymerisation results and only a small amount of C_{10} substance can be isolated. This possessed $d_{15\cdot5}$ .8559 and in reaction with semicarbazide gave evidence of ketonic character, although admixture with the expected tertiary alcohol seemed probable.

Distillation of the resin produced during distillation of tagetone at low pressure, always gave a dark colored liquid of very unpleasant odour and capable of separation by distillation into two fractions which evidently represent dimers of tagetone.

It is hoped, as opportunity offers to continue the investigation of the reactions of tagetone.

Experimental.

Reduction of tagetone with zinc dust and ammonium chloride.

To 100 ccs. of tagetone dissolved in alcohol there were added several ccs. of a saturated ammonium chloride solution followed by gradual addition of zinc dust. Much heat was developed and the flask was kept cold with ice water. Additional ammonium chloride and zinc dust were added until no further heat was developed. The product was then extracted with ether and on isolation submitted to fractional distillation.

Three fractions described below as (*a*), (*b*), (*c*), were eventually obtained.

Fraction (*a*), 56 ccs., readily reacted with semicarbazide acetate but the semicarbazone only slowly solidified and crystallised. All attempts to obtain it pure by crystallisation from various organic solvents (in which it is readily soluble) were fruitless, an oil invariably separating. For the ketone regenerated from the semicarbazone, the following constants were obtained :—

$d_{15\cdot5}$=.844 ; N_D^{20}=1.4350 ; b.p.=186-190°C.

Found C=77.7, H=11.5.

($C_{10}H_{18}O$ requires C=77.9, H=11.7).

Oxidation with acetone permanganate gave as products, isovaleric acid and β isovaleryl α methyl propionic acid. Only small amounts of the latter acid were obtained and the oxidation results would indicate some admixture of a principal product, presumably ketone III. with ketone I.

The alcohol $C_{10}H_{20}O$, obtained on reduction with Na and alcohol possessed constants : $d_{15\cdot5}$ = .8512 ; N_D^{20} = 1.4420 ; b.p. = 197°C.

Fraction (*b*) 25 ccs., fractionated as far as possible, possessed the following constants :—

$d_{15\cdot5}$ = .8940 ; N_D^{20} = 1.4850 ; b.p. = 115-120°C. (4mms).

Found C = 82.8, H = 10.7.

($C_{20}H_{32}O$ requires C = 83.3, H = 11.1).

Iodine value 305 indicating 3 double bonds.

No constitution has been assigned to this substance, though by analogy with similar bodies produced by reducing mesityl oxide there are several possibilities including that of the system analogous to desoxy-mesityl oxide.

Fraction (*c*) possessed the following constants :—

$d_{15\cdot5}$ = .9094 ; b.p. = 140-150°C (4mms.)
Found C = 78.6, H = 10.8.
($C_{20}H_{34}O_2$ requires C = 78.4, H = 11.1).
Iodine value 302.

Only a small quantity of (*c*) was produced.

Reduction of tagetone with sodium and cold alcohol.

By reduction in the cold, 50 ccs. tagetone gave 25 ccs. of a pleasant smelling alcoholic body. After purification by means of the acid phthalate it possessed the following constants :—

$d_{15\cdot5}$ = .8512 ; N_D^{20} = 1.4420 ; b.p. = 197°C (760 mms.).
Found C = 76.5, H = 12.7.
($C_{10}H_{20}O$ requires C = 76.9, H = 12.8).

These constants agree with those given for dihydro-tagetol.

Reduction of tagetol with zinc dust and alcoholic sodium hydroxide.

Zinc dust was added slowly to 100 ccs. of tagetone dissolved in alcoholic sodium hydroxide (400 ccs.) until no further heat was developed. The flask was then heated under reflux for 3 hours and the reaction products isolated by ether extraction.

Separation by fractional distillation at 3 mm. pressure gave two substances of molecular composition $C_{20}H_{34}O_2$, together with a small fraction of a lower boiling point liquid which readily gave a crystalline semicarbazone M.P. 92.5°C and therefore ketone I., was presumably present in the original tagetone.

The constants of the higher boiling liquids were determined as follows :—

(*a*) $d_{15\cdot5}$ = .9405 b.p. = 140-150°C. (4 mms.)
Iodine value 191.
(*b*) $d_{15\cdot5}$ = .9399 b.p. = 160-170°C. (4 mms.)
Iodine value 214.

Fraction (*a*) gave with hydroxylamine an oxime containing 6.9% of nitrogen, while in the case of (*b*) the oxime contained 3.9% of N. The percentage of nitrogen for one oxime group is 4.3% and it is concluded that fraction (*b*) contained two ketone groups while (*a*) contained only one.

Hydrolysis of tagetone with barium hydroxide solution.

Twenty grammes of tagetone were heated under reflux with 200 ccs. methyl alcohol saturated with barium hydroxide for three hours and the products isolated by steam distillation and fractionation.

The principal product, isolated in addition to a small amount of methyl isobutyl ketone was found to possess the following constants—

$d_{15\cdot5}$ = .9046 ; N_D^{20} = 1.4640 ; B.p. = 75-80°C. (4 mms.)
Found C = 71.9, H = 10.9.
$C_{10}H_{18}O_2$ requires C = 70, H = 10.6).

The combustion results were not altogether in satisfactory agreement with the formula $C_{10}H_{18}O_2$, but there is no doubt that the product can only be accounted for by such a formula. Addition of water to the unsaturated system had evidently taken place but the yield was small owing to resinification.

Reaction of tagetone with the Grignard reagent MgCH3I.

Twenty-five grammes of tagetone were slowly added to the theoretical quantity of $MgCH_3I$, when a vigorous reaction occurred.

From the reaction product a small amount of liquid of b.p. 66°C. (3 mms.) was isolated possessing the following constants :—

$d_{15\cdot5} = .8559$; $N_D^{20} = 1.4520$.

This was separated into two portions by reaction with semicarbazide and it is likely that the reaction had followed the normal course with substances of the tagetone type, giving a ketone and a tertiary alcohol.

The greater portion of the tagetone was however converted into products with high boiling points, indicating polymerisation during the reaction.

Polymers of tagetone.

The constants determined for the two fractions isolated from the resinified material always resulting in the fractionation and distillation of tagetone were as follows :—

(*a*) $d_{15\cdot5} = .9786$; b.p. = 130-140°C. (4 mms.)
(*b*) $d_{15\cdot5} = .9750$; b.p. = 150-160°C. (4 mms.)

In both cases combustion results indicated $C_{20}H_{32}O_2$.

Only a small proportion of the resin is however distillable.

Reaction of tagetone with hydroxylamine.

From the reaction of tagetone with hydroxylamine in alkaline solution, in addition to the oxime already described (*loc. cit.*) it was found possible to isolate an oximino ketone. This was effected by solution in dilute sulphuric acid. For the recovered oximino ketone the following constants were obtained—

$d_{15\cdot5} = .969$; $N_D^{20} = 1.4720$; b.p. = 100-102°C (4 mms.)
Found N = 7.9%.
($C_{10}H_{19}NO_2$ requires 7.6%).

The oximino ketone readily reduced Fehlings solution on warming and gave all the reactions of such a body.

REFERENCES

1. Law, H. D. (1912), J.C.S., pp. 1017-1022.
2. Jones, T. G. H., and F. B. Smith (1925), J.C.S., pp. 2530-2539.
3. Jones, T. G. H. (1926), J.C.S., pp. 2767-2770.

The Problem of the Brisbane Tuff.

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PLATES IV.-VI.

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1. INTRODUCTION.

The following paper records an attempt to discover the origin, and explain the mode of formation of the rock now known as the Brisbane Tuff. While the authors long ago realised that this rock possessed a number of unusual features, their doubts as to its true nature were revived and strengthened when a section showing well-developed columnar structure was exposed in the municipal quarry at Windsor some three miles north of the centre of the city of Brisbane. A more detailed examination disclosed other anomalous features, but a search of the literature showed that the characters displayed by the Brisbane Tuff, although rare, were not unique but could be closely paralleled in the "Great Hot Sand Flow" of Alaska and in the "Ignimbrites" of New Zealand, while they also resembled in certain respects the "*Nuees ardentes*" of Mt. Pelee.

In the pages which follow only those features that have a direct bearing on the origin and nature of the Brisbane Tuff will be considered. For a more general account the reader is referred to the paper by Mrs. C. Briggs (1928) published in these proceedings.

2. EARLIER VIEWS AS TO ORIGIN AND MODE OF FORMATION.

The rock which is now known as the Brisbane Tuff was first described by Leichhardt (1855) who examined the rock on his visit to Brisbane in 1844. The publication in which his account occurs is in German, a free translation of which reads as follows :—

> "Forming the steep bank of the Brisbane River opposite the Government Gardens and between Petrie's Bight and New Farm there occurs a rock of pale violet colour which furnishes an excellent building stone. It encloses pieces of talc-schist but one notices felspar crystals too and these reveal the true nature of the rock. I consider it a Domite although, since it has broken through the talc-schist and so included many fragments of that rock, one is inclined at first to regard it as a conglomerate."

The next observer was Wilson (1856) who described the formation as "a large dyke of flesh-coloured porphyry, containing crystals of quartz and felspar and many fragments of the slate-rock through which it has been erupted. These fragments show no indication of having been fused or altered."

A. C. Gregory (1879) also regarded the rock as an intrusive porphyry containing fragments of "slate." He pointed out that "portions of silicified wood are embedded in the lower surface of the erupted mass."

Rands (1887) disagreed with the earlier workers and described the rock as a "Volcanic Ashy Sandstone" for the following reasons : "Taking into consideration the nature of the rock, its being full of angular pieces of other rocks, the absence of any change in the surrounding schists and lastly its position in relation to the other formations . . . . I have come to the conclusion that it is a 'volcanic ash' and not a porphyry, and that it lies at or near the base of the Ipswich beds." Rands also stated that the included fragments attain the size of pebbles or boulders towards the base and that "It has also near its base pieces of silicified and also of carbonised wood."

As a result of Rands' work the pyroclastic origin of the rock was generally accepted and it became known as the "Brisbane Tuff" a name which it still bears in geological nomenclature, although the earlier term "Porphyry" is still used by local engineers and those engaged in quarrying the stone.

That some uncertainty yet lingered in the minds of geologists as to the nature and origin of the rock is shown by Walkom's (1918) cautious statement that it was "probably of volcanic origin (though there is no indication of its source) resulting from the deposition of volcanic ash . . . . ."

Dunstan (1920) although he expressed no opinion as to the position of the focus of volcanic activity had definite views as to the nature of the eruption which he expressed as follows: "Volcanic outbursts at the beginning of the Triassic period formed a very thick deposit of dust or ash over the hills and valleys in the Brisbane district, and the timber growing on the shales and schists at that time was enveloped and destroyed by a great thickness of this dust. The deposits evidently were not laid down as mud, as the tops of the hills were as thickly covered as the bottoms of the valleys, while in addition the presence of charcoal at the base of the tuffs, quite unchanged even after the lapse of such a length of time, gives evidence of the burning of some of the timber while its envelopment was taking place."

Ball (1920) called attention to the possible relationship of the Brisbane Tuff with the acid intrusions of the Indooroopilly area.

Richards (1924) suggested that "it is not unlikely that the source of the activity was to the East or South-east of Brisbane in a region now foundered below sea-level," while a few years later the present authors (1927) considered the possibility of Castra (twelve miles east-south-east of Brisbane) marking one focus of activity.

The most recent study of the Brisbane Tuff is that of Mrs. C. Briggs (1928) who concluded that "the tuff was laid down on land surface, the continuity of which was broken by a series of small fresh-water lakes" but that "There is no direct indication of the centre of eruption of this tuffaceous material within a reasonable distance of its outcrops." This authoress also suggested that there might be some genetic relationship between the Brisbane Tuff, the Indooroopilly Intrusives and the Enoggera Granite which chemically and mineralogically have much in common.

3. Observations.

(*a*) *In the Field.* (*See* Plates V. and VI.).

The Brisbane Tuff occurs almost at the base of the Ipswich Coal Measures of Triassic age which overlie with a marked unconformity the Brisbane Schists of early Palaeozoic age.

At the present time outcrops which can with reasonable certainty be correlated with the Tuff as typically developed are scattered over an area measuring 34 miles by 9 miles, with a decided concentration in and about the city of Brisbane where the principal outcrop takes the form of an elongate mass measuring about 12 miles in a N.N.W.-S.S.E. direction. To the west of this principal outcrop lie the Brisbane Schists. Within the schists and forming an intrusive suite roughly parallel with and some two or three miles west of the main mass of Tuff is the major intrusion known as the Enoggera Granite and a host of minor intrusions of an acid nature which have been called the Intrusive Rhyolites. The granite occupies the northern part of this intrusive belt while the Intrusive Rhyolites are for the most part concentrated in the south. To the east of the principal outcrop of Tuff there lies a geological complex consisting in part of inliers of Brisbane Schist, in part of more or less isolated outcrops of Tuff, and in part of younger beds of the Ipswich Series.

The present discontinuity of the Tuff may represent an original condition due to accumulation on the lower portions of an uneven surface, for the junction of the Ipswich Series and Brisbane Schists is, as pointed out by Marks (1910), an exceedingly irregular one. Indeed the relationship between the two series appears to be a typical "buried landscape" unconformity. Nevertheless the present distribution may be in part due to erosion. The fact that the Tuff has (with the remainder of the Ipswich Series) been subjected to moderate folding seems to have had little influence on the matter owing possibly to the coincidence of synclinal areas with original depressions.

The basement on which the Tuff rests usually consists either of a coarse rubble breccia made up of large angular fragments of the underlying schist and suggestive of a consolidated scree, or of a fissile mudstone containing numerous plant remains. The latter when present is never more than a few feet thick and may rest directly upon the Brisbane Schists or be separated from them by varying thicknesses of the rubble breccia. In one locality, however, the fossiliferous mudstone is represented by a thin band actually within but almost at the top of the breccia. In some places the rubble breccia grades laterally into coarse basal conglomerates and other shallow water deposits. A very striking feature associated with the base of the Tuff is the great number of fossil trees some of them over two feet in diameter. These are not in position of growth but appear to lie upon the bed of the Triassic lake and on the surrounding shores.

Although the data are not available on which reliable estimates of the maximum thickness of the Brisbane Tuff can be based it is certainly of the order of hundreds of feet. Thicknesses of from 200 to 300 feet have been definitely established but it seems probable that at its greatest the Tuff was more than 500 feet thick. Although the thickness certainly varies considerably and in particular appears to decrease to the east the Brisbane Tuff forms a stratigraphical unit in a sedimentary series.

In those places where the lower part of the Tuff has been considerably weathered it usually has the appearance of a stratified deposit owing to the more resistant nature of one or more hard bands. One such band in particular is seen in certain exposures to form the very base of the Tuff. This is from one to three feet in thickness and is clearly differentiated from the overlying Tuff owing to its superior hardness and compactness. That something in the nature of bedding is present is also suggested by the fact that even in the more massive portions stone-masons find that the Tuff " works " more readily along what would correspond to the bedding planes.

But apart from the features noted in the last paragraph there is a notable absence of stratification. The Brisbane Tuff as seen in a cliff face or a quarry wall presents a most striking appearance. In such positions it stands as vertical walls of massive rock with no sign of stratification even in those portions immediately underlying the shallow soil, but with strongly developed joints which are the more noticeable since they are absent from both the immediately underlying and overlying rocks. The joint planes as typically developed are widely spaced and at right angles to each other but closely spaced and curved joint planes are also met with. Sometimes the vertical joints are much more strongly developed than the others and a roughly prismatic structure results, but the most striking system of joints is that found in the municipal quarry at Windsor where there is developed a very pronounced columnar structure (*see* Plate VI., Fig. 2).

In its general appearance as in its detailed arrangement this columnar jointing is closely comparable with that frequently met with in lavas and equally distinct from the prismatic jointing occasionally found in sediments. A comparison of Plate VI.,, Fig. 2 with the figures of Iddings (1909 Figs. 13, 17) illustrating the columnar basalt of Orange Mountain, New Jersey, is instructive in this respect.

The columns are tolerably uniform in size with an average diameter of approximately twelve inches. The sides vary from nearly straight to somewhat undulate. About two-thirds are pentagonal, the majority of the remainder being six-sided or four sided. Ball-and-socket jointing is not developed and there is no pronounced tapering of the columns. The columns as a whole are neither horizontal nor vertical, the arrangement being somewhat irregular but including certain regularly divergent and convergent structures. In so far as one may generalise the principal structure appears to consist of a collection of approximately vertical columns in the heart of the structure forming a nub from which other curved columns diverge to form a basin-like arrangement.

The upper ends of many of the columns appear to be continuous with as if welded into the overlying massive non-columnar Tuff.

These features show the structure to be typical of that formed in igneous rocks by thermal contraction as distinct from the prismatic structures due to convectional circulation or to internal expansion (*see* Sosman, 1916).

The shales immediately below the columnar Tuff are unusual in that they have been considerably contorted and even in places brecciated and indurated.

In certain localities the Brisbane Tuff shows features closely resembling some of the fluxion structures seen in acid lavas. These may take the form of continuous lines or of a streaky distribution of materials of different hardness or colour which is emphasized by weathering.

A notable feature is the compactness of the rock which has resulted in its use as a local building stone (*see* Richards 1918).

One of the most striking characters of the Brisbane Tuff is the presence of very numerous fragments of the underlying Brisbane Schists. These fragments seldom exceed a few inches in diameter and are very angular. Although many of these appear indurated others show no obvious sign of metamorphism but in view of their original obdurate nature this may not be very significant. Fragments of rhyolite, usually of small size, also occur as inclusions but these are not so common or conspicuous. Of particular interest are the inclusions of fossil wood within the Tuff. These are usually of the nature of silicified petrifactions, but there also occur fragments of carbonised wood and natural charal, coespecially in the lower part of the Tuff.

In the heart of one of the columns of the Tuff at Windsor there was discovered by the authors a fragment of graphite, irregular in shape and about one inch in length and showing all the appearances of having been fused (*see* Plate VI., Fig. 1). The graphite fragment is enveloped by an area of Tuff throughout which there are disseminated minute particles of graphite. This graphitic halo is not concentrically arranged with regard to the fragment but is far wider on one side than the other suggesting that the material that gave rise to the halo had moved steadily in that direction.

Of all the inclusions whatever their nature, it may be said that they commonly show no sign of orientation, but that when a definite arrangement is developed as sometimes occurs in the more massive variety it is roughly parallel with the base of the Tuff.

An unusual development of the Brisbane Tuff has been described by the authors (1927) from Castra where volcanic mud balls or "accretionary lapilli" (*see* Wentworth and Williams 1932) are well developed in an extremely fine-grained variety of Tuff. Similar structures in a similar base have since been found at Aspley. These occurrences represent the northerly and easterly limits respectively of the Brisbane Tuff proper.

(*b*) *Under the Microscope* (*see* Plate IV.).

Although when judged by hand-specimens alone the Brisbane Tuff appears to be a tolerably uniform and easily recognisable rock (its most variable feature being its colour), yet under the microscope a considerable variety is to be seen. The most notable feature in this variety is that the bedded material from the base of the Tuff shows nothing but clastic structures and could be described as a typical rhyolitic vitric tuff whereas specimens from the overlying massive Tuff lack the normal tuffaceous characters and are more or less dominated by plastic or fluidal structures.

As typically developed the bedded Tuff is closely comparable with that figured by Pirsson (1915 Fig. 2) except that the glass shards have been devitrified and silicified as have also the more minute fragments of glass dust which originally constituted the base. Embedded in this vitroclastic material are a few comparatively large crystals of quartz showing idiomorphic or broken outlines with an occasional crystal of felspar.

The microslides obtained from the massive Tuff although they exhibit much greater variety nevertheless form a natural group in that they are all influenced by the development of fluidal structures comparable with those seen in lavas.

The most extreme variety of this second group (*see* Plate IV. Fig. 5) resembles the " welded pumice " figured by Iddings (1909 Fig. 22) from the Yellowstone National Park. The other extreme of this group is found in a markedly brecciated rock in which angular fragments of " welded pumice " are a striking feature. Intermediate between these extremes and perhaps more typical of the group as a whole are those rocks in which streaks of the more plastic material are welded into a rock made up of material comparable with the " collapsed pumice " of Iddings (1909 Fig. 21) the whole suggesting " eutaxitic structure."

All of the varieties of this second group commonly contain a considerable number of quartz " phenocrysts " a characteristic feature of which is their deep embayment. Felspar " phenocrysts " are also common but these are usually idiomorphic although occasionally embayed.

4. Summary and Inferences.

The observations recorded above show that in the Brisbane Tuff one finds what at first sight appears to be a curious mixture of tuffaceous and non-tuffaceous characters so that it is not surprising that in the past it has been variously regarded as a lava flow, as an intrusion and as a tuff. An analysis of the relevant data, however, shows that the normal and abnormal characters are by no means indiscriminately mixed for, although it is true that certain characters are found throughout the Tuff, others are definitely restricted, while several are limited to a single occurrence.

A consideration of the various features present and their distribution suggests that the Brisbane Tuff should be regarded as made up of two types, each of which has its own varieties. These types may be called the Stratified Type and the Massive Type respectively.

The Stratified Type when present is restricted to the lowest portion of the Brisbane Tuff. It is definitely stratified and is weakly jointed. At its base are found numerous petrified trees. The many inclusions of Brisbane Schist show little or no sign of metamorphism. In microstructure the rock is typically vitroclastic.

The marginal occurrences at Castra and Aspley containing accretionary lapilli may be regarded as a special development of the type.

The Stratified Type of the Brisbane Tuff combines so many normal tuffaceous characters that it at least may be true to name. Nevertheless there are several features which are somewhat unusual. The first of these is the presence of fragments of natural charcoal (a feature which the Stratified Type shares with the Massive Type). These at first seem to imply a temperature in the enclosing material greater than that expected of a volcanic ash. Indeed Fenner (1920, p. 578) uses similar carbonized fragments as one of the criteria for distinguishing the " great hot sand-flow " of the Katmai region from the associated ash falls.

On the other hand Grange (1931, p. 229) has described from the north island of New Zealand, charred wood in a layer of volcanic ash less than six inches thick, fifty miles from the supposed source at Taupo. He considers that this and other carbonized fragments common in the area were " charred by the hot ashes " and that " the carbonized wood is similar in composition to that of charcoal formed by destructive distillation at 250°C."

A second unusual feature consists in the strangely uneven base of the Stratified Type. This unevenness appears to be due not to original depressions in the underlying surface but to downward protuberances from the base of the Tuff. (*see* Plate V., Fig. 1).

The Massive Type of the Brisbane Tuff overlies the Stratified Type and is over 200 feet in thickness. It shows no sign of stratification but is strongly jointed. Many inclusions lie parallel to the base and show definite signs of metamorphism. Under the microscope the rock is seen to be dominated by plastic and fluidal structures.

The occurrence at Windsor where columnar structure is associated with the development of graphite and where the underlying Ipswich shales are locally disturbed and indurated is thought to represent an extreme development of the Massive Type, the presence of which may be connected with its position in what appears to have been a small lateral embayment of the main valley.

The Massive Type of the Brisbane Tuff combines so many non-tuffaceous characters that the word Tuff must be regarded as misleading. All the evidence points to such very high temperatures at the time of its formation that much of the material composing it was virtually plastic if not actually fluidal. Since rhyolitic glass becomes plastic only when the temperature approaches 1000°C. the Massive Type can hardly be explained as a solidified ash. Indeed many microsections appear remarkably like devitrified and silicified glassy lavas. In particular the columnar material at Windsor which in other respects is quite typical of the Massive Type shows evidence of very high temperatures, for here in addition to the other evidence we have the presence of the columns themselves and the included fragment of graphite both of which indicate temperatures more characteristic of a lava flow than an ash fall.

In spite of the differences noted above the Stratified Type and the Massive Type have so many factors in common, including chemical composition and geographical distribution that it is reasonable to conclude that both types came from the same volcanic centre, but their differences are so notable that a separate *modus operandi* is needed for the formation of each type.

It appears that while the earlier formed Stratified Type (and more particularly that containing the accretionary lapilli) might be explained as due to a series of violent volcanic explosions followed by the deposition of showers of ash about the shores and within the waters of a series of small lakes, such an explanation is hopelessly inadequate to account for the Massive Type and especially so for the columnar material at Windsor. To explain the Massive Type one needs to account for: 1. An initial fragmentation of igneous material together with much foreign material; 2. The conversion of this fragmental material into a plastic largely welded mass.

The absence of any known source of the Brisbane Tuff has long mystified geologists and led Richards (1924, p. 286) to suggest that the centre of activity may have been somewhere to the east or south-east in a region now below the sea.

The present authors (1927, p. 60) in discussing the origin of the volcanic mud balls ("accretionary lapilli") at Castra wrote "It might be thought that the presence of mud balls at Castra could serve as an indication of the proximity of one of the centres of eruption which ejected the Brisbane Tuff . . . .'' but "The evidence from Luzon (Phillipine Islands) does not lend much support to the idea that these balls indicate the centre of eruption.''

Mrs. Briggs (1929, p. 158) was unable to find any indication as to the centre of eruption but was of the opinion that "The uniformity of the material suggests that the source of origin was approximately at the same distance from all points on the outcrop. This, together with the fineness of the material and the absence of coarse volcanic ejectamenta would suggest that the source was not very close to the present outcrop.''

At Upper Brookfield some twelve miles south-west of Brisbane there occurs a coarse volcanic agglomerate with fragments of rhyolite up to twelve inches in diameter which may well mark the site of an ancient volcano, but except that it is later than the Brisbane Schists the age of this volcanic series is unknown. Although it is possible that the agglomerate and associated tuffaceous rocks may be coeval with the Brisbane Tuff they are lithologically so different including as they do andesitic and other relatively basic tuffs that the authors do not suggest this point as the possible centre of eruption.

In view of the fact that the columnar Tuff at Windsor combined evidence of very high temperature with local disturbance of the underlying shales the authors considered the possibility of this point marking an actual focus of eruption. To test this hypothesis they arranged through the courtesy of Mr. E. F. Gilchrist, B.C.E., City Engineer, to have a bore put down at the point. This was done, but the Tuff was found to extend only 43 feet below the quarry floor which was the depth to be expected if the Tuff merely occupied a basin shaped depression.

The authors have been unable to establish any normal centre of volcanic activity and are forced to the conclusion either that it is hidden from sight by the Tuff itself or that the Tuff originated in some unusual manner possibly from a series of fissures. In the latter case the swarm of rhyolitic intrusives in the Indooroopilly area may represent the denuded remnants of the dykes which acted as feeders.

With regard to the mode of emplacement of the Massive Tuff the combination of clastic and plastic phenomena seems to necessitate a type of volcanic action intermediate between an outpouring and an explosion.

Having arrived at these conclusions on the internal evidence presented by the Brisbane Tuff itself, let us now turn to similar developments elsewhere in the hope that they may shed light on the local problem.

5. Comparison with Other Areas.

Since the beginning of the present century evidence has been accumulating to show that, especially as regards the more siliceous material, volcanic activity is not restricted to simple effusions of lava and violent expulsions of ashes, but that there are other modes of extrusion intermediate between these extremes which combine in varying degree the clastic and fragmental qualities of a tuff with the plastic and fluidal qualities of a lava. This conclusion which has been founded on actual observations of volcanic eruptions is supported by the petrological nature and field occurrence of volcanic rocks of many ages from many parts of the world. Thus there is every reason to believe that many volcanic rocks which have given rise to considerable controversy in the past may be explained in terms of these special phases of igneous activity.

(*a*) *The Incandescent Avalanches* (*Nuees Ardentes*) *of Mont Pelee and La Soufriere.*

Anderson and Flett (1903, p. 500 *et seq*) point out that the climax of a Pelean eruption is manifested by the appearance of an avalanche of incandescent sand and the passage of a great black cloud. The outburst never appears in the form of molten lava but always "in the form of a cloud which rises to a certain height and then flows over the surface of the ground." "The mixture of dust and gases is so heavy that it courses down the slopes like a torrent in a river, clinging to all the valley bottoms, ever availing itself of the steepest descents and deflected by the projections and irregularities of the ground." As a result of such an eruption there accumulates a foot or two of unstratified Tuff made up almost wholly of fragmental crystals, the whole rock having the chemical composition of an andesite.

Lacroix (1904) who has made a close study of the matter does not regard these eruptions of the *nuee ardente* type as unique. On the contrary he has classed with them the eruption of Vesuvius that was responsible for the destruction of Pompeii in 79 A.D. and similar outbursts in Java, Japan and the Azores.

(*b*) *The Great Hot Sand-Flow of the Valley of Ten Thousand Smokes.*

At the same time as the great eruption of the Alaskan volcano Katmai in 1912 the floor of a neighbouring valley was, in the words of Fenner (1920, p. 576) "covered with a thick deposit of ash and pumice, which in most places has buried every detail of the former topography, and whose surface now forms a gently sloping plain. Thousands of fumaroles have found vent through this deposit and are sending out exhalations of hot gases and vapours . . . . This ashy deposit covers the old floor of the valley to a great depth (possibly several hundred feet in certain areas) . . ."

Griggs (1918, p. 117) was the first to recognise the unusual nature of this volcanic material and supposed it to have been a "Great Hot Mud Flow" which had been forced out of fractures in the valley floor. Fenner (1920) while agreeing with Griggs that the material originated from numerous dykes within the valley itself, regarded the Tuff as having been "a dry, highly heated mass of sand and pumice rather than a water-bearing mud." The same author points out that "Observations show plainly that, in the first place, this material was not thrown violently into the air to descend over the general landscape, but that it was restricted very definitely to topographic depressions . . . The thorough manner in which vegetable material engulfed by it was carbonized and the indications of brush fires started by it can hardly be explained except on the supposition that it possessed a high temperature, probably near incandescence. In many places adjacent to it but beyond its borders, fallen trees lie as if overthrown by a violent wind accompanying it." "Considering further the origin of the sand flow, we suppose that rhyolitic magma, charged with dissolved gases, rose to the surface in the newly formed vents . . . and produced by moderately forcible disruption, an outward spreading and forward moving torrent of incandescent sand and pumice, each particle of which was surrounded by and partially suspended in gases which it continued to give forth during its impetuous flow."

Lacroix agrees with the above interpretation and refers to the eruption as "*nuee ardente Katmaienne.*"

In a later publication Fenner (1923, p. 67) drew attention to Wolf's description of the eruption of Cotopaxi in 1877 and showed how most of the unusual features that puzzled Wolf could be explained as due to an eruption of the then unknown "*nuee ardente* type"—"the black mass suddenly boiling up and overflowing the rim of the crater on all sides, the prodigious speed with which it precipitated itself down the slopes, the great mass and short duration of the flow, the heavy clouds concealing the mountain within a few minutes, the rain of ashes immediately afterwards, the carbonization of tree trunks, the lack of coherent lava flows, the forcible manner in which the outburst spread over valleys and ridges on the upper part of the cone and later flowed down gulches in a more collected form—these point almost irresistibly to this form of eruption."

(*c*) *The Ignimbrites of the North Island of New Zealand.*

Marshall (1932, p. 198) has suggested the name "Ignimbrite" for a type of rock which has a wide occurrence over 10,000 square miles in the North Island of New Zealand. In the past the rock has been variously regarded as a tuff, as a lava, and as a flowbreccia, but Marshall compares it with the material of Mont Pelee and Katmai and deduces a similar origin. He points out in an unpublished paper, which the authors have been privileged to see, that Ignimbrites differ from ordinary rhyolitic tuffs in their uniform and normally fine texture, the absence of bedding, the pronounced prismatic jointing, their coherence and effective solidity and in the "flow structures" to be seen under the microscope. On the other hand they may be distinguished from normal rhyolitic lavas in their great horizontal extension, the absence of glassy selvages and scoriaceous surfaces and their low specific gravity. Further, a thin bed of extremely fine glass dust often occurs below the formation. There is an increase in the specific gravity from the top to the bottom and there is no indication of mass flow. Finally Marshall points out that "There are no volcanoes in the district from which rhyolite lavas could have flowed."

Petrologically Marshall regards the Ignimbrites as divisible into three classes: *Pulverulites* composed of fine dust-like shreds of glass surrounding crystal grains. *Lenticulites* with conspicuous lenses of dark material often drawn out and embedded in fine glassy shreds with some crystals. *Lapidites* with fragments of rock embedded in fine material composed mainly of glassy shreds.

(*d*) *The Giant Columnar Pillows of Auckland.*

Structures which are closely analogous in some respects to the columnar Tuff of Windsor have been described by Bartrum (1930) from Muriwai, Auckland, New Zealand, where "the sea cliffs exhibit remarkable columnar structures in andesitic lavas of mid-Tertiary age . . . ." These lavas have developed pillow-shaped structures up to 80 feet in diameter. "They undoubtedly are submarine in origin, for, in addition to the pillow form, in some places they include marine fossils in tuffaceous debris between the pillows whilst they rest on tuffs with similar fossils. The seas into which they were poured were very shallow . . . ." With regard to the origin of these unusual structures Bartrum concludes that "the large radially columnar spheriodal masses . . . . represent large pillows formed by the outpouring of small quantities of liquid rock from dyke-fissures that reached the floor of a shallow sea in which thick beds of tuff were being laid down."

(*e*) *Comparisons and Contrasts.*

Although, with the exception of the last, all of the occurrences noted have been referred to eruptions of the one type, for all have points in common, they nevertheless show considerable variation in such important points as chemical composition, lithological nature and quantity of material erupted. Consequently, it is not to be surprised that the Brisbane Tuff, while generally similar to them all, presents points of difference from each.

The Brisbane Tuff differs from the *nuees ardentes* of the West Indies in its more siliceous composition, and in the much larger proportion of glassy fragments, in its plastic characters, and in the enormously greater amount of material.

The Brisbane Tuff resembles the hot sand flow of the Valley of Ten Thousand Smokes in chemical composition, in the proportion of glassy to crystalline material, in thickness and extent. The chief differences are that the local rock is more compact and exhibits welded and fluidal structure in a more marked degree.

The Brisbane Tuff resembles the Ignimbrites of New Zealand more closely than any of the other occurrences with which it has been compared. The authors have been very fortunate in that they have both enjoyed personal discussions with Dr. Marshall on the nature of Ignimbrites and have, through his courtesy, been able to examine many microsections of typical material. In addition one of them has recently visited New Zealand and studied the Ignimbrites in the field. The features which most closely unite the Brisbane Tuff with the New Zealand Ignimbrite and which appear to mark them off from the West Indian and Alaskan rocks are their lava-like characters. These are shown by their strongly welded nature, by an approach to fluxion phenomena and by the development of columnar jointing.

Features which the Brisbane, New Zealand and Katmai occurrences have in common are enormous bulk, rhyolitic nature, high glass content and absence of any normal centre of eruption.

While the columnar pillows of Muriwai have several features in common with the columnar Tuff at Windsor, they differ in that although they are set in tuffaceous material, they themselves are definitely lava forms.

6. Conclusions.

As a result of their observations in the field and under the microscope, and after comparisons with similar rocks in other parts of the world the authors have come to the following conclusions :—

1. The Brisbane Tuff although a stratigraphical unit is made up of two distinct petrological types.
2. Of these the lower or Stratified Type is sufficiently normal in its characters to call for no special hypothesis of origin.
3. The upper or Massive Type has so many non-tuffaceous characters that it is unlikely that it represents a solidified ash fall.

4. The combination of tuffaceous and non-tuffaceous characters presented by the Massive Tuff could be most readily explained as due to an enormous eruption of the incandescent avalanche type.
5. In particular the material at Windsor, as a result possibly of its location in an embayment of the valley wall or possibly on account of its proximity to a hidden source became welded into what was virtually a rhyolitic lava which on cooling gave rise to columnar structure.
6. No centre for this volcanic activity has been established, but it seems possible that the numerous rhyolitic intrusives lying to the west of the Tuff represent the somewhat deeply eroded representatives of the dykes which acted as feeders. Again the volcanic centres may lie buried beneath the Tuff itself.
7. The Massive Type of the Brisbane Tuff presents many features closely analogous with those of the Ignimbrites of New Zealand and has also much in common with the Hot Sand Flow of Alaska.

REFERENCES.

Anderson, T. and Flett, J. S. (1903)—Proc. Roy. Soc. London, Series A, Vol. 200.
Ball, L. C. (1920)—Qld. Govt. Min. Jrnl., Vol. 21, p. 266.
Bartrum, J. A. (1930)—Jour. of Geol., Vol. 38, p. 447.
Briggs, C., (1929)—Proc. Roy. Soc. Qld., Vol. 40, p. 147.
Dunstan, B. D. (1920)—Introduction to Qld. Geol. Surv. Pub. No. 267, p. 5.
Fenner, C. N. (1920)—Jour. of Geol. Vol. 28, p. 569.
Fenner, C. N. (1923)—National Geographic Society, Contributed Technical Papers, Katmai Series, No. 1.
Grange, L. J. (1931)—New Zealand Jrnl. Sci. and Tech., Vol. 12.
Gregory, A. C. (1879)—"Geological Features of the South-eastern Districts of Queensland," Legislative Assembly Papers.
Griggs, R. F. (1918)—Ohio Jrnl. of Science, Vol. 19, No. 2, p. 117.
Iddings, J. P. (1909)—"Igneous Rocks," Vol. 1.
Lacroix. A. (1904)—"La Montagne Pelee et ses Eruptions," p. 363.
Leichhardt (1855)—"Beitrage zur Geologie von Australien," Halle, p. 53.
Marks, E. O. (1910)—Qld. Geol. Surv. Pub. No. 225, p. 8.
Marshall, P. (1932)—New Zealand Jrnl. Sci. and Tech., Vol. 13.
Pirsson, L. V. (1915)—Am. Jrnl. Sci., Vol. 40, p. 191.
Rands, W. H. (1887)—Qld Geol. Surv. Pub. No. 34, p. 1.
Richards, H. C. (1924)—Aus. Ass. Adv. Sci., Vol. 17, p. 286.
Richards, H. C. and Bryan, W. H. (1927)—Proc. Roy. Soc. Qld., Vol. 39, p. 60.
Sosman, R. B. (1916)—Jour. of Geol., Vol. 24, p. 224.
Walkom, A. B. (1918)—Proc. Linn. Soc. N.S.W., Vol. 43, Pt. 1, p. 48.
Wentworth, C. K. and Williams, H. (1932)—Bull. Nat. Res. Cncl. U.S.A., No. 89, p. 45
Wilson, J. S. (1856)—Q.J.G.S., Vol. 12, p. 288.

THE PROBLEM OF THE BRISBANE TUFF.

DESCRIPTIONS OF PLATES.

Plate IV.

Microphotographs of specimens of the Brisbane Tuff taken in ordinary light. Magnification *ca.* 25.

Figure 1.—Devitrified and silicified fine vitroclastic tuff of the Stratified Type from the base of the formation at Leichhardt Street Quarry(*see* Plate V, Fig. 1).

Figure 2.—Similar to Figure 1 and showing larger fragment of charred wood. From Collin's Wharf Quarry.

Figure 3.—Example of the Massive Type used locally as a building stone. Bowser and Lever's Quarry.

Figure 4.—Extreme example of the Massive Type showing fluidal structures closely simulating those of Rhyolite. Municipal Quarry, St. Lucia.

Figure 5.—"Welded Pumice" from the Massive Type. Municipal Quarry, Morningside. (Compare Iddings, 1909, Fig. 20).

Figure 6.—Specimen showing fluidal structures from the columnar variety of the Massive Type (*see* Plate VI.). Municipal Quarry, Windsor.

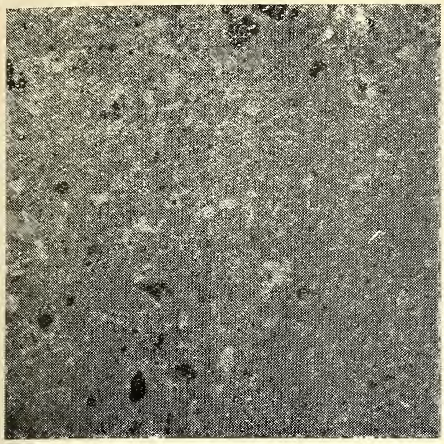

Figure 1

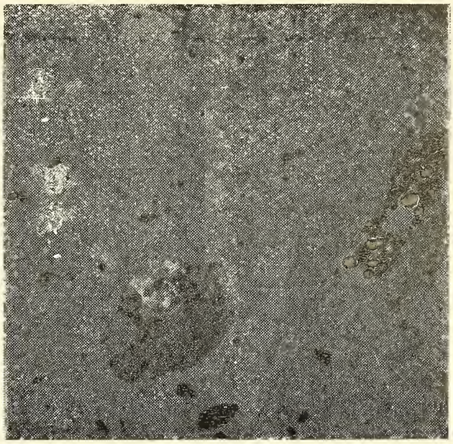

Figure 2

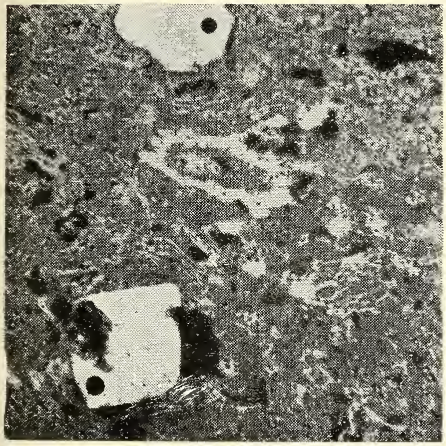

Figure 3

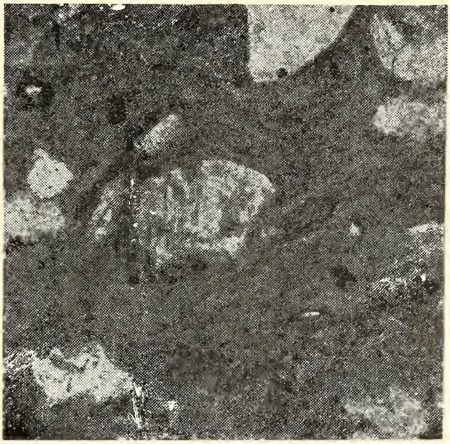

Figure 4

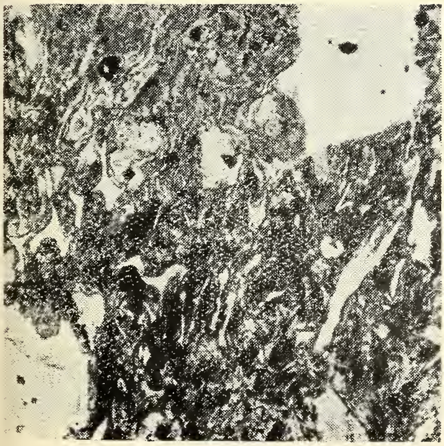

Figure 5

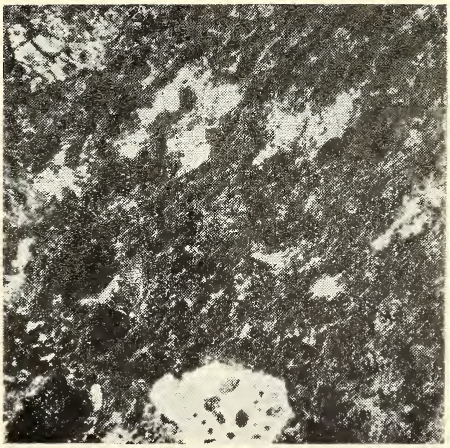

Figure 6

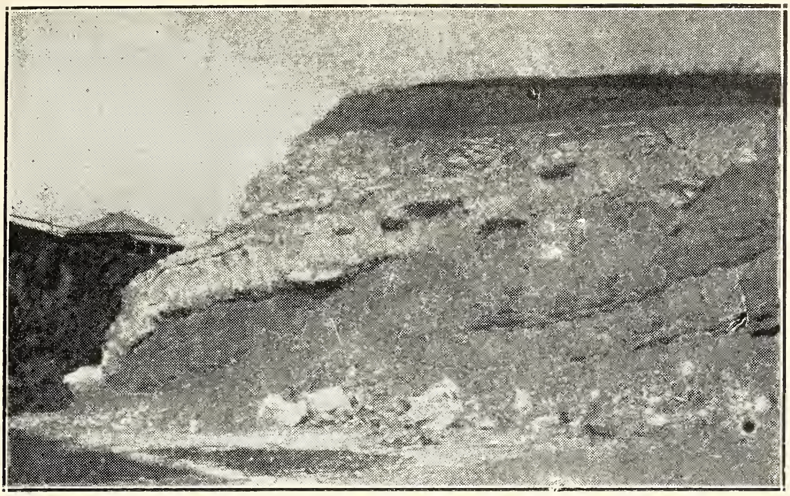

Figure 1.

Stratified Type of Brisbane Tuff (light) overlying rubble-breccias and shales (dark) which form base of Ipswich Series. Leichhardt Street Quarry.

Figure 2.

Massive Type of Brisbane Tuff showing absence of bedding and well developed jointing. Kangaroo Point.

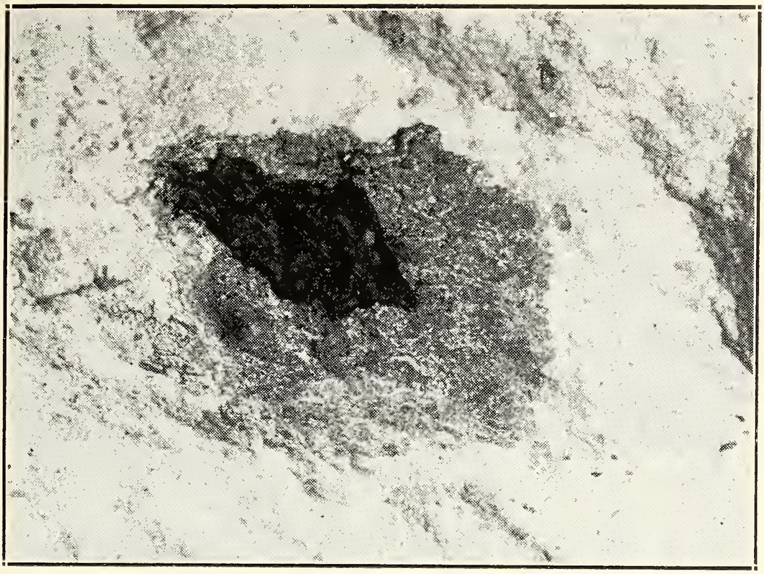

Figure 1.

Graphitised wood-fragment in columnar variety of Massive Type of Brisbane Tuff X2. Municipal Quarry, Windsor.

Figure 2.

Development of columnar variety of Massive Type of Brisbane Tuff (*see* Plate IV.,) Figure 6). Municipal Quarry, Windsor.

The Lower Carboniferous Corals of Australia

By Dorothy Hill, M.Sc. (Queensland), Ph.D. (Cantab).

Plates VII.-XI. and Seven Text-Figures.

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CONTENTS.

INTRODUCTION.

This paper revises, where possible, those species of Australian Lower Carboniferous corals already erected, and describes several new species collected by the author. It deals with the "*Naos*" modification of septa in these and other Rugose corals; and describes skeletal malformation in an Australian Viséan coral. It also gives a brief summary of our present knowledge of the Lower Carboniferous stratigraphy of Australia, and a note on variation in Rugose coral species.

The work was begun at the University of Queensland, and completed at the Sedgwick Museum, Cambridge, by the author while she held consecutively the Open Scholarship for Scientific Research and the Foundation Travelling Scholarship of the University of Queensland, and the Old Students' Research Fellowship of Newnham College, Cambridge. She wishes to record her gratitude to the authorities concerned in these awards, and to thank Miss G. L. Elles, Dr. Stanley Smith, Dr. W. D. Lang, Mr. A. G. Brighton, Dr. H. D. Thomas, Dr. F. W. Whitehouse, Dr. W. H. Bryan, Mr. W. S. Dun and Mr. J. S. Fletcher for a great deal of assistance. She is glad to state that publication was made possible by grants from the Commonwealth of Australia

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Genus SYMPLECTOPHYLLUM gen. nov.

Symplectophyllum, from συμπλεκτος, woven; φιλος, a leaf, that is a septum.

Genotype.—*Symplectophyllum mutatum* sp. nov. from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland.

Diagnosis.—Simple Rugose corals with a very variable axial structure involving septa and tabulae. The septa are dilated in their early stage, but later the median part may become cavernous, and the peripheral breaks down into horizontal tissue and consists of long narrow convex plates connected by granules of stereome. The tabulae, although sometimes complete, are usually incomplete. The dissepiments are small, and rather elongated, but do not enter the periphery of the coral. Stereome is irregularly developed.

Remarks.—The genus is interesting for two reasons; first, it shows a type of septal modification like that seen in the Silurian genus *Naos* Lang (1926, p. 428), and permits an explanation of such a structure; second, amongst the varying expressions of its axial structure it shows patterns reminiscent of those which Thomson (1883, pp. 436 seq.) regarded as diagnostic for his Scottish Viséan genera *Rhodophyllum*, *Aspidiophyllum*, *Dibunophyllum*, *Kumatiophyllum*, *Centrephyllum* and *Carcinophyllum*.

SYMPLECTOPHYLLUM MUTATUM sp. nov. (Plate VII.)

Holotype:—F 2943, consisting of 8 slides and 4 pieces; in the University of Queensland Collection. (Plate I., figs. 1-6.)

Diagnosis.—As for genus.

Description.—External characters: Large simple corals usually with a long conico-cylindrical adult stage, sometimes turbinate. The largest specimen (broken at both ends) was 13 cm. long with a maximum diameter of 3 cm. The average adult diameter is 2.5 cm. The epitheca is thick, with faint annulations and striations.

Internal structures—Immature stage: Transverse sections of immature stages were obtained from only four corals. These, illustrated in Plate VII., figs. 6, 9, 16, and 27, show similarity in septal characters, diversity in the structure of the large axial area, and diversity in the amount of stereome present. The *septa* are dilated[1] and crowded. (Plate VII., fig. 27 shows 24 of each order at a diameter of 7 mm.). The minor septa are from half to two-thirds as long as the major, which usually attain a length of only one-third the diameter of the corallite, since they are very seldom continuous with the septal lamellae of the axial structure. Septal dilation[2] always occurs; in one section (fig. 27) it is so pronounced that the interseptal loculi are closed. *Dissepiments* are already present in these sections, although in fig. 27 they are entirely masked by stereome dilating the septa. The *axial area*, whose diameter is about one-third that of the corallite, may have its component plates entirely masked by stereome (fig. 27),

(1) Seen microscopically, the septa are pinnately fibrous.
(2) Whilst the septa when examined by a lens appear well defined and separate from the darker investing stereome which may fill the interseptal loculi, under the microscope they and the darker stereome are seen to merge into one another and their fibres are optically continuous.

diameter 7 mm.) ; it is known from transverse section only and may show sections of tabulae and dilated, discrete septal ends, variously arranged, with much (fig. 9, diamater 7 mm.) or little (fig. 6, diameter 12 mm.) stereome ; or it may be occupied only by one or two semi-circular sections of tabulae about a dilated median lamella continuous with two opposite septa (fig. 16, diameter 6 mm.). The nature of the tabulae at these stages is unknown.

Adult stage : At a diameter of about 2 cm. the coral is mature. The septal characters are diagnostic, but the structure of the axial area whose diameter is 0.25 to 0.35 that of the corallite, is very variable.

The *septa* are crowded and dilated with stereome. They are pinnately fibrous, and though when examined by a lens they appear well defined and separate from the darker investing stereome which may fill the interseptal loculi, under the microscope they and the darker stereome are seen to merge into one another and their fibres are optically continuous. The major septa are usually discontinuous with the septal lamellae of the axial area, and the minor septa are 0.5 to 0.75 as long as the major. Axially both orders of septa are normal, and evenly thickened. In the median parts of the more dilated septa there seems to have been a tendency for the irregular deposition of the septal stereome, for caverns of irregular outline are left in the septum (*see* Plate I., figs. 28 and 30). When these are left along the plane of the septum it appears split, and in them dissepiments may arise. The boundary between the median parts of the septa and the investing stereome is often very irregular. Peripherally the dilated contiguous septa (which are essentially the vertical elements of the coral skeleton) break down into tissue with the character of horizontal skeletal elements.[1] The horizontal nature of this tissue is best seen in vertical section (Plate I., figs. 2, 11, 13, 22 and 25). In each septum this tissue consists of a large number of thin closely packed transverse plates, very long in the direction of elongation of the dissepiments ; *i.e.*, they have been deposited at successive levels of the peripheral calical floor. Some of them are axially continuous with dissepiments. They are thin and evenly arched upwards, and are sparsely and irregularly connected one to another by granules of stereome, which may sometimes unite to form short rods[2] piercing a few plates at right angles (Plate I., fig. 8). Since peripherally each septum was so dilated in the young stage as to be in contact with its neighbours, the equivalent series of plates in the adult stage are also in contact. Some of the plates of a series are grouped, and these groups are continuous with groups from the next series. Sometimes the relics of the median part of a septum are seen buttressing or even piercing the inner plates of a series, but usually the two zones of septal modification are discontinuous and a ring of coarse dissepiments is developed between them (Plate I., figs. 1, 10 and 14). Rarely, at points of septal insertion, one short major and two short minor septa are developed in the place of one minor septum. All three correspond to only one peripheral series of transverse plates, so that this septal modification had occurred before septal insertion had been completed (*See* septa at A, Plate I., fig. 1).

(1) The horizontal nature of this tissue was first pointed out to me by Dr. Stanley Smith.
(2) These represent the vertical rods described in the Silurian *Naos* by W. D. Lang (1926).

Stereome is always present, varying in amount and position. Plates originating as vertical tissue, *i.e.*, the septa and the septal lamellae of the axial structure are usually much dilated by the growth of all their pinnately arranged fibres into the interseptal loculi, so that the latter may become closed. Although the fibres of the septa and of the dilating stereome are continuous, there is a change in the direction of their deposition at the boundary of the septa, so that due to refraction of transmitted light the boundary of the septum appears as a dark line, and the dilating or investing stereome appears darker than the septa themselves. In the case of horizontal tissue, *i.e.*, dissepiments and tabulae, stereome may be deposited between the vertical elements (sometimes continuous with the fibres of the latter) on the upper surfaces and upper surfaces only of a series of dissepiments and tabulae representing all or part of a particular calical floor ; and such deposition may be recurrent.

Dissepiments are numerous, small, rather elongate and steeply inclined ; they do not occur between the septal modifications at the periphery but where the septa fail immediately within this peripheral zone one or two more or less continuous rings of large dissepiments may be developed. (Plate I, figs. 1, 10 and 14).

The *tabulae* form with the *septal lamellae* a very variable *axial structure.* The septal lamellae, which are usually twisted and discontinuous with the septa proper, are variously developed ; and on this variation depends the nature of the tabulae and the pattern of the axial structure. If the lamellae are few, they are usually irregular in course and discontinuous vertically ; and the tabulae then tend to be complete and broadly domed. Axial structures reminiscent in transverse section of those Thomson (1883, pp. 463-83) considered diagnostic of *Aspidiophyllum*, *Kumatiophyllum*, *Centrephyllum* and *Rhodophyllum* result (Plate I., figs. 1-13 and 19). But the few lamellae may attain a rough dibunophylloid arrangement, and the tabulae are then more steeply domed and less complete (Plate I., figs. 15-18). When the lamellae are more numerous they are usually strongly twisted and continuous vertically. The tabulae are then incomplete and the arrangement is histiophylloid. (Plate I., figs. 14 and 26). Stereome is common in the axial structure (*see* Plate I., figs. 20-26), and is usually developed when numerous lamellae are present, and the pattern is then carcinophylloid. All these, and intermediate patterns may occur in the one individual, as a study of Plate I. shows, but usually one type is predominant.

Remarks.—The *material* used in this study consisted of 20 individuals all from the same locality and horizon, and from which over 100 slides and surfaces have been cut. The corals appear to have grown in place, and are encrusted by fine growths of calcareous algae. Owing to the massive unweathered nature of the fine grained grey limestone matrix, no individuals with tips were collected, and no photographs of external form could be made.

The species is a variable one, and variation occurs in shape, amount of stereome present, pattern of the axial structure, the occurrence of caverns in the median parts of the septa, and the degree of development of the peripheral modification of the septa into transverse tissue. Variation in shape cannot be correlated with any other character. Gerth (1921) in his studies on the Permian corals of Timor showed that there long thin forms were comparatively free from stereome, while the short stout forms were very stereoplasmid; but in these Queensland Viséan corals there is no such connection.

Variation in the amount of stereome present is most striking in this species, and all other variations except that in shape appear to be in some degree dependent on it. The young corallite is very stereoplasmid, but becomes less so with growth. After such a disappearance stereome may again be deposited at one or more horizons, varying in amount and position (Plate VII., figs. 2, 22 and 25). The holotype is not very stereoplasmid, but F 2511 is a typical example (Plate VII., figs. 21-23). This discontinuous deposition cannot be correlated with any change in diameter of the coral, such as might be expected were it a rejuvenescence character.

Variation in the pattern of the axial structure is extreme as described above, and is dependent on the amount of stereome present and the development of the septal lamellae. A consideration of all slides and surfaces shows that there is no progressive transition from one type to another ; such changes as occur do so suddenly, and with the possibility of reversion, so that no particular pattern is of specific value.

Caverns occur in the median parts of the septa only if the septa concerned were previously dilated.

Peripheral dilation of the septa seems to be necessary before the peripheral series of transverse plates can be developed ; but when stereome has dwindled from the corallite these series can still be seen developed to the width of the earlier dilation of the septa ; their derivation from the vertical elements is not then obvious, and they look like modifications of the dissepimental tissue (Plate VII., fig. 10). Septa are secreted in invaginations in the base of the polyp, and the floor tissue (tabulae and dissepiments) by the flatter parts of the base. Should the invaginations become wide enough and shallow enough, the tissues they secrete will resemble floor tissue. This seems adequate as an explanation of the *Naos* type of modification. The connecting granules of stereome probably represent secretions from the more active points of calcification in the invagination. The rods seen in *Naos* and occasionally in *Symplectophyllum* represent the simple trabeculae secreted behind such active points of calcification.

Genus AMYGDALOPHYLLUM Dun and Benson.

Amygdalophyllum Dun and Benson, 1920, pp. 339-341.
Genotype.—*Amygdalophyllum etheridgei* Dun and Benson, 1920, pp. 339-341, Pl. xviii, figs. 2-6 non fig. 1[1].

Diagnosis.—Simple, conical or cornute Rugose corals with a wide fine-tissued dissepimental area, and typically with numerous long straight septa, a remarkably large solid columella, and incomplete tabulae. Rare diphymorphic[2] individuals may occur.

(1) Benson and Smith (1923, footnote p. 161) state that the original of fig. 1 proved when cut to be a specimen of *Zaphrentis sumphuens* Etheridge fils., which externally resembles *A. etheridgei*.

(2) A diphymorph (*see* Smith and Lang 1930) of a columellate coral is a group of individuals in which the columella fails, the septa retreat from the axis, and the tabulae flatten or become distally arched. The phaceloid forms have parricidal gemmation.

Remarks.—As so defined the genus is known only from the Lower Carboniferous (Viséan) of South Eastern Queensland and North Eastern New South Wales; but its relations with the British Lower Carboniferous *Koninckophyllum magnifivum* Thomson are being investigated. Each species of *Amygdalophyllum* shows a superabundant secretion of calcium carbonate, seen in the large solid columella and the dilated septa. When the septa are so dilated peripherally as to be in contact, they sometimes show the interesting type of modification to horizontal tissue typical of *Symplectophyllum*. But in *Amygdalophyllum* this modification is not seen in all the possible septa of one individual, nor in all the individuals of one species, nor in all the species of the genus. The genus therefore sheds light on how a trend in septal modification may be expressed.

AMYGDALOPHYLLUM ETHERIDGEI Dun and Benson.

Amygdalophyllum etheridgei Dun and Benson, 1920, pp. 339-341 and Pl. xviii, figs. 2-6 non fig. 1[1].

Amygdalophyllum etheridgei Dun and Benson; Benson and Smith 1923, pp. 161-5; Pl. viii, figs. 1-3; Pl. ix, fig. 2.

Holotype—A.M. 1311 (figured Benson and Smith, pl. ix, fig. 2) and syntypes A.M. 1132 and A.M. 1133 (Benson and Smith, pl. viii, fig. 3) in the collection of the Australian Museum, Sydney, Sections R22072 from the holotype and R21997 from a syntype, in the British Museum.

Diagnosis.—Large *Amygdalophyllum* with very numerous dilated septa; major septa confluent with the columella; minor septa unusually long; columella extremely large, fibrous, elliptical and cuspidate in section; tabellae small, sub-equal.

Remarks.—The species is known only from the original locality in mudstones of the Burindi Series (Viséan) at Babbinboon, N.S.W, For adequate description, *see* Benson and Smith, 1923, pp. 161-5. Pl. viii., figs. 1-3; Pl. ix., fig. 2.

AMYGDALOPHYLLUM INOPINATUM (Etheridge fil.) (Plate VIII., figs. 1-8).

Koninckophyllum inopinatum Etheridge fil., 1900, pp. 20-21, Pl. 1, fig. 2; Pl. ii, figs. 9 and 10.

Koninckophyllum inopinatum Etheridge fil.: Benson and Smith 1923, p. 161.

Lectotype.—(Here chosen) F 1606 in the collection of the Geological Survey of Queensland, the original of Etheridge's Pl. ii, fig. 9, from the Upper Viséan limestone of Lion Ck., Stanwell, near Rockhampton, Queensland.[2]

Diagnosis.—Large *Amygdalophyllum* with very numerous septa; major septa reaching almost to the columella, but not confluent with it; columella lenticular cupsidate in section, narrower than in *A. etheridgei*.

Description.—The corallum is robust, conical or turbinate, straight, sometimes with a slightly curved and flattened or spreading base of attachment (*see* Plate VIII., fig. 8). Average dimensions of type material: height 3.5 cm., diameter 3 cm. of Riverleigh specimens height 4 cm., diameter 3 cm., with a large[3] individual, incomplete, 7 cm. in height,

(1) *See* footnote 1, p. 67.

(2) This specimen was the only one of Etheridge's syntypes that I was able to find in August, 1932.

(3) Under constant favourable conditions there would seem to be no limit to the size attainable by any corallum; for the skeleton is formed by accretion from the polyp, which has unlimited growth; *i.e.*, it continues growing though usually at a constantly diminishing rate until it dies or, if a sexually reproducing, divides.

and 4.5 cm. in maximum diameter. Calice with a round everted margin, probably shallow. Epitheca thin, annulate.

The septa are very numerous and vary in number in different individuals. Specimens from the type locality show a variation between 42 and 99 septa of each order, and the Riverleigh specimens between 52 and 64. In the Riverleigh specimens the septa also vary in strength of development, *e.g.*, they may be dilated in the tabulate area (*see* Plate VIII., fig. 1). The major septa extend almost to the columella where their axial edges may be turned aside. They are seldom if ever confluent with it. In specimen E 2952 from Riverleigh this incipient diphymorphism has progressed to further withdrawal of the septa from the axis and discontinuity in the columella. The minor septa are seldom more than half the length of the major and are thinner. Indeed in F 2491 from Riverleigh in which the septa are very tenuous, the minor septa occasionally fail leaving the dissepiments between the major septa arranged in an irregular herring-bone pattern (Plate VIII., fig. 4). This specimen shows a weak development of the *Naos*[1] trend in that the septa and dissepiments in parts of the periphery are replaced by continuous series of *Naos*-like horizontal tissue of closely packed plates, but these are not connected by granules of stereome.

Dissepiments are numerous; those near the tabulae are small and steeply inclined but towards the periphery they become less steeply inclined and rather elongate. Discontinuity in the septa (usually the minor) of some Riverleigh specimens is complementary to the development of large dissepiments on which the septa are represented as crests. As the discontinuity is peripheral it is regarded as a weak expression of the lonsdaleoid[2] trend. The tabulae are incomplete and domed. The axial tabellae are large and broadly arched upwards and outwards and are supplemented near the dissepimental zone by smaller plates concave upwards and outwards.

The columella is oval and extends the entire length of the corallite in the Stanwell forms, but in the Riverleigh specimens it is usually less strongly developed and may be oval, elliptical or plate-like in section, or rarely, discontinuous vertically.

Distribution.—The species is known only in South Eastern Queensland, from the Upper Viséan limestones. In addition to the type locality (*supra*) it occurs in the Riverleigh limestone on Latza's Farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera.

Remarks.—Structurally this species might be regarded as *A. etheridgei* in which an incipient expression of the diphyphylloid trend has resulted in the comparative withdrawal of both orders of septa from the axis, and in the weaker development of the columella. On the other hand it is quite possible that a strongly columellate form like *A. etheridgei* could be derived from one less strongly columellate. The two species are widely separated geographically. Variation in *A.*

(1) The *Naos* trend is here defined as a tendency for stereome dilated septa to break down peripherally into horizontal tissue in the form of numerous fine convex plates transverse to each septum, the plates being connected by granules of stereome whose perfect arrangement is in rods normal to the plates. But for a full description of this trend and its expression *see* pp. 76-78.

(2) The lonsdaleoid trend is one in which the septa withdraw from the periphery.

inopinatum is great, especially in the Riverleigh specimens, as seen above, in size, number of septa, dilation of septa and amount of modification due to the very weak and sporadic expression of the diphyphylloid, lonsdaleoid and *Naos* trends.

AMYGDALOPHYLLUM CONICUM sp. nov.

(Plate II., figs. 14-48 and Text-fig. 1).

Holotype.—A slide on which are mounted 8 sections of E 36 (Plate II., figs. 14-21).

TEXT-FIGURE 1.

Amygdalophyllum conicum sp. nov.
Paratype F2435 in the University of Queensland collection. Natural size.

Paratypes.—F 2445 (4 slides and 1 piece) shows (Plate II, figs. 37-40) the maximum development of Trend (1) (*vide infra*).

F 2942 (8 slides) shows (Plate II, figs. 41-48) the maximum development of Trend (2) (*vide infra*).

F 2437 (4 slides with 10 serial sections, and 1 piece) shows (Plate II, figs. 22-31) the same of Trend (3) (*vide infra*).

All types are in the University of Queensland Collection, from the Upper Viséan Riverleigh limestone of Latza's Farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, Queensland.

Diagnosis.—Short straight conical *Amygdalophyllum* with deep conical calyx and small columella. Before dissepiments arise, the major septa are straight, confluent with the columella, and slightly and evenly dilated. Adult appearance is variable due to the differential expression of three common trends ; (1) septal dilation, chiefly peripheral, (2) peripheral modification of these dilated septa to horizontal tissue, and (3) withdrawal of the septa fron the periphery.

Description.—External characters : The corallum is a straight cone (Text-fig. 1) or subturbinate ; the adult individuals show great constancy in size—height about 4 cm., and diameter about 2 cm. ; the conical calyx is from 1 to 2 cm. deep. When the septa are dilated or modified to transverse tissue, they form flat stripes on the calical floor widening towards the periphery. Otherwise they rise from the floors as thin bars. Epitheca faintly striated, thick, and irregularly annulate.

Internal structures : In the youngest stage observed, diameter 2 mm., the septa are arranged pinnately, coalescing at the centre ; the cardinal fossula is very large, and the transverse tissue is represented by simple tabulae only (Plate II., fig. 41). This pinnate stage has been called in other corals the zaphrentoid. With the appearance of rudimentary minor septa, the pinnate symmetry gives place to radial, and the well developed major septa coalesce axially with a distinguishable columella. The minor septa then lengthen and dissepimental tissue arises. This is the last stage in which all the individuals are identical.

In fully mature corals some characters are common to all individuals, but there is variation due to the sporadic expression of three common trends. Common characters are these: There are about 30 septa of each order, the minor septa being about half the length of the major, which show a tendency to withdraw from contact with the columella (Plate II., figs. 16-21). The columella is small but continuous vertically, and lenticular or ellipsoidal in section. The tabulate are incomplete, and slope up towards the columella; the tabellae are convex upwards and outwards and of unequal size, those abutting on to the columella being larger. When the septa are withdrawn from the columella the tabellae tend to become flat. Superimposed on these common characters are the modifications due to the sporadic expression of three trends. The first of these is the dilation of the septa; this may be peripheral so that the septa are in contact there (Plate II., figs. 37-40), or in the tabulate area (Plate II., fig. 33). The second, the *Naos* trend, is expressed by the modification of some of the dilated septa which are in contact peripherally, into horizontal tissue. In each septum this consists of numbers of fine convex transverse plates connected by granules of stereome or vertical relics of the septa. The transverse plates of one septum may be continuous with those of the next (Plate II., figs. 46-48). The third, the lonsdaleoid trend, is expressed by the withdrawal first of the minor, and later of the major septa also, from the epitheca, the septa being represented as crests on the dissepiments (*see* Plate II., figs. 22-24, 33, 36, 40, 46-47). These three trends may be expressed in different degrees in the same individual.

Remarks.—The 66 slides from 22 specimens, all from the same locality and horizon (*supra*) form a very complete and very convincing example of the extreme variation possible in individuals of one species due to the differential expression of common trends. Such a species may be called a variable species.

AMYGDALOPHYLLUM sp. near CONICUM Hill.

(Plate II., figs. 49-50).

Specimen F 2449 (2 slides and 4 pieces) in the collection of the University of Queensland from the Upper Viséan Riverleigh limestone of Latza's Farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland, probably represents a *forma* of *Amygdalophyllum conicum*, which is abundant at the same locality and horizon.

Description.—External characters: The specimen consists of a large hysterocorallite or rejuvenescence bud arising centrally from a broken mature calyx, the diameter of the bud at origin being 15 mm., while that of the parent is 25 mm. The bud continues for 4 cm., where it is broken across. It is then of oval section, the longer diameter being 25 mm., and the smaller 20 mm. The bud of this individual is thus larger than the average mature individual of *A. conicum.* The epitheca is thin and probably discontinuous.

Internal structures: The septa are of two orders, 30 in each cycle. The major septa are usually in contact with the columella and the minor septa are half their length. Both orders are dilated to the shape of a wedge, and in contact peripherally. The *Naos* trend is strongly developed, for where the septa are in contact they often become modified into horizontal tissue consisting of numbers of thin convex plates as wide as the septum, in contact or continuous with others from the neighbouring septum. In each septum these plates are connected by granules of stereome, irregular in position or in series forming rods normal to the plates, or by vertical relics of the septum. Not all the dilated septa are so modified. In vertical section these transverse modifications are seen to be continuous axially with dissepiments. Dissepiments are developed between major and minor septa where these are not in contact. They are of moderate size, very elongate, and the steepness of their inclination increases with their distance from the periphery. They may become very large and strongly developed when the septa (whether modified or not) become discontinuous. The tabulae are incomplete ; the tabellae immediately about the columella tend to be flattened and larger than the rest which are irregular in size and inclination. Most of the tabellae seem crushed and broken. The columella is very irregular in outline, of variable strength of development, but usually small, and may fail completely.

Remarks.—This corallite differs from *A. conicum* only in its rejuvenescence, its larger size and the stronger development of the *Naos* trend.

AMYGDALOPHYLLUM VALLUM sp. nov. (Plate II, figs. 9–13).

Holotype.—F 2950 (4 slides and 2 pieces) from the Upper Viséan Riverleigh limestone of Latza's Farm, Portions 21 and 22, Parish of Nalmoe, County of Yarrol, near Mundubbera, Queensland, in the collection of the University of Queensland. (Plate II, figs. 9-11).

Diagnosis—Small trochoid *Amygdalophyllum* with regularly dilated short[1] septa, fine regular dissepiments, wide tabulate area and strong oval fibrous columella.

Description.—The corallum is robust, straight and conical, height and diameter each about 20mm. The epitheca is thin and annulate. The septa are of two orders, straight and regularly dilated so that they are approximately equal in width to the interseptal loculi, slightly tapering axially. The major septa are short, extending little over half way towards the axis ; the minor septa are about half this length. The dissepiments are very small, regularly arranged in thin concentric rings, steeply inclined. The tabulae are incomplete, with tabellae of two series of equal radius ; the inner series consists of large plates only slightly inclined upwards and outwards over most of their course ; but at the columella they arch vertically to take part in its construction, and at their peripheral edges they bend sharply downwards ; they may occasionally reach the dissepiments, but usually the small more highly arched outer tabellae separate them from the dissepiments. The columella is widely oval, solid, an independent rod not buttressed by axial septal ends, and is formed by the coalescence of the up-arched edges of the inner tabellae.

Remarks.—The interest of this species lies in the septa being short while the columella remains very strongly developed ; and in the columella being formed by the up-arched axial edges of the inner tabellae. The shortness of the septa is obviously not due to lack of available calcium carbonate, for the septa themselves are dilated. Three specimens only are known, all from the type locality.

([1]) Short septa are those which have withdrawn from the axis.

Genus APHROPHYLLUM Smith.

Aphrophyllum Smith, 1920, pp. 53-55.
Genotype.—*Aphrophyllum hallense* Smith, 1920, pp. 53-55, Pl. ii, figs. 1-5.

Diagnosis.—Large Rugose corals, either compound (massive with imperfectly contiguous corallites), or growing in groups which might not be true colonies. The corallites are usually laterally compressed with long major septa which reach or nearly reach the axis. At maturity the septa withdraw from the periphery. The tabulae are broadly domed and incomplete.

Remarks.—The genus is known only from the Viséan of South Eastern Queensland and North Eastern New South Wales.

APHROPHYLLUM HALLENSE Smith (Plate IX, figs. 3–5).

Aphrophyllum hallense Smith, 1920, pp. 53-55, Pl. ii, figs. 1-5.
Holotype.—A.M. 1038 from F 17648 from the Viséan Burindi Series of the Parish of Hall, 16 miles south of Bingara, New South Wales, in the Australian Museum, Sydney; figured Smith 1920, Plate ii, figs. 1, 3-5; part of the holotype is A 5051 in the Sedgwick Museum.

Diagnosis.—Massive *Aphrophyllum*, corallites imperfectly contiguous, turbinate, with average diameter 15 mm.; septa not crowded; peripheral zone of dissepiments up to one third the radius of the corallite, inconstant.

Description.—The corallum is compound, massive. The corallites are imperfectly contiguous, partly rounded or imperfectly polygonal turbinate and laterally compressed. The largest corallite has a diameter of 20 mm.; the average diameter is 15 mm. Gemmation is lateral. The septa rarely show a radial arrangement since the corallites are laterally compressed. They are dilated and wedge-shaped, varying in number between 20 and 32 of each order. The major septa reach or nearly reach the axis; their axial edges are sometimes turned aside or may be twisted together to form an axial structure. The minor septa are seldom more than half the length of the major. The dissepiments of the interseptal loculi are small, regular and steeply inclined; but the horizontal tissue which frequently separates a group of the septa from the epitheca is less steeply inclined, and consists usually of coarse dissepiments convex upwards and inwards, but sometimes of broad flat close-lying platforms. These are thin and very wide, each being continuous transversely for some distance round the corallite, and continuous axially with ordinary interseptal dissepiments. The peripheral zone of transverse tissue need not extend all round the corallite; frequently only one half or one quarter of any given transverse section is affected by the peripheral failure of the septa. It is often crushed. The tabulae are broadly domed, thin, and very numerous; as many as 30 have been counted in 1 cm. They are irregularly interrupted by axial septal ends and are consequently usually incomplete. They may be supplemented[1] by smaller plates at the dissepimental wall. Layers of stereome may be deposited on the upper surface of the horizontal tissue, especially at the junction of the dissepiments with the tabulae.

Distribution.—The species is known only from New South Wales, where in addition to the type locality it occurs in the Viséan Burindi limestones in a quarry at Taree.

(1) Jones (1932, p. 60) distinguishes two series of tabellae. I do not consider his outer series constant or characteristic enough to be diagnostic.

Remarks.—The resemblance of the species to *Endophyllum abditum* Edwards and Haime has been noted by Smith (1920, p. 55) and Jones (1932, p. 60). The occurrence in it of the thin, closely packed and very wide peripheral platforms is probably an expression of the *Naos* trend, although here this transverse tissue has not been traced back to prove modification of dilated septa. Similar tissue occurs in the other species of this genus, and there it can be shown to have arisen from *Naos*-like modifications of the septa.

APHROPHYLLUM FOLIACEUM sp. nov. (Plate IX, figs. 6–16, text-fig. 2).

"*Palaeosmilia retiformis* Eth. fil. MS" F. W. Whitehouse MS, quoted J. H. Reid 1930, p. 35.

Holotype.—F 2430 in the collection of the University of Queenslana, from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland; text-fig. 2.

TEXT-FIGURE 2.

Aphrophyllum foliaceum sp. nov.

Holotype F2430 in the University of Queensland collection. ½ diameter.

Diagnosis.—Large *Aphrophyllum* probably compound but possibly only very gregarious simple corals ; peripheral zone of dissepiments very wide, up to two-thirds the radius of the corallite.

Description.—External characters : The corallites occur in large numbers close together and may be imperfectly contiguous ; they are probably compound, but no budding has been observed. The corallites are large, very rapidly expanding to a diameter of 60 to 80 mm. (text-fig. 2, Plate III, figs. 6–8) ; they may remain squat and broadly turbinate, or grow to a great height, the maximum height observed being 240 mm. The tall weathered out specimens give the appearance of a number of funnels of nearly equal diameters placed in a concentric series at irregular distances apart, owing to the discontinuous development of the peripheral zone of dissepiments. The calyx is deep, with domed floor and everted margin (*see* Plate III, fig. 16). Epitheca is usually not preserved, thin.

Internal structures : Immature stages : A series of surfaces obtained by grinding down a tip showed that septal insertion occurs in the usual four positions, but is accelerated in the counter quadrants. The insertion of minor septa is according to the plan described by S. Smith (1913, p. 62) for *Aulophyllum.* The outline of the immature stages is usually, but not always, ellipsoidal. The plane of elongation always coincides with the cardinal and counter septa ; but the halves so divided are not mirror images, even in the number of the septa. The septa are pinnately fibrous in microscopic structure and are only slightly and evenly thickened. The major septa extend from the periphery towards the plane of elongation ; and in the more compressed corallites their axial edges may be inclined towards the cardinal and counter septa. The minor septa remain very short.

Adult stages : The corallite matures when its peripheral zone of coarse dissepiments arises. Its outline becomes more nearly circular, but the septate area remains faintly elongate in the plane of the cardinal and counter septa. The major septa are of unequal length, and extend straight towards the axis, their arrangement being thus more radial than in the young stages. Opposite their axial edges short lamellae which in transverse section resemble small paliform lobes may arise ; or the edges may be turned aside, or twisted together to form an inconstant axial structure. The minor septa are usually half as long as the major, but rarely and sporadically the two orders become almost equal in length (Plate III, fig. 12). The septa may be continued towards the epitheca as crests on the coarse peripheral dissepiments. They may sometimes be dilated, and the dilation may be regular, or rarely so irregular that they no longer have plane sides (Plate III, fig. 12). In parts of two specimens, a *Naos*-like modification of peripherally dilated septa has occurred, and in vertical sections the peripheral transverse tissue is seen to consist of numbers of closely packed platforms, continuous transversely, but which still indicate their derivation from the septa by the curves opposite the parent septa. They are however unconnected vertically by stereome (Plate III., figs. 6, 7, and 13).

The dissepiments of the interseptal loculi are small and steeply inclined, but those of the peripheral zone are usually very large and elongated in planes approaching the horizontal. This tissue is developed in alternately wide and narrow zones as if by rejuvenescence. The strong basal platform of each wide zone is possibly epitheca and grows out from the septate area at a uniformly widening angle. On it smaller elongate dissepiments are laid down till a horizontal surface is attained, when the process begins again. At times these coarse dissepiments are replaced by transverse tissue derived by *Naos*-like modification of the septa, as described above. The tabulae are broadly domed but incomplete, being interrupted by the axial ends of the major septa; they may also be reinforced centrally by smaller domed tabellae. They are closely packed, as many as 20 being counted in 1 cm.

Distribution.—About 20 specimens were collected from the type locality. The species is also represented by three rolled and broken specimens from the Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, and possibly one from Old Cannindah Homestead, near Monto, Queensland.

Remarks.—In the strong lateral compression of the area with septa and in the wide peripheral zone of dissepiments, this species is reminiscent of *Humboldtia* Stuckenberg (1895, p. 224) and *Keyserlingophyllum* Stuckenberg (1895, p. 219) from the Dinantian of Russia. But the types of these genera are inaccessible so that a discussion of their relations with *Aphrophyllum* is not possible. The species is of interest in the acceleration of septal insertion in the counter quadrants, and in the sporadic expression of the *Naos* trend.

While what are probably paliform lobes are common in two of the three Lion Ck. specimens and infrequent in the Riverleigh specimens, the character is not considered of specific value, since some individuals in a corallum of the compound *A. hallense* show such lobes while others do not.

The Expression of a Trend towards Septal Modification in Certain Rugose Corals.

(Plates I, II, and III).

Certain Rugose coral individuals which occur in the Upper Viséan limestone of Riverleigh[1] in Queensland have in common a particular modification of their septa. This is a peripheral modification of septa which have been very much dilated by stereome, particularly where such dilation has caused the peripheral closing of interseptal loculi. The replacing tissue in each septum consists of a stack of thin plates convex upwards and inwards, as wide as the septum was thick. They are elongated parallel to the peripheral part of the calical floor, *i.e.*, parallel to the inclination of true dissepimental tissue. This character suggests that they represent horizontal tissue, and when it is seen, that axially groups of them are continuous with dissepiments, and that laterally also groups are either continuous with groups in neighbouring septa directly, or rarely through a narrow dissepiment, there can be no doubt that they are horizontal tissue replacing the dilated vertical septum. Vertical continuity is attained by granules of stereome connecting two successive plates and not by rods at right angles to the plates; though very rarely, these granules may be arranged one above the other so that extremely short rods are formed. In explanation of the origin of this modification we may note that

(1) On Latza's farm Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland.

peripheral dilation of the septa till they are almost or quite in contact seems to be necessary before the peripheral series of plates can be developed. Septa are secreted in invaginations in the base of the polyp, and the floor tissue (tabulae and dissepiments) by the flatter parts of the base. Should the invaginations become wide enough and shallow enough, the tissue they secrete will resemble floor tissue ; and this seems adequate explanation. The connecting granules of stereome probably represent secretions from the more active points of calcification in the invagination. Any rods would represent the simple trabeculae secreted behind almost normally active points of calcification.

Such a modification can be used as a generic character in *Symplectophyllum* Hill since it affects in varying degree some or all of the septa at maturity. In this genus the median parts of the dilated septa may become cavernous ; but this phenomenon cannot be seen to have any causal connection with the peripheral modification to horizontal tissue (Plate I).

This modification is also known as *Amygdalophyllum* Dun and Benson. But here it is known in only two of the four species, and in neither is it diagnostic, since it occurs sporadically at maturity in only two individuals of *A. conicum* Hill and one of *A. inopinatum* (Etheridge). In *A. conicum* it arises in dilated contiguous septa (Plate II) ; but whether this is so in *A. inopinatum* cannot be ascertained, since the earlier parts of the corallite are broken off. In the former the details are clear and well executed ; but in the latter the execution seems to have been much rougher.

The third genus occurring at this locality and showing this modification is *Aphrophyllum* Smith. Two of about 20 individuals of *A. foliaceum* Hill show it sporadically in dilated septa not quite in contact (Plate III). None of the remaining genera occurring at this locality show the trend, although septal dilation does occur in them.

It is seen in a third individual of *A. foliaceum* occurring at a different locality on the same horizon—the Lion Ck. limestone at Stanwell, Queensland, while the New South Wales species of *Aphrophyllum*, *A. hallense* Smith, occurring in two localities[1], also shows this modification. In the New South Wales species, however, the plates of neighbouring septa are continuous in platforms, and curves denoting each septum in these continuous platforms are flattened out, while the connecting stereome granules disappear. The appearance of finished craftsmanship is thus lost, and the details appear only roughly sketched.

Thus there is in Carboniferous corals at various localities in Eastern Australia a tendency or trend for dilated septa to become modified peripherally in mature parts of the corallum into horizontal tissues vertically connected by stereome granules. The expression of the trend can in one case be used as a generic character, but is otherwise quite sporadic, and may be found with much minuteness and exactness of detail or only roughly sketched out. While the septa affected are always strongly dilated, it does not seem absolutely necessary that they should be in contact. In their unmodified condition these septa were pinnately fibrous. The above corals are the only ones known to me to

(1) 16 miles south of Bingara, Parish of Hall, N.S.W. ; and Quarry at Taree, N.S.W.

show this curious modification in the Carboniferous. *Nagatophyllum* Ozawa (1925, pp. 78-80, Pl. xii, figs. 1–5) from the Dinantian of Japan would seem from the figures to have septa peripherally modified into similar stacks of transverse plates, but without examination of the actual material I cannot be sure.

In the Middle Devonian of Torquay, England, '*Chonophyllum perfoliatum*' auctt. shows sporadically a somewhat similar peripheral modification of dilated septa into horizontal tissue. Here the zone affected is very wide, and the septa are not always in contact; the stacks of plates formed are kept in vertical continuity by short rods at right angles to the horizontal tissue. In this species the structure is often masked by thin smears of the stereome of the dilated septa remaining unmodified (Plate III, figs, 17–19). French's figure of *Cyathophyllum tinocystis* (1885, p. 28, Pl. i, fig. 1), from the lower Upper Devonian of Grund, shows this type of modification. The forms from the Lower Devonian of Bohemia which were placed by Pocta (1902, p. 111) in the genus *Chonophyllum* show similar modifications. In America (Canada West) this modification in the Devonian species *Naos magnificus* (Billings) has been described by Scherzer (1892, pp. 259–62, Pl. viii, fig. 5).

In the Silurian (Niagaran) of Arctic America, the genus *Naos* Lang (1926, p. 428) shows a perfect development. Here the horizontal tissue is widely spaced and replaces dilated septa separated by narrow dissepimental alleys, and vertical continuity is attained by long strong vertical rods at right angles to the transverse tissue (well figured by Lang op. cit. Pl. xxx, figs. 1–3). Since this genus shows the most perfect development of the modification (for in later occurrences the highly developed vertical rods tend to be represented by granules of stereome), the trend might be called the *Naos* trend.

In its sporadic occurrence and varying degree of perfection it resembles any other trend in corals, whether such a trend affects only vertical or horizontal elements or both. The sporadic development of this septal structural trend deserves emphasis. The governing factor seems to be neither chronological nor systematic; and although the septa must be strongly dilated before the modification can arise, it is not a necessary result of such dilation. The unmodified septa are of the ordinary pinnately fibrous type in *Symplectophyllum*, the only one where the microscopic structure is known.

Skeletal Malformation in an Australian Carboniferous Coral.

Plate III, figs. 1–2.

A fragment[1] of a large simple Rugose coral from the Upper Viséan limestone of Riverleigh[2] in Queensland shows undoubted skeletal malformation. This obscures the tissue of the axial area and affects groups of septa in increasing degree. Because of its malformation it is impossible to say with certainty to which species the coral belongs, but its septal, dissepimental and outer tabulate structures are like those of *Amygdalophyllum inopinatum* (Etheridge), which is common at the same locality.

(1) F 2465 in the University of Queensland Collection; a part of this is A 5064 in the Segdwick Museum.

(2) Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland.

Description.—The fragrant of corallite was slightly curved, about 8 cm. long, expanding from a diameter of about 3.5 cm at the bottom to 4.5 cm at the top, where it was slightly compressed.

The unaffected parts of the corallite show the following internal structures. The septa are thin, leaf-like and crowded, about 66 of each order. The major septa are long, extending into the axial area, where they are masked by malformation. The minor septa attain half this length. The dissepiments are numerous, elongate, and not very regular ; the inner ones are smaller and more steeply inclined than the outer. Only a little of the outer part of the tabulate area is not malformed, but it can be seen that the tabulae are incomplete and that often two series of plates, an inner and an outer, are present. The outer series consists of numerous flat-lying concave plates. It is absent when the inner dissepiments are so steeply inclined as to be almost vertical and thus to form a wall on to which the tabellae of the inner series then abut directly. These are large, convex and steeply arched upwards towards the axis. It is impossible to say whether they abutted originally on to a columella, or merely formed a dome as in *Palaeosmilia.*

Malformation affects an increasing area in the corallite. In the lowest part of the fragment it is pronounced in the axial area and in a group of septa forming a segment 6 mm. in width at the epitheca ; a second, smaller group in which five septa are malformed extends from the axial area not quite to the epitheca. The area of these two affected sepments increases with the age of the corallite, while a third group of septa also becomes involved, the malformation rapidly spreading outwards from the axial area to the epitheca. On the upper surface of the fragment, fully half of the corallite is malformed. The malformed structures and also the adjacent normally developed elements are often macerated.

In each of the affected areas normal development of the vertical and horizontal elements of the coral skeleton no longer takes place. The first stage is the dilation of the septa with stereome starting from the axial ends until interseptal loculi are practically absent. Then these dilated vertical elements become discontinuous, or extremely tortuous in course, or even suppressed altogether. The normal horizontal tissue is entirely suppressed, but in the irregular loculi formed by the discontinuity or suppression of the dilated vertical elements, widely spaced uncurved plates may arise, which may or may not be horizontal.

The stereome is deposited as a lining to the septa (usually on both surfaces but sometimes on one only) and occasionally on the upper surface of horizontal tissue. Microscopic investigation of the stereome rarely shows traces of fibrosity such as one associates with the normal deposition of a coral skeleton. Mostly it appears granular or non-fibrous ; but as frequently in normally formed dilated septa the fibrosity is masked by the state of preservation, it cannot be assumed that this stereome differs in any way from that which dilates normal septa. Bands of dark spots may be discerned running parallel to the surface which the stereome is lining. This is a common condition in *Caninia.*

Remarks.—It is idle to speculate on the nature of the adverse conditions causing the malformation ; but it is important to note that here the deposition of stereome linings is without doubt due to adverse conditions. Whether stereome deposited in adverse conditions differs in structure from that deposited under normal conditions is not arguable on the ambiguous evidence given by this specimen. A series of experiments on and subsequent sections of modern corals would give the best approach to this problem. I hope to undertake work on these lines in the future.

Genus CARCINOPHYLLUM Thomson.

Carcinophyllum Thomson 1881, pp. 241-244.

Genotype.—Carcinophyllum kirsopianum Thomson[1] 1881, pp. 243-4; text-fig. 3 on p. 241, and Pl. ii, figs. 7, 7a, and 7b, from the Lower Carboniferous of Arbigland, Dumfries, Scotland.

Diagnosis.—Simple or dendroid Rugose corals, with a central column in which the septal lamellae are dilated, irregular, and anastomosing, and a mesial plate is present. The septa dilate towards the periphery of the corallum, and form a stereozone; but through most of the corallum they are separated from the epitheca by coarse dissepiments. The tabulae between the central column and the dissepiments are widely spaced, and are flat or sagging.

Remarks.—In the British representatives of this genus, the peripheral stereozone is scarcely ever perfect owing to the excessive development of the lonsdaleoid trend; but in the Australian species the stereozone is infrequently broken through, and that at maturity only.

CARCINOPHYLLUM PATELLUM sp. nov. (Plate IV, figs. 1–17).

Holotype.—F 2534 (2 slides and 3 pieces) in the University of Queensland collection, from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Plave IV., figs. 1-2.

Diagnosis.—Small simple or dendroid *Carcinophyllum*; the central column is dibunophylloid and dense with stereome; the stereozone is wide and only infrequently interrupted by coarse dissepiments. Gemmation is calicular.

Description.—The corals when simple are slenderly conical attaining a maximum diameter of 13 mm. The average diameter is 10 mm. at a height of 40 mm. The dendroid forms arise by calicular budding, three or four hystero-corallites being given off from the parent calyx. The epitheca shows wide arched interseptal ridges, with deep narrow septal grooves. The septa are of two orders, usually about 24 of each, but there may be as many as 30. They are pinnately fibrous and thick, being lined or invested with fibrous stereome. The major septa are usually discontinuous with the lamellae of the central column. The minor septa are short, and the peripheral stereozone is as wide as the length of the minor septa. Its continuity is usually due to the major and minor septa being so thick as to be in contact, but any interseptal loculi may be filled by fibrous stereome resting on horizontal tissue and lining (investing) the already dilated septa. In mature corallites the septa may withdraw from their bases at the epitheca and large dissepiments convex upwards and inwards arise, on which the septa may be represented as stout crests. Since loculi rarely occur between the major and minor septa, fine dissepiments are usually absent. Small thin concave tabulae occur between the central column and the stereozone, widely spaced and seldom invested with stereome.

(1) A neotype for this species is being described.

The central column, whose diameter may be one third that of the corallite, consists of a medial plate with a few sinuous vertical lamellae abutting on to it, and long highly inclined tabellae ; the vertical elements may be so dilated and so much stereome may be deposited on the upper surfaces of the tabellae that the column may be solid. In rare instances it is free from stereome, and in this case it loses its definition, the inner series of tabellae becomes continuous with the outer, and the septa also are less dilated (Plate IV, figs. 14-17).

Distribution.—In addition to the type locality where it is common, this species occurs in Viséan limestones at Old Cannindah Homestead, near Monto, Queensland.

Remarks.—This species is remarkable for its tendency to become dendroid, and for its constant possession of a stereozone. The stereozone, in that it is as wide as the minor septa are long, and in that it may be formed by the dilated septa coming into contact, resembles the stereozone of the Permian corals of Timor, such as '*Carcinophyllum*' *wichmanni* (Rothpletz). The consequent repression of interseptal dissepiments is also characteristic of the Permian corals, but in the latter the peripheral withdrawal of the septa, with the formation of large dissepiments does not occur. Among the English representatives of the genus, *C. patellum* resembles *C. densum* Ryder from the D_2 zone the most closely.

Genus LITHOSTROTION Fleming.

Lithostrotion **Fleming 1828, p. 508.**
Genotype.—Lithostrotion striatum **Fleming 1828, p. 508, =** ***Lithostrotion sive Basaltes minimus striatus et stellatus,*** **Lhwyd, 1699, p. 124 ; Pl. (xvi) ; 1760 Editio altera, p. 125, Pl. xxiii.**[1]

Diagnosis.—' Phaceloid and cerioid Rugose Corals which have, typically, a columella, long major septa, and large tent-shaped tabulae, usually supplemented at the theca by smaller and nearly horizontal tabulae. Dissepiments are well developed in the larger species, but absent in the very small forms. Gemmation is nonparricidal. Diphymorphs of *Lithostrotion* have no columella, short septa, flat or distally arched tabulae, and, in the phaceloid forms, parricidal gemmation.'[1]

Remarks.—The genus is very prolific in the lower Carboniferous of Europe, Asia and Australia. The boundaries of both the genus and its species are extremely difficult to define, since the individuals of all species vary a great deal. The group is more easily dealt with and understood if we postulate that the members of the genus *Lithostrotion* Fleming all possess potentialities to follow definite developmental trends[2] ; *i.e.*, characters potentially common to the group as a whole may be expressed or suppressed in different individuals. The common trends in *Lithostrotion* are :—

1. The progressive development in external form usual in Rugose corals from dendroid forms through phaceloid and cerioid to asteroid forms. In the last stage there is a correlative change in internal structure.

2. The eridophylloid trend ; *i.e.*, a tendency for neighbouring corallites in dendroid and phaceloid forms to become united by lateral outgrowths of extratabulate tissue.

(1) Smith and Lang, 1930, p. 178.
(2) *See* Lang, 1923, pp. 120-136.

3. Trends in structure in the axial region.

(*a*) The diphyphylloid trend; the septa withdraw from the axis, the columella disappears, and the tabulae become flat or distally arched.[1] Diphyphylloid individuals (diphymorphs) have been separated off from the typical *Lithostrotions*, *i.e.*, those with long septa, by Smith and Lang (1930, p. 179) as genomorphs of the genus. A genomorph of *Lithostrotion* is understood to be a group of individuals in which a trend common to all members of the genus reaches an expression whereby the group is well demarcated from typical *Lithostrotion.* Such individuals may arise in any species of the genus. A diphymorph is a genomorph in which the trend concerned is the diphyphylloid trend.

(*b*) A clisioid trend; the more or less complete tabulae of the typical forms become replaced by small, incomplete tabulae or tabellae, which may become arranged in an axial and a periaxial series, the columella being retained. Phaceloid and cerioid groups of individuals in which the tabulae are replaced by tabellae (not arranged in axial and periaxial series) have been separated off by Schindewolf[2] into the subgenera *Cystidendron* Schindewolf and *Cystistrotion* Schindewolf. If the conception genomorph be accepted, then these two might also logically be regarded as genomorphs.

(*c*) A cionoid trend; in which the columella becomes very large. It may be expressed independently of the clisioid trend, or the same individuals might show both. *Cinoodendron* Benson and Smith was erected to receive two specimens which might be regarded as *Lithostrotion* with abnormally large columellae.

4. The lonsdaleoid trend; the septa retreat from the epitheca leaving a coarse peripheral ring of dissepimental tissue, on which they may be represented as crests. A cerioid group showing this trend well developed has been separated off by Yabe and Hayasaka (1915, p. 93) as a sub-genus *Lithostrotionella* Y. and H. This might also be regarded as a genomorph.

(1) In this connection it should be noted that amongst groups related to *Lithostrotion* and at present recognised as distinct genera, the axial structure of *Nemistium* Smith, and the long axial septum of *Dorlodotia* Salee and *Thysanophyllum minus* Nicholson and Thomson possibly represent intermediate halted stages in the development of the diphyphylloid trend, or may be quite independent developments. In many cases it is uncertain whether forms without a columella have been derived from columellate forms or *vice versa.* In *Orionastraea lonsdaleoides* nov., however, the forward trend leading from cerioid to asteroid forms is accompanied by columellate corallites becoming diphyphylloid; the tabulae become flat and complete, and not distally arched or divided into an inner and an outer series. No corallites with a *Nemistium*-like axial structure are seen, but the long axial septum characteristic of *T. minus* is a frequent occurrence. (*Diphystrotion mutabile* nov.) gives no clue as to whether the non-columellate corallites are derived from columellate or *vice versa*, but the same remarks may be made about its axial structures as about those of *O. lonsdaleoides.*

(2) Schindewolf (1928 pp. 148-51) also separated the columellate *Lithostrotions* with complete tabulae and fine interseptal dissepiments into two subgenera; *Siphonodendron* M'Coy (phaceloid) and *Lithostrotion* Fleming (cerioid).

Except where mutually exclusive, all these various trends may be found in one and the same individual ; but usually only one is pronounced ; and the individuals thus distinguished may be united in genomorphic groups. As far as we know genomorphs may arise at any period within the range of the genus.

It is to be noted that it is convenient to regard as a *genus* the group of forms included in *Orionastraea* Smith, which differs from typical *Lithostrotion* in the manifestation of *two* internal structural trends in an advanced stage—that due to the change from cerioid to asteroid form, and the diphyphylloid trend. *Orionastraea* merges into *Lithostrotion* in the species *O. ensifer*. If the groups *Dorlodotia* Salee and *Thysanophyllum minus* Thoms. and Nich. be derived from *Lithostrotion* Fleming, then here also two trends have been concerned.

Remarks on the Australian species.—Three Australian species of *Lithostrotion* Fleming, *L. columnare*, *L. arundineum*, and *L. stanvellense* have already been described by R. Etheridge Jr. (1900, p. 10), who placed them provisionally in this genus, and their status was confirmed by Dr. Stanley Smith (1920, p. 61). Etheridge's three species are here redescribed on topotypic material and on specimens from other localities in Queensland and New South Wales. Variation in the Australian species seems to be caused by differences in the degree of development of trends which all the individuals possess in common ; and in such variation they agree with their European congeners. Also, while in some localities a species is more or less variable, in other places, more rarely, no variation is apparent, and the species may be spoken of as having reached a stable expression ; *i.e.*, in some localities a particular expression is only one amongst a whole series, but in one locality it is isolated. It is possible then, that sometimes the expression of a trend may be a function of the geography of the individual.

The Australian species " agree in all essential characters with their European congeners. Yet as a group they present certain distinctive characters." [1]. These differences may be summed up as follows :—

1. 'Columella. This is usually much stouter than in British species.

2. Tabulae. The tabulae in the Australian species are to a great extent replaced by arched tabellae ;'[2] 'or are sharply bent, as in *Cionodendron*.'[3]. In the case of *L. columnare* and *L. arundineum* there is moreover a marked tendency for the tabulae to become strongly differentiated into an axial and a periaxial series, the inner series being strongly arched and fairly uniform, and the outer irregularly disposed and on the whole more widely separated, some being nearly flat and horizontal, and others steeply inclined and more curved.

3. ' Septa. The septa exhibit a marked tendency to become disunited from the epitheca in the adult stage.'[3]. Axially the septa are typically grouped, and whether grouped or not, confluent with the columella.

(1) S. Smith, 1920, p. 61.

(2) Because of this replacement Schindewolf (1928, p. 149) placed these species in his subgenera *Cystidendron* and *Cystistrotion*.

(3) Benson and Smith, 1923, p. 169.

4. 'Dissepiments. Dependent upon the disruption of the septa from the epitheca, the external dissepiments (not being intercepted by the septa) frequently form an outer zone entirely built up of course dissepimental tissue as in *Lonsdaleia.*

It is the prevalence and combination of these characters, and not the presence of any one of them, that distinguishes the Australian from the British forms, since in the less typical examples among the British species such features may occasionally be noted.'[1] In other words we may say that the British and Australian species possess in common the same trends ; but certain of these tend to be expressed more strongly in one continent than in the other.

LITHOSTROTION COLUMNARE Etheridge. Plate X, figs. 18–25.

Lithostrotion (?) *columnare* Etheridge fil. 1900, p. 18 ; Pl. i, fig. 1 ; Pl. ii, figs. 1-5.
Lithostrotion columnare Eth. fil., S. Smith, 1920, p. 61 ; Pl. v, figs. 1-2.
Cystistrotion columnare (Eth. fil.) Schindewolf, 1928, p. 149.
Lectotype.—(here chosen), F 1604 in the Queensland Geological Survey collection, from the Upper Viséan Lion Ck. Limestone, Stanwell, near Rockhampton, Queensland, being the original of Etheridge's Pl. ii, fig. 1.

Diagnosis.—Large cerioid *Lithostrotion* comparable in size with the British *L. arachnoideum* (M'Coy) showing great variation ; major septa confluent with strong columnella ; minor septa long and dissepimental tissue copious ; tabulae incomplete, variable.

Description.—The corallum is compound, large, cerioid or occasionally partly asteroid. The corallites are long and straight with an average diameter of 10 mm.[2] The epitheca of each corallite is variably developed, and may be thickened, or thin and irregular, or as a line of vesicles filled with secondary deposit. There are 20 to 25 stout septa of each order ; their peripheral edges are usually in contact with the epitheca (Plate IV, fig. 18), but may sometimes withdraw and be separated from it by dissepiments (Plate X, fig. 23, the lonsdaleoid trend), or they are occasionally irregular in course and confluent with those of contiguous corallites (Plate X. fig. 25, the asteroid trend). The axial edges of the major septa are confluent with the columella, either separately or conjoined in groups. The minor septa attain two-thirds the length of the major. Dissepiments are small, numerous (4 to 7 rings), and regular except at the epitheca where they may be coarsely developed (Plate X, figs. 23–24), the lonsdaleoid trend ; or they may be continuous with those of neighbouring corallites (Plate X, fig. 25), the asteroid trend. The inner ring of dissepiments is sporadically invested with stereome. The columella is styliform or cylindrical in transverse section and usually thickened. The tabulae are incomplete ; they are to a great extent replaced by strongly arched tabellae, convex upwards and outwards and varying in size (Plate X, figs. 19–20) ; or more rarely (and this is a constant character in Riverleigh specimens) they may be strongly differentiated into an axial and a periaxial series, the tabellae of the inner series being strongly arched and fairly uniform, and those of the outer irregularly disposed and on the whole more widely separated, some being nearly flat and horizontal and others steeply inclined and more curved (Plate X, figs. 20 and 22). Gemmation is always intermural.

(1) Benson and Smith, 1923, p. 169.

(2) The Riverleigh individuals (Plate X, figs. 21-22) are much smaller, with a constant diameter of 5 mm.

Distribution.—In addition to the type locality the species occurs at Horton R., between Eulowrie and Pal Lal, New South Wales, in the Viséan Burindi limestones, and in the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland.

Remarks.—Variation is very pronounced in the Lion Ck. and Horton R. specimens; but the Riverleigh corallites have a constant expression, which however is seen in some Lion Ck. specimens. The variation can be said to be due to sporadic weak expressions of the lonsdaleoid and the asteroid trends, and of trends leading to incompleteness of the tabulae and to the arrangement of the replacing tabellae in axial and periaxial series. The only one of these trends expressed in the Riverleigh specimens is the last, and the tabellae are always arranged in axial and periaxial series. This material is also distinguished by the constant small size of its corallites (5 mm. diameter) and correspondingly smaller number of septa. The reason of this stabilization, whether difference of horizon or habitat or some other cause, has not been ascertained.

LITHOSTROTION STANVELLENSE Etheridge (Plate IV, figs. 26–33, text-fig. 3).

Lithostrotion (?) *stanvellensis* (*sic*) Etheridge fil., 1900, p. 20; Pl. i, fig. 5; Pl. ii, figs. 7-8.
Lithostrotion stanvellense Eth. fil., S. Smith, 1920, p. 63; Pl. iii, figs. 1 and 3-6; Pl. iv, figs. 1, 1a, and 3.
Cystidendron stanvellense (Eth. fil.), Schindewolf, 1928, p. 149.
Lectotype.—(here chosen) F 1603 in the Geological Survey of Queensland collection, from the Upper Viséan Lion Ck. limestone of Stanwell, near Rockhampton, Queensland, being the original of Etheridge's Pl. i, fig. 5.

Diagnosis.—Large dendroid *Lithostrotion* comparable in size with the British *L. martini* Edwards and Haime; major septa confluent with a strong columella; minor septa short and dissepimental zone narrow; tabulae typically incomplete. Gemmation lateral. The septa may withdraw from the columella and budding is then calicular.

TEXT-FIGURE 3.
Lithostrotion stanvellense Eth. fil.
Upper Viséan Riverleigh Limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. F. 2945 in the University of Queensland collection. Natural size.

Description.—The corallum is dendroid (text-fig. 3) or inclined to caespitose, and large, and the corallites are then irregular in direction of growth, long, and usually between 8 and 10 mm. in diameter, though diameters of 5 mm. and 15 mm.[1] are not infrequent the epitheca shows well-marked growth accretions and indistinct striae. A phaceloid corallum is also known[2], in which the corallites are close and parallel, and may attain the gigantic diameter of 22 mm. (Plate X, fig. 27), the epitheca being regularly ornamented with both annulations and striations.

The septa are straight, usually unthickened, and vary in number according to the diameter of the corallite from 24 to 44 of each order. Typically the axial edges of the major septa are grouped and the resultant combined groups are confluent with the columella (Plate X., fig. 26) ; often[3] however, the septa fail to make contact with the columella (Plate X, fig. 27) ; and in one corallum[4] they are withdrawn so far as to be little longer than the minor septa; this weakly diphymorphic corallum shows the calicular budding typical of diphymorphs, although the columella is present (Plate X, fig. 31). The minor septa are short and attain little more than one third the length of the major. The dissepimental zone is narrow and consists of two or three rows of small irregular dissepiments, the innermost being sporadically invested with stereome. Sporadically the peripheral ends of the septa may be separated from the epitheca by large dissepiments (the lonsdaleoid trend). The columella is thickened, and may be round, oval, fusiform or radiate in transverse section. The tabulae are usually incomplete (Plate X, fig. 29), being replaced by copious tabellae of various sizes, convex upwards and outwards, sometimes with short horizontal plates between them and the dissepiments ; but these latter are seldom so numerous as to form a periaxial series. Gemmation is typically lateral[5], but in the weakly diphymorphic corallum mentioned above it is calicular, and the relation between the neo—and atavo—tissues is the same as described by Smith and Ryder (1927, p. 339) in *Stauria favosa* (Linnaeus).

Distribution.—In addition to the type locality the species occurs in the Viséan Burindi limestones of the Parish of Hall, at Hall Ck., near Bingara, New South Wales ; in the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland ; in the Viséan crystalline limestone of Crinoid Mt., Diglum, Barmundoo Goldfield, near Gladstone, Queensland ; and it has been reported (Whitehouse, 1927, p. 189) from Old Cannindah Homestead, near Monto, Queensland.

Remarks.—The Stanwell specimens are typical, with a constant expression, and are notable for the incompleteness of the tabulae and the strength of the columella. The Bingarra and Riverleigh material is however very variable. The Bingara corallites vary in size (Plate X, fig. 32) from 5 to 11 mm., the tabulae are usually complete, the lonsdaleoid trend is weakly expressed and there is much investment by stereome of septa, columella and inner ring of dissepiments. In the

(1) Large forms are common in the Riverleigh limestone.
(2) From the Riverleigh limestone.
(3) Especially in the Riverleigh limestone.
(4) Also from the Riverleigh limestone.
(5) One case was observed in which the bud and parent had a common epitheca, but the corallites were malformed at the contact (Plate X, fig. 28).

Riverleigh limestone the species is very common and the coralla and corallites are usually very large. One large phaceloid colony and one weakly diphymorphic corallum with calicular budding have been collected here. The locality is notable for the weak development of the diphyphylloid trend, shown by the septa failing to make contact with the columella ; the tabulae may be complete or incomplete, and the lonsdaleoid trend is weakly expressed. The Barmundoo material is referred to *L. stanvellense* by growth form only, since it is too crystalline to section.

LITHOSTROTION ARUNDINEUM Etheridge (Plate X, figs. 34–38).

Lithostrotion (?) *arundineum* Etheridge fil. 1900, p. 19 ; Pl. i, figs. 3-4 ; Pl. ii, fig. 6.
Lithostrotion arundineum Eth. fil., S. Smith, 1920, p. 63 ; Pl. iv., figs, 2, 2a).
Cystidendron arundineum (Eth. fil.) Schindewolf, 1928, p. 149.
Lectotype.—(here chosen) F 1602 in the Geological Survey of Queensland collection from the Upper Viséan Lion Ck. limestone of Stanwell, near Rockhampton, Queensland, being the original of Etheridge's Pl. i, fig. 3.

Diagnosis.—Phaceloid *Lithostrotion* comparable in size with the British *L. irregulare* auctt. ; the major septa are typically confluent with the strong columella ; the dissepimental zone is very narrow ; the tabulae are incomplete, and the tabellae are typically arranged in an axial and a periaxial series. Gemmation is lateral.

Description.—The corallum is phaceloid and large ; the corallites are long, straight, parallel, close, often in contact, 4–5 mm. in diameter ; they are thinly epithecate, with delicate growthrings and distinct interseptal ridges. There are about 20 septa of each order, straight and sometimes dilated. Typically the axial edges of the major septa are confluent with the columella (Plate X, fig. 34), either previously conjoined in groups or independently ; but they often fail to make contact with the columella, abutting instead on the axial tabellae[1]. The minor septa are short, less than half the length of the major. Dissepiments are correspondingly few and are small and regular, the inner ring being frequently invested with stereome. The strong columella is cylindrical or styliform in transverse section, often much thickened. The tabulae are incomplete[2] and the replacing tabellae are usually arranged in an axial series of strongly arched and fairly uniform plates, and a periaxial series of irregularly disposed and rather more widely separated plates, some being nearly flat and horizontal, and others more steeply inclined (Plate X, fig. 35). Gemmation is always lateral.

Distribution.—In addition to the type locality, the species is known from Viséan limestones at :—

1. Near the police station, Horton R., County Murchison, New South Wales.
2. Between Eulowrie and Pal Lal, Horton R., Co. Murchison, N.S.W.
3. Crinoid Mt., Diglum, Barmundoo Goldfield, near Gladstone, Q.
4. Mt. Grim, Gladstone District, Q.
5. Near Texas, South Queensland.

Remarks.—The Stanwell specimens are stable save for a frequent slight expression of the diphyphylloid trend. This is also seen occas-

(1) At Stanwell and the Horton R.
(2) Except at Mt. Grim.

ionally in the Horton R. material which however is also notable for the stereoplasmid thickening of the vertical elements, particularly the columella (Plate X, figs. 36–38), which attains a size comparable with that of *Cionodendron columen* Benson and Smith[1] (Plate X, figs. 39–40). Probably some of these Horton R. specimens, *e.g.*, figs. 37–38 should be regarded as *C. columen.* Work on this point is in progress. The Barmundoo specimens are referred to *L. arundineum* on external form only, since they are too crystalline to section. The Mt. Grim specimen also is rather crystalline. In the few corallites in which the structure is clear, all the septa reach the columella, and the tabulae are complete. All that can be said of the sheared Texas specimen is that it belongs to *Lithostrotion* more probably than to any other genus. It resembles *L. arundineum* in size and form, and appears to have a columella. If it be *Lithostrotion* then the 'Gympie Series' of the Texas District includes Lower Carboniferous beds.

Lithostrotion, genomorph (*Diphyphyllum* Lonsdale).

Lithostrotion Fleming 1828, p. 508, genomorph (*Diphyphyllum* Lonsdale) Smith and Lang 1930, p. 180.

Genomorphotype.—Diphyphyllum concinnum Lonsdale 1845, p. 624; Pl. A, fig. 4. (Since the type of *D. concinnum* is lost, Smith and Lang, 1930, p. 180, base their description of *Diphyphyllum* on *D. lateseptatum* M'Coy, 1849, which 'if not conspecific is certainly congeneric with *D. concinnum*').

Diagnosis.—'Phaceloid *Lithostrotion* which have no columella, or one which is reduced to spines on successive tabulae. The axial tabulae may be flat or convex, but have downturned edges which either meet the tabulae below them or extend to the dissepimental wall; the outer, smaller tabulae abut against the inner tabulae. The dissepiments, which are small, are well developed in the larger forms. Gemmation is parricidal.'[2]

Remarks.—The genomorph[3] occurs in abundance in the Viséan limestones of Europe, usually in association with *Lithostrotion.* It is possible that it contains representatives of a primitive stage of *Lithostrotion,* and also forms derived from *Lithostrotion* by reversion.[1]

Lithostrotion sp. (*Diphyphyllum* sp.). Plate XI, figs. 1–2.

Diphyphyllum sp. Benson and Smith 1923, p. 168.

Material.—No. 4510 or 4515 in the collection of the Geological Survey of New South Wales, and sections R 20872 and R 21998 in the British Museum and A 5494 in the Sedgwick Museum; from the Viséan Burindi limestone of the Parish of Moorawarra, near Somerton, New South Wales.

Description.—The material consists of a large number of broken and isolated corallies. Each is about 5 mm. in diameter, and straight. There are from 12 to 20 septa of each order. The major septa extend about half-way towards the axis, and the minor septa are half this length. The dissepiments are confined to one or two rings, and are small and regular. The tabulae are of two series, the inner ones being large and almost horizontal, and the outer small and sloping downwards to the dissepiments.

(1) Were it not for the greater number of septa and the sharply bent tabulae, *C. columen* might be regarded as *L. arundineum* in which the columella is even more strongly developed than in the Horton R. specimens.

(2) Smith and Lang, 1930, p. 180.

(3) Smith and Lang (loc. cit.) 'restrict the genomorphic name (*Diphyphyllum*) to the diphymorphs of *Lithostrotion,* considering that in this group the diphymorph structure is a condition due to other causes than normal phyletic development; and that a suitable stimulus may start any individual along this trend.'

Remarks.—This is the only example of (*Diphyphyllum*) known from Australia. The diameter of its corallites and the number of septa suggest relation to *L. arundineum* Etheridge. It would not be surprising however if further material showed that these specimens should be placed under *Aulina simplex* sp. nov. The diphymorph condition is extremely rare in Australian *Lithostrotions* ; even the slight withdrawal of the septa from the columella is infrequent, whereas it is usual in almost all British *Lithostrotions*, with the notable exception of the Scottish forms described by Thomson (1883, pp. 397-406) which compare with the Australian forms.

LITHOSTROTION genomorph (*Diphystrotion* Smith and Lang).

Lithostrotion Fleming 1828, p. 508, genomorph (*Diphystrotion* Smith and Lang) 1930, p. 184.

Genomorphotype.—*Stylastraea inconferta*, Lonsdale, 1845, p. 621, Pl. A, figs. 2, 2a-c. Smith and Lang 1930, p. 184.

Diagnosis.—' Cerioid *Lithostrotion* in which there is no columella, or one which is reduced to spines on successive tabulae, and in which the tabulae are slightly convex or flat and in most cases complete. The dissepimental tissue is typically coarse. Parricidal gemmation has not been observed.' [1]

Remarks.—The cerioid diphymorph is less common than the phaceloid, and the individual corallites always show great variation.

LITHOSTROTION sp. (*Diphystrotion mutabile* sp. nov.). (Plate V, figs. 3–4)

Holotype.—F 2387 and 4 slides cut from it, in the University of Queensland collection from the Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, Queensland. Part of the Holotype is a 5492 in the Sedgwick Museum, Cambridge. Plate V, figs. 3-4.

Diagnosis.—(*Diphystrotion*) with much thickened corallite walls, and with dissepiments sparsely and sporadically developed.

Description.—The corallum is cerioid. The corallites are of sinuous growth, with an average diameter of 4 mm. (Plate V, figs. 3–4. The epitheca of each always has a lining of stereome about 0.55 mm. thick. The internal structure varies sporadically in each corallite, and from corallite to corallite. The septa are stout, rather sinuous, and sometimes separated from the epitheca by dissepiments on which they may leave crests. There are from 12 to 16 of each order. The major septa are of variable length ; the axial edges of 3 to 5 (two being opposite), may very occasionally meet in the eentre to form a columella ; or the major septa may be only half as long as the radius of the corallite. Intermediate stages between these extremes are more often seen, a frequent feature being the greater length of one, or of two opposite septa. The minor septa are very short with an average length of one third the radius of the corallite. Dissepiments occur sporadically, usually as a single ring of rather large plates between the septa. They may be entirely lacking, and sometimes some of the septa withdraw from the periphery, when a coarse dissepimental tissue develops as in *Lonsdaleia.* The tabulae are usually complete and almost horizontal ; but they may be broken or bent up by long axial edges of septa, or by an occasional columella ; where no dissepiments are present the tabulae extend to the epitheca. They are closely spaced, 10 being counted in a space of 5 mm. The columella when

(1) Smith and Lang, 1930, p. 184.

present is discontinuous, or is represented by crests of axial septal edges on the tabulae.

Remarks.—The type specimen is the only one known. It is probably not the diphymorph of *L. columnare* Eth., the only cerioid *Lithostrotion* found with it. Variation is extreme, sporadic, and not at all progressive with growth, this applying even to the development of dissepiments. The diphyphylloid trend is almost completely expressed; and the lonsdaleoid trend is expressed weakly and sporadically.

Genus CIONODENDRON Benson and Smith.

Cionodendron Benson and Smith 1923, p. 165.

Genotype.—*Cionodendron columen* Benson and Smith 1923, p. 165-7, Pl. viii., figs 4-5; Pl. ix, figs. 4 and 7, from the Viséan (Burindi) of New South Wales.

Diagnosis.—Phaceloid Rugose corals identical in general structure with *Lithostrotion* Fleming, and comparable in size with *L. arundineum* Eth., but distinguished by the excessively large and well formed columella, the dilated septa, and the sharply bent tabulae.

Remarks.—*See* below.

CIONODENDRON COLUMEN Benson and Smith. Plate IV, figs. 39–40.

Cionodendron columen Benson and Smith, 1923, pp. 165-7; Pl. viii, figs. 4-5; Pl. ix, figs. 4 and 7.

Holotype.—No. 1464 in the Geological Survey of New South Wales collection, from the Viséan Burindi series of Slaughterhouse Ck., near Gravesend, N.S.W. Sections from it have been placed in the British Museum, R 21999 and R 22000-01. Plate IV, figs. 39-40. Also figured Benson and Smith 1923 Pl. viii, figs. 4-5; Pl. ix, figs. 4 and 7.

Diagnosis.—As for genus.

Description.—That given by Benson and Smith (1923, pp. 165-7) is adequate and easy of reference.

Remarks.—In growth habit and size of corallites the species closely resembles *L. arundineum* Eth., but is distinguished by the abnormally strong columella, the constancy with which the major septa are confluent with it, the greater number of septa (26 of each order as against 20), and the nature of the tabulae which "for the greater part extend from the theca to the columella, but are bent irregularly and at high angles both towards the theca and the columella." [1] Many corallites called here *L. arundineum* from the Horton R., N.S.W, show columellate-septate characters near those of *C. columen*, but have tabellae arranged on the *L. arundineum* plan. (Plate IV, figs. 37–38). Further work on these forms is in progress, and it is hoped will clarify the relation between the two species.

In addition to the specimen from the type locality Benson and Smith described (1923, p. 167) an isolated corallite associated with (*Diphyphyllum*)[1] in the Parish of Moorawarra near Somerton, N.S.W.

Genus ORIONASTRAEA Smith.

Orionastraea Smith 1916a, p. 2; 1917, p. 294.

Genotype.—*Sarcinula phillipsi* M'Coy 1849, p. 125; Smith 1917, p. 298, Pl. xxiii, figs. 1-2.

Diagnosis.—Asteroid or sometimes partly cerioid Rugose corals, related to *Lithostrotion*, but with columella weakly developed or absent; with septa withdrawn from the axis, and sometimes also from the periphery.

(1) *See* p. 54.

Remarks.—The genus is demarcated from the *Lithostrotion* group in that the development of the diphyphylloid condition is constantly accompanied by the loss of the dividing epitheca and sometimes also by the development of a lonsdaleoid condition. As above defined the genus has probably arisen from different species of *Lithostrotion* and (*Diphystrotion*). In England it is characteristic of the uppermost Viséan. The one Australian species appears to have been derived from the massive *L. columnare* Eth. by the three changes mentioned above, since the two are found at the same locality and horizon, and these three conditions are seen weakly and sporadically developed in *L. columnare.*

Orionastraea lonsdaleoides sp. nov. (Plate V., figs. 5–11).

Holotype.— F 2938 and slides in the University of Queensland collection from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Part of the holotype has been placed in the Sedgwick Museum, No. A 5485, Plate V, figs. 6-8.

Diagnosis.—*Orionastraea* with the numerous septa of neighbouring corallites separated by a wide development of coarse peripheral dissepiments, with rare traces of epitheca ; a degenerate columella is often present.

Description.—External characters : The corallum is asteroid, spreading and large. The few calices observed show a central cone rising from a deep narrow collar-like trough ribbed with septa, the trough having a wide broadly domed rim formed by the broadly arched dissepimental tissue between the septa of two neighbouring corallites. The holotheca[1] is thick, with well marked growth rings and longitudinal striations.

Internal structures :—The corallites have an average diameter of 10 mm. The septa of each are withdrawn from the periphery and confined to a periaxial column about 5 mm. in diameter. They are rather sinuous and thin, and there are from 16 to 18 of each order. The major septa are of unequal lengths ; they may all be withdrawn from the axis ; but usually one (or sometimes two) is longer than the others, and has a thickened axial edge ; often the axial edges of a few others unite with this thickened one, and a degenerate type of columella is thus formed. The minor septa are also of unequal length, about half as long as the major. Since the septa are withdrawn from the periphery. each corallite has a peripheral zone of dissepiments about 2.5 mm. wide, in which the original course of the septa may occasionally be traced by crests. These dissepiments are very coarse and broadly arched, and usually continuous with those of neighbouring corallites since only rare traces of a dividing epitheca in the form of palisade-like rods, occur. The dissepiments are arranged domewise over the position of the lost epitheca, and incline so steeply downwards towards the tabulae that they form an almost continuous wall to the septal columns. Small dissepiments are sometimes developed between the major and minor septa. The tabulae are confined to the septal columns. They are closely packed and usually complete and horizontal, but may be broken and bent up by the axial edges of longer major septa, or by a degenerate columella.

(1) Hudson 1929, footnote p. 442, 'the outer covering of the cerioid corallum and the basal epitheca of the astraeoid corallum.'

Ontogeny:—Buds may arise calicularly (as in phaceloid diphymorphs) but are parricidal only when they are axial in origin. Non-parricidal buds may also arise, more rarely, from the dissepiments above the position of the lost epitheca; this type of budding is probably a relic of the mural budding characteristic of columellate *Lithostrotions.* The initial stage in budding is the formation of a concavity in a small area of the floor tissue, and in this the new structures are laid down, rather thicker than the old. Vertical septal ridges, irregular in course, grow in no set order, and there is very little difference between major and minor septa. Occasionally one seems longer than the others, or possibly two opposite ones join, but there is nothing definitely to prove the presence in the embryo of a columella. But the buds are hysterocorallites, and as such would not be expected to recapitulate in ontogeny the phylogeny of the species. The septa next approach radial regularity, one being longer than the rest, and major and minor septa are distinct and alternate, but without dissepiments between them. Meanwhile the external dissepimental tissue is growing up as a coarse encircling tissue. The normal adult expression is attained by the development between the outer parts of the septa of small dissepiments, and a senile stage is reached by the breaking away of these into the peripheral tissue, carrying on them the septal crests.

Remarks.—This species, which is known only from the type locality, is undoubtedly a transitional one; for the loss of the epitheca is not entire, and the corallum is not so spreading nor the dissepimental tissue so flat as in typical species of *Orionastraea*; while the imperfect development of the diphyphylloid condition is seen in the presence of a degenerate columella, and in the occurrence of both parricidal and non-paricidal gemmation. The lonsdaleoid condition is the only one fully developed. In its presumed derivation from *L. columnare* Eth., this species is an interesting example of parallel evolution in different species of the same form group in places as far apart as Queensland and England.

Genus AULINA Smith.

Aulina Smith 1916a, p. 2; 1917, p. 290.
Genotype.—*Aulina rotiformis* Smith 1916a, p.p. 2-3; 1917, pp. 290-4; Pl. xxii, figs. 6-11, and text-figs. 3-4.

Diagnosis[1].—Simple, phaceloid or asteroid Rugose corals in which an inner tube or aulos is formed by the union of the deflectal axial edges of the major septa. The aulos separates the inner larger tabulae, which are flat, from the more numerous outer and smaller tabulae, which slope outwards and downwards. If a dissepimental wall be present all the septa are dilated at it.

Remarks.—*Aulina*, which occurs in the Upper Viséan limestone of the north of England, has been regarded (Smith 1925, p. 495 and 1928, p. 119) as representing an endpoint of a lineage from *Lithostrotion* Fleming. The occurrence in Australia of a simple *Aulina*, however, makes it more probable that the English compound species have developed from some undescribed simple aulate form than from (*Diphyphyllum* β Smith).

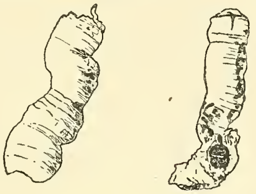
(1) Amended from S Smith 1925 p. 486, and 1928 p. 114.

AULINA SIMPLEX sp. nov. (Plate V., figs. 12–29, text-fig. 4).

Holotype.—8 slides (F 2939) in the University of Queensland collected from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Plate V, figs. 13-29.

Diagnosis.—Simple *Aulina* with very sparse dissepiments.

Description.—The corallites are simple, elongately conicocylindrical (text-fig. 4), and of irregular appearance due to short irregularities in the direction of growth, and to growth constrictions and swellings. The average diameter attained is about 5 mm. The epitheca is thick, with indistinct striae. Root processes are often present.



TEXT-FIGUE 4.
Aulina simplex sp. nov.
Paratype F 2940 in the University of Queensland collection. Natural size.

There are about 20 thin septa of each order, the minor septa being extremely short and tooth like. The major septa are deflected axially and unite to form the aulos or septal tube, the deflection beginning about half way between the epitheca and the tube. The aulos thus firmed is wide, about one third the diameter of the corallite. It shows considerable variation. It may be perfectly curved ; rarely it may be incomplete and horse-shoe shaped, while in some sections (Plate V, fig. 14) it is absent, and the short amplexoid septa are straight. In this latter case the tabulae are complete and horizontal (Plate V, fig. 12), of one series only. Usually the tabulae are well differentiated into an inner and an outer series separated by the aulos. Those of the inner series are horizontal, about 4 in a space of 3 mm. Those of the outer series are thinner, and almost twice as numerous (Plate V, fig. 16), and incline steeply downwards to the epitheca, or dissepiments if these are present. Dissepiments are but seldom developed, never well enough to form a complete ring. They may separate the septa from the epitheca (Plate V, fig. 14).

Ontogeny: Only two specimens were suitable for ontogenetic study. The earliest stage of each examined (diameter 1 mm.) showed at strong epitheca with straight septa meeting at the axis (Plate V, fig. 29). In one (corallite A), the arrangement was pinnate ; but in the other, the holotype (F ghi) it was approximately radial. Only the holotype showed the formation of the aulos (Plate V, fig. 13-29), which appeared at 1.5 mm. diameter as an open loop ; the axial ends of two septa diverged, and met their similarly directed neighbouring septa so that an open loop resulted. A root process then caused disturbance in the arrangement, and at a diameter of 2 mm. the aulos was seen to be complete. In corallite A, however, it was already complete at 1.5 mm. diameter and it cannot be argued on the above evidence that the aulos is first formed as an open loop, since in the holotype the presence of the root process may have been responsible for such an origin. The adult stage is attained by the cyclic insertion of very short minor septa, and the sporadic appearance of dissepiments.

Remarks.—The aulos is rather less perfectly developed than in the English phaceloid and asteroid species.

Variation in Rugose Coral Species.

The description given above of the Lower Carboniferous Corals of Australia may be said to demonstrate the great variation possible in Rugose coral species.

That species are variable in a manner quite distinct from and additional to ontogenetic changes, is more easily proved in compound than in simple species, for differences between individual corallites in a corallum are self-evident and striking. So much so that an investigator working with the inelastic idea of the fixity of characters of a coral species would have no hesitation in placing two such different corallites, which might have been found broken from the corallum, into two different species or even genera. Recent papers by English authors (particularly Dr. Stanley Smith), on species of *Lonsdaleia* M'Coy (Smith 1916) and *Corwena* Smith and Ryder (1926) in the Carboniferous, and of *Stauria* Edwards and Haime (Smith and Ryder, 1927), *Xylodes* Lang and Smith and *Kodonophyllum* Wedekind, (Smith and Tremberth, 1929), and *Acervularia* Schweigger (Smith and Lang, 1931) give excellent demonstrations of the variation possible among individuals in a corallum.

That variation is equally great in simple species is not so evident, but failure to recognise it has clouded the study of corals with endless lists of synonymous species. In Great Britain the chief unfortunate effect has been the host of species erected by the pioneer James Thomson[1] for the Scottish Lower Carboniferous corals. That the principle of the fixity of minute characters in a coral species as used by him is wrong is proved by the fact that later workers have never been able to apply his nomenclature, for no specimens could be found to fit in with all the numerous fixed specific characters required. Thomson was particularly unfortunate in that he based his genera and species on the nature of the axial structure, for later work (chiefly by Dr. Stanley Smith) has shown that this is the most variable part of the corallum. The chief published papers illustrative of the variation possible within a simple species are perhaps those on *Aulophyllum fungites* (Fleming), (Smith, 1913), *Hettonia fallax* Hudson and Anderson (1928), and *Caninophyllum archaici* (Ed. and Haime) (Lewis 1929). Some species are more variable than others.

Wide variation being recognised as possible in Rugose coral species, the laws governing it should be sought for. A hypothesis of variation which fits in with all facts known to me is put forward in the following paragraphs.

It was seen in the description of *Amygdalophyllum conicum* Hill that one of the chief differences between individuals was in the frequency of the occurrence of septa which had withdrawn from the periphery of the coral so that they were separated from the epitheca or their bases at the epitheca by large dissepiments convex towards the axis. While there was a tendency for the number of such septa to increase towards the calyx, the incidence of the condition could not be said to be due to age alone ; a few septa, chiefly minor, would be

(1) For list of Thomson's papers *see* Gregory 1917.

affected in an early part of the corallite, while higher up they would again be extending normally to the periphery, and others would have withdrawn. It might with justice be said that the condition arises sporadically and is ephemeral. Now when a number of neighbouring septa are affected, and withdrawn a long way from the periphery, a condition like that in *Lonsdaleia* is attained ; and if all the septa are affected, a zone of dissepiments indistinguishable from that in *Lonsdaleia* results. This last is never fully realised in any *A. conicum* known to me. The tendency for the septa to withdraw from the periphery is known as the lonsdaleoid trend[1] ; and we might say that in *A. conicum* the lonsdaleoid trend is weakly, sporadically, and ephemerally expressed ; and it is this which is responsible for part of the variation in *A. conicum*. It is likewise responsible for part of the variation in *Symplectophyllum mutatum* Hill, *Amygdalophyllum inopinatum* (Etheridge), *Carcinophyllum patellum* Hill, the three Australian species of *Lithostrotion* Fleming (*Diphystrotion mutabile* Hill) and *Aulina simplex* Hill.

In the species *Aphrophyllum foliaceum* Hill and *Orionastraea lonsdaleoides* Hill, while there are parts of the corallites where some or all of the septa extend to the periphery, the general condition is one in which the septa are entirely withdrawn from the epitheca and lonsdaleoid border of dissepiments is present which is diagnostic of the species.

Thus the Australian Lower Carboniferous Corals show that the lonsdaleoid trend varies in the degree to which it finds expression ; further, that if the trend is well expressed it tends to be constantly so, and thus to be a diagnostic character ; but if it is ill expressed it tends to operate only sporadically and ephemerally, and thus to be a cause of variation in the species. But the same process has been at work in both cases.

A study of British species leads to the same conclusions. From published descriptions and figures it can be seen that the expression of the lonsdaleoid trend is strong and almost constant and consequently diagnostic in the Silurian *Spongophylloides grayi* (Edwards and Haime) and *Arachnophyllum* M'Coy, and in the Lower Carboniferous *Caninia cylindrica* Scouler, *Lithostrotionella* Yabe and Hayasaka (a Japanese group), *Thysanophyllum minus* Mich. and Thoms., *Dorlodotia* Salee, *Lonsdaleia* itself, and many others. It is weakly, sporadically, and ephemerally expressed, and of variational significance only in *Lithostrotion*, most clisiophyllids, *Caninia* auctt., *Rylstonia benecompacta* Hudson and Platt, *Hettonia fallax*, and many others. It is impossible that all the forms in which it is observed, whether weakly or strongly expressed, can be closely related. In fact it is known in so many Rugose corals that one suspects that it is potential in all Rugosa.

A second variation in *A. conicum* was the occasional slight ephemeral withdrawal of the septa from the axis, with or without a noticeable weakening of the columella. This was seen also in *A. inopinatum* and the three species of *Lithostrotion*. Again, in *Symplectophyllum* and *Aphrophyllum* Smith, neither of which have a columella,

(1) The word trend has come to mean a number of different things to as many different people. I use it in the sense of the original definition of Lang (1923, p. 125) a trend of development is a line along which "a character appears to carry out in its evolution a predetermined course." A phenomenon such as the appearance in many different lineages, by many different paths, of a columella in the Carboniferous should not be referred to as a trend. It is an acme of homeomorphy.

the septa occasionally withdraw from the axis, there is a perceptible weakening in the strength of any axial structure which may have been present, and a flattening of the tabulae. In the two species *Diphystrotion mutabile* and *Orionastraea lonsdaleoides*, however, it is usual for the septa to have withdrawn from the axis, for the columella to be but weakly developed or absent, and for the tabulae to be flattened, although an axial arrangement like that of typical *Lithostrotion* may occur. There can be no doubt that the same trend is responsible in all these cases, but that it varies in the degree of expression.

It can attain an even stronger expression in the English *Lithostrotion* group. Here Smith and Lang (1930) observed that in a number of individuals belonging to any species, irrespective of horizon, the diphyphylloid condition could arise well expressed in only a few, most, or all of the individuals of a corallum. For such a group of colonies which is still within the genus, yet differs in a certain character from typical members of the genus, they propose the term genomorph. They recognise species within a genomorphic group, each species of the genomorph (*Diphyphyllum*) for instance being the diphymorph of its parent species of *Lithostrotion*. While the value of the conception genomorph in systematics is problematical, it is of great use in emphasizing the potentiality of all individuals of a genus to develop in a certain direction.

The trend is also perfectly expressed and diagnostic in the European Silurian *Acervularia brevisepta* Weissermel. It is seen causing variation in species by being but weakly and ephermerally expressed in *Xylodes*, *Kodonophyllum*, *Streptelasma* Hall, *Phaulactis* Ryder, *Koninckophyllum* Thomson and many others.

Thus a survey of the expression of this diphyphylloid trend leads to the same conclusions as that of the lonsdaloid trend.

It has already been seen (pp. 76–78) that the *Naos* trend in septal structure can be a cause of variation in species when it is weakly and ephemerally expressed, or diagnostic in significance when well and constantly expressed.

None of these three trends can be said to be confined to related genera, or to one horizon or one locality ; but all of them may, so far as one's knowledge goes, be expressed in varying degree in any species anywhere at any time.

Up to the present the phyletic aspect of trends of development have received the emphasis in coral literature. But by studying their weaker and more ephemeral expressions we may come nearer to an understanding of variation. One trend of great phyletic significance is the progressive change from simple corals through dendroid, phaceloid, and cerioid forms to asteroid. It cannot be denied that development along this line is potential to all corals. There is no reason to suppose that trends in internal structure also are not potential to all Rugose corals.

I consider it reasonable to state as a working hypothesis that in Rugose coral species variation is the resultant of the differential weak and ephemeral expression of trends which are potential to all. Further these trends may be expressed in any species anywhere at any horizon. By no means all of these trends have yet been defined.

We have no knowledge of the internal and external conditions governing the expression of these trends, except the following observations. Trends which are mutually exclusive cannot find expression in the one individual at the same time. A trend dependent on a certain condition in a coral, such as the *Naos* trend on the dilation of the septa cannot be expressed unless that condition attains. Since some species are variable in most localities, but have a stable expression in others (*e.g.*, *L. columnare* Etheridge), and since also certain trends appear characteristic of a genus in certain districts (*e.g.*, the diphyphylloid trend is well expressed in British *Lithostrotion* and very weakly in Australian *Lithostrotion*), one factor at least is dependent on the geography.

Further work on variation in coral species, on trends of development (particularly in septal structure), and on the conditions governing their expression, is in progress. The corals of the Wenlock limestone of Wenlock Edge form a particular study.

Genus MICHELINIA de Koninck.

Michelinia de Koninck 1842, p. 29.

Genotype.—(genolectotype, *see* Edwards and Haime 1850, p. lx) *Calamopora tenuisepta* Phillips 1836, p. 201, Pl. ii, fig. 30, from the Lower Carboniferous of Bolland and the Mendips.

Diagnosis.—Compound Tabulate corals, with a thick holotheca wrinkled in horizontal swathes ; the corallites grow in bundles and each has a thin epitheca thickly lined with stereome ; septal spines numerous, sometimes very short and irregular ; mural pores very large and remote, and tabulae well developed, complete or incomplete.

Remarks.—Specific differences in this group are chiefly those of external form. In internal structure evolution seems to have been particularly slow, and those of the late Devonian forms are very little different from those of the late Permian forms. Related groups are the dendroid *Rhizopora* de Koninck, the phaceloid '*Beaumontia*' *laxa* (M'Coy), and *Emmonsia parasitica* (Phillips).

MICHELINIA DENDROIDES sp. nov. (Plate V, figs. 30–35 ; text-fig. 5).

Holotype.—F 2941 in the University of Queensland collection from the Upper Viséan Riverleigh limestone of Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. A plaster cast of the holotype has been placed in the Sedgwick Museum, No. A 5491.

TEXT-FIGURE 5.
Michelinia dendroides sp. nov.
Holotype F2949 in the University of Queensland collection. Natural size.

Diagnosis.—*Michelinia* with thin corallites bundled together to form a slender cylinder which is irregular in course, and occasionall ; gives off stunted branches of the same diameter, which carry calicesy the septal spines are very short and ragged, and pores are very scarce.

Description.—The corallum[1] is elongate cylindrical with a diameter of about 10 mm., and is inconstant in the direction of growth. It gives off in different directions at distances of about 10 mm., stunted branches whose length and diameter are approximately the same as the diameter of the parent stem. The calices open at right angles to the surface ; they are circular and deep, and their floors show neither septal striae nor spines. They occur only sporadically on the parent stem, but are grouped together in numbers on the distal parts of the stunted branches. The stereome lining the walls between the calices which open on these branches is very thick ; and on weathered surfaces it appears pitted (Plate V, fig. 30) ; each calice is immediately surrounded by a raised rim, and between two of these rims the stereome is shallowly troughed. The holotheca covering the parent stem and the proximal parts of the stunted branches is coarse, and shows, corresponding to the corallites it covers, series of scallop-like wrinkles, continuous laterally with neighbouring series (text-fig. 5).

The corallites are polygonal in section and have a diameter of 1.5 to 2 mm. ; they may attain a length of 8 mm., and are pipe-like and not trumpet shaped as in *Pachypora* Lindstrom ; they grow parallel with the parent stem and then turn outwards to open approximately at right angles to the surface of the corallum. The buds, which arise intermurally, attain adult diameter very rapidly. The corallite walls have a thick lining of stereome, which increases in thickness towards the calice. The stereome is not channelled as in *Palaeacis* Haime, nor does it show the lamellae and concentric structure of *Pachypora*. Mural pores are very scarce. Septa are developed as short spines ; they are irregular and not easily made out, usually merely giving the wall a ragged appearance. Both complete and incomplete tabulae occur, widely spaced, about 0.5 mm. apart, and usually domed.

Remarks.—The species is interesting by reason of its scolecoid corallum. There is considerable variation in length, the holotype being the longest found. The scarcity of mural pores is worthy of note.

MICHELINIA sp. (Plate V, fig. 36).

Michelinia sp. Etheridge fil. 1900, p. 7.

Material.—The corallum described by Etheridge is F 1597 in the Geological Survey of Queensland collection from the Upper Viséan Lion Ck. limestone at Stanwell, near Rockhampton, Queensland. A further corallum (Plate V, fig. 36) from the same horizon and locality is in the University of Queensland collection.

Description.—The corallum is depressed hemispherical of somewhat irregular growth ; one specimen was 25 by 38 mm., the other about 50 by 40 mm. The corallites are prismatic and crowded and vary in diameter between 2 and 4 mm. The walls have only a thin investment of stereome. Mural pores are very scarce. The septa are developed as vertical rows of tubercles or short spines, apparently not regularly developed. Tabulae are very numerous, usually as anastomosing tabellae ; a few are complete.

Remarks.—This material is insufficient for specific determination. It differs from *M. dendroides* in its massive corallum, its thin walls, and the scarcity of complete tabulae. It possibly belongs to the *M. tenuisepta* (Phillips) group.

(1) The holotype is the only specimen showing the shape.

Genus SYRINGOPORA Goldfuss.

Syringopora Goldfuss 1826, p.p. 75-76.

Genotype.—(Genolectotype, *see* Edwards and Haime 1850 p. lxii) *Syringopora ramulosa* Goldfuss 1826, p. 76, Pl. xxv, fig. 7, from the Carboniferous of Olne in Limburg, Germany. " Edwards and Haime give *Syringopora* as a synonym of *Harmodites* Fischer 1828 (which however was published two years later) and take *S. ramulosa* as the genotype of *Harmodites*, thereby implying that they consider it the genotype of Syringopora."[1]

Diagnosis.—Fasciculate tabulate corals with long thin parallel to remotely diverging tubular corallites, connected by small approximately horizontal tubules containing extensions of the tabulae. Septa may occur as small spinules. The tabulae are infundibuliform and centrally connected to form a siphon which may be crossed by horizontal plates. Gemmation lateral.

Remarks.—I have been unable to examine the type species, but the above diagnosis has been drawn up from characters observed in Goldfuss' figure, Pl. xxv, fig. 7.

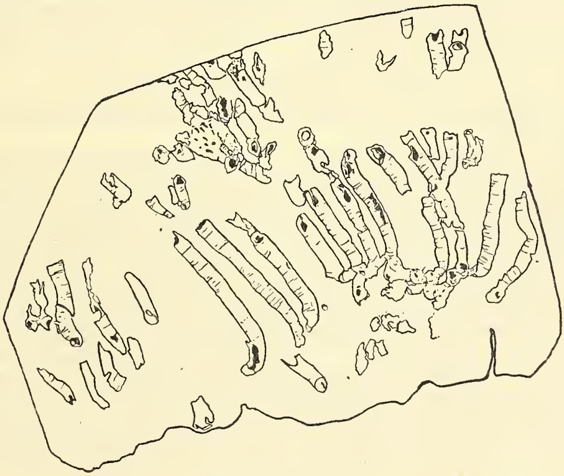
SYRINGOPORA SYRINX Etheridge (Plate XI, figs. 37–39, text-fig. 6).

Syringopora syrinx Etheridge fil. 1900 p. 6, Pl. i, figs. 6-9 ; Pl. ii, fig. 11.

Lectotype.—(here chosen) F 1595 in the Geological Survey of Queensland collection, being the original of Etheridge's Pl. i, figs. 6-9, from the Upper Viséan Lion Ck. limestone at Stanwell, near Rockhampton, Queensland.

Diagnosis.—*Syringopora* with sub-parallel corallites and extremely rare connecting tubules ; the epitheca is heavily lined with stereome which leaves free only the inner third of the corallite ; the rare tabulae developed in this free space are more or less horizontal.

Description.—The corallum is large and fasciculate. The corallites are long tubes about 2 mm. in diameter, distant, or sometimes coalescent,[2] parallel or slightly flexuous, and extremely rarely connected by transverse tubules. The epitheca is thick and is ornamented by growth rings and slight swellings and constrictions. Gem-



TEXT-FIGURE 6.
Syringopora syrinx Eth.
Viséan limestone of Crinoid Mt., Diglum Barmundoo Goldfield, near Gladstone, Queensland. G.S.Q. collection. Natural size.

(1) Lang and Smith MS.
(2) Mural pores have not been observed when two corallites are in contact.

mation is lateral. At the point of origin the new corallites, which issue either horizontally or inclined upwards, are usually about half the diameter of the parent; they rapidly attain adult diameter and an upright growth.

The epitheca is lined internally by a thick deposit of stereome, which leaves free only the inner third of the tube. The septa are irregularly developed as vertical series of long spines which are embedded[1] in the stereome lining. The spines are presumably slightly inclined upwards, but the evidence on this point is not very clear; sometimes their apices project into the free axial space. When perfectly developed, which is rare, the spines form twelve series. The narrow median free space is crossed at unequal wide intervals by unthickened tabulae, which may be horizontal, concave, convex, or irregular. No traces of infundibuliform tabulae have been seen in the stereome. The walls of the buds, and of the rare connecting processes are also lined by stereome. The connecting processes are devoid of tabulae.

Distribution.—In addition to the type locality, the species is known from the Upper Viséan Riverleigh limestone of Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland; in Viséan limestones at Pal Lal, County Murchison, New South Wales, and Crinoid Mt., Diglum, Barmundoo Goldfield, near Gladstone, Queensland; and from Lower Carboniferous calcareous sediments on Station Ck., Mt. Morgan, near Rockhampton, Queensland (F 1700, Queensland Museum collection).

Remarks.—In external appearance *S. syrinx* resembles *S. ramulosa* Goldfuss. But the thick lining of stereome and the extreme rarity of connecting tubules make the species very distinctive. It is possible that the inner free space of *S. syrinx* represents the syphon of typical *Syringopora*, and that the infundibuliform tabulae are masked in the Australian species by the thick stereome lining, as are the spiniform septa; but no traces of such plates have been observed in the stereome.

Genus PALAEACIS Haime.

Palaeacis Haime, in H. M. Edwards 1857, p. 9, explication des Planches; 1860, iii; p. 171.

Genotype.—(by monotypy) *Palaeacis cuneiformis* Haime in H. M. Edwards 1857, p. 9 Atlas, explication des Planches, Pl. E 1, fig. 2 (a, b, c, d); 1860, iii, p. 171; from the Lower Carboniferous of Spurgen Hill (Indiana), U.S.A.

L. B. Smyth (1929) states (p. 125) that "the genus *Palaeacis* was founded in 1860 by Milne Edwards"; and he also names Milne Edwards (p. 133) as the author of the type species, *P. cuneiformis*. But it is clear from Edwards' text that Haime was the author of the genus; ("*Palaeacis*, Haime, note inédite" is given as the original reference). Therefore under Article 21 of the International Rules of Nomenclature[2] it should be referred to as *Palaeacis* Haime. Milne Edwards' statement, p. 171, "Nous donnerons ici la description de ces corps, qui nous a été remise par notre regretté collaborateur, peu de temps avant sa mort" is followed by the heading *Palaeacis cuneiformis*, and a description; and although there are no quotation marks, it seems clear that Haime was the author of the specific name also in his note inédite. Also the genus should date from 1857, when the name and figures appeared in the Atlas.

(1) The course of the spines through the stereome may sometimes be traced in reflected light.

(2) C. W. Stiles 1926, p. 80. "The author of a scientific name is that person who first publishes the name in connection with an indication, a definition, or a description, unless it is clear from the contents of the publication that some other person is responsible for said name and its indication, definition, or description."

Smyth (loc. cit.) gives no diagnosis of the genus, and none is given here, since the minute structure of the type species is unknown, and may not be the same as that described for *P. axinoides* Smyth, although the ornament and occurrence of pores suggests that it is, and the two species are similar in form. Further it is uncertain whether the species *Hydnopora ? cyclostoma* Phillips which was placed in the genus *Palaeacis* by Etheridge and Nicholson (1878, p. 221), and in *Microcyathus* by Hinde (1896, p. 447), and also the species *P. humulis* Hinde, which differ in form from the type species, and in form and structure from *P. axinoides*, are to be included in the genus *Palaeacis*.

A few imperfect specimens which have been found in Queensland have an identical internal structure with that described by Smyth (loc. cit.) for *P. axinoides*, and if *P. axinoides* is correctly referred to *Palaeacis*, then the Queensland species is also.

PALAEACIS sp. cf. CUNEIFORMIS Haime. (Plate V, figs. 40–41).

External form.—With one exception the Queensland specimens seem[1] to be keeled and wedge shaped, and very flat, like *P. cuneiformis* Haime. The exceptional specimen (Plate V, fig. 40), begins like the wedge shaped forms as a pyramid of narrow rectangular cross section, but continues upwards as a flattened prism. The calices are confined to the two narrower sides of the prism, and open directly outwards. The top of the specimen is broken off. In specimens with the normal semicircular margin, the calices are confined to this upper margin, where they are all in the one median plane, *i.e.*, in the plane of flattening (as in *P. cuneiformis*), with the possible exception of one calice partly hidden by matrix in the specimen figured Plate V, fig. 41. This latter is the largest wedge shaped specimen, and is 20 mm. broad and 6 mm. from surface to surface. The elongate specimen was 10 mm. broad, 5 mm. from surface to surface, and 25 mm. high.

The apertures of the corallites are oval ; in the largest one the longer diameter was 6 mm., and the shorter 3 mm. The calices are funnel shaped, and the sides are marked by longitudinal granular septal ridges ; the granules or spines are arranged in transverse rows. The sides are perforated by pores between the septal ridges.

The ornament of the outer surface of the corallum consists of fine, close set ridges, whose disposition is variable. Smyth's description (loc. cit. p. 127) of the ornament of *P. axinoides* applies exactly, and may be repeated. The ridges " may be fairly continuous for some distance. But more often they are broken into short lengths, or even consist of rows of granules. They may be fairly straight and parallel, or sinuous, or may form a labyrinthine pattern, or a chaotic field of granules and short ridges. A parallel arrangement often occurs near the margin of an aperture and at right angles to that margin, and in general is parallel to the axis of a corallite, and indicates its trend within the corallum. When parallel there are from 4 to 6 ridges in 1 mm." Pores occur between the ridges, but can only be seen in tangential section.

In thin section the calcareous tissue of the corallum is seen to be of two kinds, as in *P. axinoides* : the one forming the lining of the calice, and the other the rest of the corallum. The lining tissue is finely

(1) They are very imperfect.

fibrous at right angles to its surface. The tissue of the rest of the corallum consists of closely placed plates each pinnately fibrous, and each arranged at right angles to the surface. The surface ridges of the corallum are the surface traces of these plates, and the surface furrows represent the planes of contact of the plates.

A canal system pierces both tissues. The canals open at right angles to the surface into the pores of the calice floor and surface of the corallum, the pores of the lining tissue being larger. The canals become irregular in course shortly below the surface of the corallum, and are concentrated in the tissue between two calices. They are excavated equally from two contiguous plates, and are usually as thick as one plate.

Distribution.—Oolitic limestone (probably Upper Viséan) on Portion 193, Parish of Mundowran, County of Yarrol, near Mundubbera, Queensland; Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, Queensland; and—reported by Dr. Whitehouse, in Reid 1930, p. 32, as " Gen. et. sp. nov. (a new genus of corals of unknown affinities) "—from the top limestone of Portions 37 and 38, Parish of Cannindah, County of Yarrol, Queensland.

Remarks.—The structure of the Queensland individuals, their ornament and their granular septal ridges are identical with those of *P. axinoides* as described by Smyth; but they differ from this species by their greater flatness, their oval calicular apertures which are arranged all in one plane, and their funnel shaped calical floors. In their flat shape, the arrangement of their calices and their ornament they resemble *P. cuneiformis.* The structure of the latter species is however unknown, and until it is the specific position of the Queensland specimens will not be clear. The very elongate Queensland individual may or may not belong to the same species as the keeled wedge-like ones; further collecting will show the possible range of variation in shape. Some specimens of *P. cuneiformis* from the type locality are taller than they are broad.

Notes on the Ages of Coral bearing Limestones in the Lower Carboniferous (Dinantian) of Australia.

In Australia Lower Carboniferous marine (Dinantian) strata have been reported from the east coast Palaeozoic geosynclinal, and from the Kimberley district iu Western Australia. They are known only from a series of isolated outcrops, geological mapping being still in an early reconnaisance stage.

In the east these outcrops are included in a strip of country 60 to 90 miles wide which runs south east inland from St. Helens (lat. 21°) (*see* map) to Cannindah (lat. 25°) and south from Cannindah to Babbinboon (lat. 31°) whence it sweeps south south east again towards the coast near Port Stephens (lat. 33°). These marine strata are referred to the Rockhampton series in Queensland and to the Burindi series in New South Wales. The Rockhampton series in its type district is thought to be conformable with marine Upper Devonian (*vide infra*), but the Burindi series in its type locality is assumed to represent only the Upper Dinantian or Viséan, and succeeds without apparent unconformity a fresh water series with Upper Devonian—Lower Carboniferons plant remains known as the Barraba mudstones. The Burindi series is succeeded by terrestrial sediments, the Kuttung

TABLE I. THE LOWER CARBONIFEROUS OF EASTERN AUSTRALIA.

Age		Queensland (Rockhampton District)		New South Wales.	
Moscovian		Neerkol Series	Marine strata Mudstones with Dinantian-Moscovian brachiopods. Pebble conglomerate.	Kuttung Series	Terrestrial; Lavas and cgts with *Rhacopteris*, etc.
Dinantian	Viséan	Rockhampton Series	Lion Ck. limestone with D_2 coral fauna. Marine strata	Burindi Series	Marine calcareous shales, cherts and tuffs with occasional limestone; with corals and brachiopods.
	Tournaisian		Beds with *Protocanites* and *Pseudarietites*.	Barraba Series	Tournaisian and Upper Devonian mudstones with *Lepidodendron*, etc.
Devonian			Upper Devonian marine strata.		

(?Moscovian) series of volcanic rocks and sediments with a *Rhacopteris* flora. No rocks which might be referred with certainty to the Kuttung series are known above the Rockhampton series, but near Rockhampton mudstones and grits containing near the base brachiopods of an Upper Dinantian and Lower Moscovian type[1] are found immediately above the limestones which are taken as the top of the Rockhampton series. They are followed (relation uncertain) by the Dinner Ck. series of non-marine sediments which contain a *Glossopteris* flora probably of Uralian age.

The Rockhampton series is believed to be conformable with the Upper Devonian of the district since there are 5000–6000 ft. of strata (shales, cherts, grits, and pebble conglomerates, calcareous and often tuffaceous) below the Lion Ck. limestone (D_2 *vide infra*) striking along the same line as the Upper Devonian; and since the goniatites *Protocanites* and *Pseudarietites* characteristic of the basal zone of the European Carboniferous are recorded[2] from "Rockhampton District." The top of the Rockhampton series is taken at the base of a pebble conglomerate overlying this D_2 limestone. (Reid and Morton (1928, p. 386) postulate a non-sequence between the limestone and conglomerate and Reid (1930, p. 34) attempts to correlate with it certain strata occurring at Cannindah. This non-sequence is denied by Whitehouse (1928, p. 441) on the grounds that this particular pebble conglomerate is no coarser than others in the Rockhampton series, and that the brachiopod fauna of the mudstones and grits above it has Dinantian as well as Moscovian affinities. Reid's attempted correlation of 1725 ft. of strata at Cannindah with the postulated non-sequence is discussed below.)

Non-marine sediments which are probably Dinantian are known in Queensland from isolated outcrops west and north of the belt of marine Dinantian, and in the Drummond Ranges, Star R. basin, Herberton and Pascoe R. districts; these contain a *Lepidodendron* and *Rhacopteris* flora, with in one case (Star R. basin) *Phillipsia* sp. and brachiopods indicating a marine incursion.

The map appended shows the extent of these Carboniferous rocks, and the localities mentioned.

Age as determined by the corals.

The corals examined for this paper and the localities where they were collected are set forth in the accompanying table. They are all Viséan in character.

It is important to know the exact age of the Lion Ck. limestone, since it belongs to the type succession of the Rockhampton series. Etheridge (1900, p. 5) who first described its fauna, said the corals had a combined Carboniferous and Permo-Carboniferous facies, but Whitehouse (1928, p. 441) gave its horizon as D_2, and this horizon is also suggested by the present work. The Lion Ck. fauna contains no form which can fairly be used to fix its horizon to any zone smaller than the Viséan of the English succession, but more detailed correlation may be made through the larger fauna from Riverleigh.

(1) Determinations by Whitehouse (1928, p. 441). He uses the term Lower Carboniferous as synonymous with Dinantian, and Upper Carboniferous as meaning all Carboniferous above the Dinantian.

(2) Whitehouse MS quoted Reid 1930, p. 35.

At *Riverleigh*[1] the corals occur in a reef limestone above and below which olive shales occur. Three and half miles away, nearer to Mundubbera, a coarsely oolitic limestone contains *Palaeacis* sp. cf. *cuneiformis* Haime, a species of *Evactinopora* and two species of lamellibranchs ; but owing to faulting, prickly pear and alluvium its relation to the main and isolated Riverleigh horizon is unknown. The Riverleigh fauna can be correlated with a fair degree of precision with the D_2 fauna of England. The chief evidence for such a correlation is given by *Orionastraea lonsdaleoides* Hill and *Aulina simplex* Hill.

In England a species transitional between *Lithostrotion* Fleming and *Orionastraea* Smith (*O. ensifer* (Edwards and Haime),) appears in the D_2 zone, and is common there. *O. lonsdaleoides* is undoubtedly such a transitional species, and therefore suggests the D_2 zone. The genus *Aulina* Smith is represented in the north of England by a dendroid and an asteroid species, in limestones believed to be above the D_2 zone of the south of England, and as such referred to a D_3 zone, whose limits and relations are however very inaccurately known. A simple species of a genus must, since there is no known example of a compound form reverting to a simple state, be considered either on the same horizon as or earlier than compound species of the same genus. *A. simplex* this indicates a high D_2 horizon.

The rest of the Riverleigh fauna gives general support to this conclusion. *Symplectophyllum* Hill is a clisiophyllid genus whose variable axial structure is reminiscent of the D clisiophyllids of Scotland and the north of England. *Amygdalophyllum* Dun and Benson is without a representative in England unless it be the Upper Viséan *Koninckophyllum* Thomson. *Aphrophyllum* Smith also is not represented in England, but *Carcinophyllum patellum* Hill is very like C. *densum* Ryder from zone D_2. *Lithostrotion* is known throughout the Viséan, but according to Schindewolf (1928, p. 149) very incomplete tabulae such as characterise the Riverleigh species of the genus are diagnostic of the Upper Viséan of D zone. The tabulate corals do not assist in straightigraphical discussion. The whole fauna is thus undoubtedly Upper Viséan or D in type, while *O. lonsdaleoides* and *A. simplex* indicate that it may be more minutely placed as homotaxial with D_2.

Lion Ck. limestone fauna : By reason of its close similarity the Lion Ck. fauna may also be placed in D_2. It may be slightly earlier than the Riverleigh fauna, but there is not yet sufficient evidence for argument.

Mt. Grim and *Diglum* : Of these isolated fossiliferous limestones, we can only say that they are Viséan in age, probably Upper Viséan.

Texas : Since the sheared coral from Texas is probably *Lithostrotion* the possibility that the " Gympie " series of Texas contain Viséan strata must be considered.

Other Queensland Localities : In addition to the corals described above, some collected by J. H. Reid from three localities in the *Can-*

(1) This new coral locality on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland, was shown to me by Mr. F. Mischlewski, a local resident. I collected from it and made reconnaisance surveys first alone, then with a party from the University of Queensland, and later with Dr. Whitehouse. The results were not sufficient for publication, but maps with some details are placed in the University of Queensland Geology Department.

nindah district have been provisionally determined by Whitehouse as follows :—

(*a*) From Old Cannindah Homestead, near Monto (Whitehouse 1927, p. 189)

Syringopora syrinx Eth. fil.
Amygdalophyllum inopinatum Eth. fil.
Lithostrotion cf. *stanvellense* Eth. fil.
Cionodendron (?) sp.

(*b*) From Splinter Ck., por. 20, par. of Cannindah, 9 miles north of Old Cannindah Homestead (Whitehouse 1927, p. 189).

Syringopora syrinx Eth. fil., and *Lithostrotion stanvellense* Eth. fil.

(*c*) From the top limestone in pors. 37 and 38, par. Cannindah, 3 miles N.E. of (*b*). (Reid, 1930, p. 32).

Palaeosmilia aff. *retiformis* (Eth. fil.)
Gen. et sp. nov. (a new genus of corals of unknown affinities)[1].

From Cania Reid lists (1930, p. 35) Whitehouse's determinations

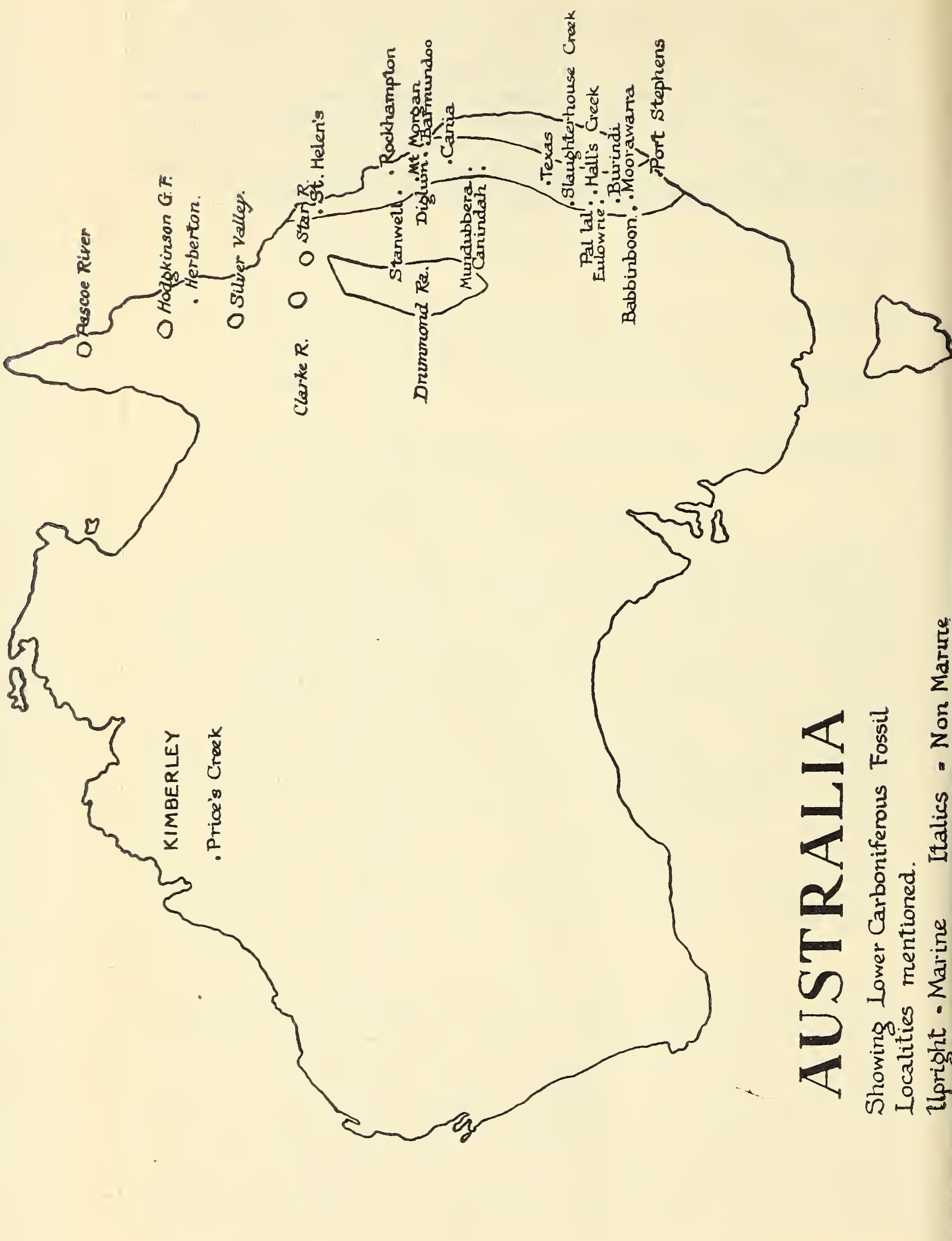
Cyathaxonia (?) sp.
Pleurophyllum spp. indet.
Lophophyllum (?) *corniculum* De Kon.

None of these corals have been sectioned, and although I was unable to obtain them for examination I consider that no reliance should be placed on the identifications. On this evidence Whitehouse assumed (1927, p. 189) that the limestones (*a*) and (*b*) were " plainly on the same stratigraphical horizon," that of the Lion Ck. limestone. So they may be, if the identifications are correct and the " stratigraphical horizon " be wide enough to include the whole of the Viséan ; for the only genus whose range is known is *Lithostrotion*, and it extends throughout the Viséan. Reid (1930, p. 34) finds his argument for a non-sequence between the Lion Ck. limestone and the overlying basal pebble bed of the Neerkol series strengthened by the exact correlation of (*a*) and (*b*) with the Lion Ck. limestone ; for he considers that 1725 ft. of strata above (*b*) in the Cannindah area, containing Dinantian (*fide* Whitehouse) brachiopods and, at (*c*) corals, have no representatives in the Stanwell section. But if (*b*) occurs towards the base of the Viséan, as is possible, while the Lion Ck. limestone is at the top, there would be room for missing strata between the two.

In *New South Wales* the isolated coralliferous localities (usually in impure or oolitic limestone) in the Burindi series of shales, cherts and tuffs, all contain very few species, and their stratigraphical relations to one another are unknown. In each case however the coral assemblage is unmistakably Viséan ; but one is not justified in arguing further. A few corals recorded in Benson's lists (1921, pp. 18–24) are not mentioned here since I was unable to examine them. A paratype of *Aulophyllum davidis* Eth. fil. (1891, p. 23) has been cut, however, and whatever else it is it is certainly not *Aulophyllum* Edwards and Haime. The specimens seem badly crushed and are probably referable to *Caninia* auctt.

(1) Dr. Whitehouse has since informed me that this is the same as the species described herein as *Palaeacis* sp. cf. *cuneiformis* Haime.

In *Western Australia* the Geikie and Rough Range series of the Kimberley are regarded as Viséan. David and Sussmilch (1931, p. 513 and fig. 3) list the series as unconformable with the Devonian and Permo-Carboniferous (Uralian), and report the occurrence in it at Price's Ck. of *Lithostrotion affine* and *Syringopora.* On writing for specimens however I was informed that they could not be traced. But the Geological Survey of Western Australia sent me a specimen from the Freney Oil Area, Kimberley, labelled *Lonsdaleia* aff. *floriformis* (Glauert 1925, p. 45). This has been cut and is not referable to *Lonsdaleia* M'Coy. It is probably a diphymorph of a cerioid *Lithostrotion,* but it is too crystalline for accurate determination.



AUSTRALIA

Showing Lower Carboniferous Fossil Localities mentioned.

Upright - Marine Italics = Non Marine

TABLE II.—SPECIES EXAMINED IN THIS PAPER, AND THEIR LOCALITIES.

X = common or fairly common. Numerals = number of specimens.

	Queensland (Rockhampton Series).							New South Wales (Burindi Series).						
	Latza's Farm, Por. 21 & 22 Par. of Malmoe, County of Yarrol, near Mundubbera) (Riverleigh limestone).	Por. 193, Par. Mundowran, County of Yarrol, near Mundubbera.	Lion Ck., Stanwell, near Rockhampton.	Station Ck., Mt. Morgan.	Mt. Grim., Gladstone Dist.	Crinoid Mt., Diglum, Bermundoo G.F. near Gladstone.	Texas.	Babbinboon	Parish of Hall, 16 miles south of Bingara.	Quarry at Taree.	Horton R., between Eulowrie and Pal Lal.	Near Police Station, Horton R.	Moorawarra, Somerton.	Slaughterhouse Ck., near Gravesend.
Symplectophyllum mutatum Hill	X		—											
Amygdalophyllum etheridgei Dun & Benson	—		—					X						
A. inopinatum (Eth. fils).	X		X											
A. conicum Hill	X		—											
A. sp. near conicum	1		—											
A. vallum Hill	2		—											
Aphrophyllum hallense Smith	—		—						X	X				
A foliaceum Hill	X		3											
Carcinophyllum patellum Hill	X		—											
Lithostrotion columnare Eth. fils. ..	X		X								X			
L. stanvellense Eth. fils.	X		X			X			X					
L. arundineum Eth. fils.	—		X		1	X	?				X	X		
(Diphyphyllum) sp.	—		—										X	
(Diphystrotion) mutabile Hill	—		1											
Cionodendron columen Smith	—		—										1	X
Orionastraea lonsdaleoides Hill	X		—											
Aulina simplex Hill	X		—											
Michelinia dendroides Hill	X		—											
M. sp.	—		2											
Syringopora syrinx Eth. fils.	X		X	1		X					X			
Palaeacis sp. cf. cuneiformis Haime ..	—	X	1											

LIST OF WORKS TO WHICH REFERENCE IS MADE.

Benson, W. N., 1921. "A Census and Index of the Lower Carboniferous Burindi Fauna." Rec. Geol. Surv. N.S.W., vol. x. Pt. 1, pp. 12–74, pl. viii.

Benson, W. N., & Smith, S., 1923. "On some Rugose Corals from the Burindi Series (Lower Carboniferous) of New South Wales; together with a Short Account of the Upper Palaeozoic Rocks of the Area in which they were collected." Q.J.G.S. vol. lxxix. pp. 156–71, pls. viii–ix.

David, T. W. E., & Sussmilch, C. A., 1931. "Upper Palaeozoic Glaciations of Australia." Bull. Geol. Soc. Am. vol.. 42, pp. 481–522; 3 figs.

Dun, W. S., & Benson, W. N., 1920. Section B:—Palaeontology, in Benson, W. N., Dun, W. S., & Browne, W. R. "The Geology, Palaeontology and Petrography of the Currabubula District, with notes on adjacent regions." Proc. Linn. Soc. N.S.W. vol. xlv. pp. 337–374, pls. xviii–xxiv.

Edwards, H. Milne, 1857–1860. 'Histoire Naturelle des Coralliaires, ou polypes proprement dits.' 3 vols., Atlas of 32 pls., 8vo., Paris, vol. i, 1857; vol. ii., 1857; vol. iii., 1860; atlas et explication des planches, 1857.

Edwards, H. M., & Haime, J., 1850–54. 'A Monograph of the British Fossil Corals.' Palaeont. Soc., London.

Etheridge, R., Jr., 1891. 'A Monograph of the Carboniferous and Permo-Carboniferous Invertebrata of New South Wales.' Part I. Coelenterata. Mem. Geol. Surv. N.S.W., Pal. No. 5, 64 pp., 9 pls.

———————, 1900. 'Corals from the Coral Limestone of Lion Creek, Stanwell, near Rockhampton.' Bull. No. 12, Geol. Surv. Q. pp. 5–24, pls. i.–ii.

Etheridge, R., Jr., & Nicholson, H. A., 1878. "On the Genus *Palaeacis*, and the Species occurring in British Carboniferous Rocks." Ann & Mag. Nat. Hist. (5) i. pp. 206–227, pl. xii.

Fischer de Waldheim, G., 1828. "Notice sur les Polypiers Tubipores fossiles." Progr. Invit. Soc. Imp. Nat. Moscou; 4to, Moscou, pp. 23 and 1 pl.

Fleming, J., 1828. 'A History of British Animals.' 8vo, Edinburgh.

Frech, F., 1885. "Die Korallenfauna des Oberdevons in Deutschland." Zeits. der deutsch. geol. Ges. vol. xxxvii. pp. 21–130, pls. i.–xi.

Gerth, H., 1921. 'Die Korallenfauna der Dyas von Timor.' in Wanner, J., 'Palaeontologie von Timor.' Lief. ix. Abt. xvi. pp. 67–147, pls. cxlv.–cl.

Glauert, F., 1925. 'Palaeontological Contributions to the Geology of Western Australia, XV:—A List of Western Australian Fossils, Supplement No. 1,' in Bull. 88 Geol. Surv. W.A., 1926.

Gregory, J. W., 1917. "Thomson's Genera of Scottish Carboniferous Corals." Trans. Geol. Soc. Glasgow vol. xvi. pp. 220–243.

Goldfuss, G. A., 1826. 'Petrefacta Germaniae' vol. i. pt. 1, pp. 1–76, pls. i.–xxv. Folio, Dusseldorf.

Hinde, G. J., 1896. "Descriptions of New Fossils from the Carboniferous Limestone, II. On *Palaeacis humilis* sp. nov., a new Perforate Coral, with Remarks on the Genus." Q.J.G.S. vol. lii. pp. 440–447, pl. xxiii. figs. 1–18.

Hudson, R. G. S., 1929. "On the Lower Carboniferous Corals *Orionastraea* and its Distribution in the North of England." Proc. Leeds Phil. Soc. vol. i. pt. ix. pp. 440–457, pls. i.–iv.

Hudson, R. G. S., & Anderson, F. W., 1928. "On the Lower Carboniferous Corals. *Hettonia fallax,* gen. et. sp. nov." Proc. Leeds Phil. Soc. vol. i. pt. vii. pp. 335–340, pls. i.–ii.

Jones, O. A., 1932. "A Revision of the Australian Species of the Coral Genera *Spongophyllum* Ed. & H., and *Endophyllum* Ed. & H. with a Note on *Aphrophyllum* Smith." Proc. Roy. Soc. Q. vol. xliv. pp. 50–63, pls. iii.–iv.

Koninck, L. G. de, 1842. 'Description des Animaux Fossiles qui se trouvent dans le terrain Carbonifère de Belgique.' Liège 1842–44, 650 pp., pls. A–H and i.–lv.

Lang, W. D., 1923. "Trends in British Carboniferous Corals." Proc. Geol. Assoc. vol. xxxiv. pp. 120–136.

————, 1926. "*Naos pagoda* (Salter), the Type of a New Genus of Silurian Corals." Q.J.G.S. vol. lxxxii. pp. 428–35, pl. xxx.

Lewis, H. P., 1929. "On the Avonian Coral *Caninophyllum* gen. nov., and *C. archiaci* (Edwards and Haime)." Ann. Mag. Nat. Hist. (10) iii. pp. 456–468, pls. xi.—xii.

Lhwyd, Edward, 1699. 'Lithophylacii Britannici Ichnographia,' etc., 8vo. London and Leipzig. 1760, Editio altera. Oxford.

Lonsdale, W., 1845 in Murchison, R. I. and others, 'The Geology of Russia and the Ural Mountains,' vol. i. 4to. London and Paris.

M'Coy, F., 1849. "On Some new Genera and Species of Palaeozoic Corals and Foraminifera." Ann. Mag. Nat. Hist. (2)iii. pp., 1–20 119–136.

OZAWA, Y., 1925. "Palaeontological and Stratigraphical Studies on the Permo-Carboniferous Limestone of Nagato, Pt. II :—Palaeontology." Jour. Coll. Sci. Imp. Univ. of Tokyo vol. xlv. pp. 1–90, 14 pls.

PHILLIPS, J., 1836. 'The Geology of Yorkshire, Part II.' xx. and 253 pp., pls. i. xxv.

POCTA, F., 1902. 'Anthozoaires and Alcyonaires,' being tome 2 of vol. viii. in Barrande, J., 'Système Silurien du Centre de la Bohême, pt. 1 : Recherches Paléon tologiques," Prague.

REID, J. H., 1930. 'The Queensland Upper Palaeozoic Succession.' Queensland Geol. Surv. Pub. No. 278, Brisbane.

REID, J. H., & MORTON, C. C., 1928. "Central Queensland Geological Section." Q'l'd. Govt. Mining Jour. pp. 384–389.

SCHINDEWOLF, O. H., 1928. "Prinzipienfragen der biologischen Systematik." Palaeont. Zeit. ix. Bd. pp. 122–169.

SMITH, S., 1913. "On the Genus *Aulophyllum*." Q.J.G.S. vol. lxix, pp. 51–77, pls. v.–ix.

————, 1916. "The Genus *Lonsdaleia* and *Dibunophyllum rugosum* (M'Coy)." Q.J.G.S. vol. lxxi. (for 1915) pp. 218—272, pls. xvii.—xxi.

————, 1916A. Abstract Proceedings Geol. Soc. London, No. 995.

————, 1917. "*Aulina rotiformis*, gen. et. sp. nov., *Phillipsastraea hennahi* (Lonsdale), and *Orionastraea* gen. nov." Q.J.G.S. vol. lxxii. (for 1916) pp. 280–307, pls. xxii.–xxiv.

————, 1920. "On *Aphrophyllum hallense* gen. et. sp. nov. and *Lithostrotion* from the Neighbourhood of Bingara (N.S.W.)." Jour. and Proc. Roy. Soc. N.S.W. vol. liv. pp. 51–65, pls. ii.–v.

————, 1925 "The Genus *Aulina*." Ann. Mag. Nat. Hist. (9) xvi. pp. 485–496, pl. xxiv.

————, 1928. "The Carboniferous Coral *Nemistium edmondsi* gen. et. sp. nov." Ann. Mag. Nat. Hist. (10), i. pp. 112–120, pl. v.

SMITH, S., & LANG, W. D., 1930. "Descriptions of the Type-specimens of some Carboniferous Corals of the Genera "*Diphyphyllum*," "*Stylastraea*," "*Aulophyllum*, and *Chaetetes*." Ann. Mag. Nat. Hist. (10) v. pp. 178–194, pls. vii.-viii.

————————, 1931. "Silurian Corals—The Genera *Xiphelasma* gen. nov., and *Acervularia* Schweigger, with Special Reference to *Tubiporites tubulatus* Schlotheim, and *Diplophyllum caespitosum*, Hall." Ann. Mag. Nat. Hist. (10) viii. pp. 83–94, pls. ii.–iii.

SMITH, S., & RYDER, T. A., 1926. "The Genus *Corwenia* gen. nov." Ann. Mag. Nat. Hist. (9) xvii. pp. 149–159, pls. v.–vi.

————————, 1927. "On the Structure and Development of *Stauria favosa* (Linnaeus)." Ann. Mag. Nat. Hist. (9) xx. pp. 337–43, pl. ix.

SMITH, S., & TREMBERTH, R., 1929. "On the Silurian Corals *Madreporites articulatus* Wahlenberg, and *Madrepora truncata* Linnaeus." Ann. Mag. Nat. Hist. (10) iii. pp. 361–376, pls. vii.–viii.

SMYTHE, L. B., 1929. "On the Structure of *Palaeacis*." Scient. Proc. Roy. Dublin Soc. vol. xix. (N.S.) pp. 125–138, pls. vi.–viii.

STILES, C. W. (Sec. Int. Comm. Zool. Nomencl.) 1926. Internat. Rules. Proc. Biol. Soc. Washington, vol. xxxix. pp. 75–104.

STUCKENBERG, A., 1895. "Korallen und Bryozoen der Steinkohlenablagerungen des Ural und des Timan." Mem. Com. Geol. vol. x. No. 3, 244 pp. and 24 pls.

THOMSON, J., 1881. "Contributions to our Knowledge of the Rugose Corals from the Carboniferous Limestone of Scotland." Proc. Phil. Soc. Glasgow vol. xii. (for 1880) pp. 225–261, 3 pls.

————, 1883. "On the Development and Generic Relations of the Corals of the Carboniferous System of Scotland." Proc. Phil. Soc. Glasgow vol. xiv. pp. 296–520, pls. i.–xiv.

WHITEHOUSE, F. W., 1927. "Notes on Palaeozoic Fossils from the Cannindah District (Upper Burnett), collected by Mr. J. H. Reid." Q.G.M.J. 1927, p. 189.

————————, 1928. Q.G.M.J. 1928, p. 441.

YABE, H., & HAYASAKA, Y., 1915. "Palaeozoic Corals from Japan, Korea, and China, Part III.—*Lonsdaleia*, *Lithostrotion*, *Diphyphyllum*, and *Thysanophyllum*." Jour. Geol. Soc. Tokyo, vol. xxii. pp. 93–109, 127–142. No. pls. or figs.

EXPLANATION OF PLATES.

PLATE VII.

Symplectophyllum mutatum sp. nov. from the Upper Viséan Riverleigh Limestone of Latza's Farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Specimens and slides in the University of Queensland Collection.

All figures natural size.

Figs. 1 – 6. Sections from holotype F 2943. Septal lamellae few and discontinuous, and stereome scanty. At A note point of insertion of new septa (*see* p. 7). Fig. 4 shows a large root process. The Median Vertical Sections show the haphazard occurrence of complete and incomplete tabulae and stereoplasmid and non-stereoplasmid horizons.

Figs. 7 – 9. Sections from F 2946. Septal lamellae more numerous and twisted, with more stereome.

Figs. 10–11. Sections from F 2385. A faulted specimen. The pseudo fossula at B is due to injury. Stereome scanty. Note the rings of dissepiments. *See* also figs. 31–33.

Figs. 12–13. Sections from F 2454. Very open axial structure. At C traces of trabeculae in vertical section of septa.

Fig. 14. Transverse section from F 2959. Non-stereoplasmid axial structure with twisted but discontinuous axial lamellae. Both types of septal modification well shown. Part of this specimen is A 5470 in the Sedgwick Museum.

Fig. 15. Tr.S. from F 2451. Dibunophylloid axial structure.

Figs. 16–19. Tr. sections from F 2947. Dibunophylloid axial structure lost in highest section fig. 19.

Fig. 20. Tr.S. from F 2512. Stereome abundant, septal structure well shown.

Figs. 21–23. Sections from F 2511. Stereome abundant, variable in amount.

Fig. 24. Tr.S. from F 2514. Stereome abundant.

Fig. 25. M.V.S. from F 2499. Stereome abundant.

Fig. 26. Tr.S. from F 2489. Stereome abundant, septal lamellae numerous, continuous and twisted. *See* figs. 29 and 30.

Fig. 27. Tr.S. from young stage of F 2948, a stereoplasmid corallite.

Fig. 28. Part of fig. 20 to show the septal modifications in Tr. S.

Fig. 29. Tangential V.S. through the peripheral series of transverse plates between the points D and E in fig. 26.

Fig. 30. Tangential V.S. through the median cavernous parts of the septa between the points F and G in fig. 26.

Figs. 31–33. Tangential V.Ss. between the points H and J, K and L, M and N, respectively in fig. 10, to show details in the arrangement of the peripheral series of transverse plates.

PLATE VIII.

Amygdalophyllum from the Upper Viséan Riverleigh limestone of Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Specimens and slides in the University of Queensland collection.

All figures natural size.

Figs. 1 – 3. *A. inopinatum* (Etheridge fil.). Sections from F 2949. Fig. 1 is from lower stage than fig. 2; note in it the septa dilated in the tabulate area, and the withdrawal of the minor septa from the periphery. Neither of these characters appear in fig. 2.

Fig. 4. *A. inopinatum.* Tr.S. from F 2491. Note *Naos* septal modification and peripheral withdrawal of the septa. Part of this specimen is A 5065 in the Sedgwick Museum.

Fig. 5. *A. inopinatum.* Tr.S. from F 2493. Dilated septa thinning peripherally.

Fig. 6 *A. inopinatum.* Tr.S. from F 2384. A small specimen.

Figs. 7 – 8. *A. inopinatum.* Sections from F 2482. Note basal outgrowth for attachment in fig. 8.

Fig. 9 – 11. *A. vallum* sp. nov. Sections from the holotype F 2950. Note traces of the formation of the columella from the tabulae in fig. 10.

Figs. 12–13. *A. vallum.* Sections from paratype F 2453. Fig. 12 is taken through the bottom of the calyx.

Figs. 14–21. *A. conicum* sp. nov. Serial sections from the holotype F 2951. Note septa withdrawn from aixs in fig. 17 and from periphery in figs. 18 and 21.

Figs. 22–31. *A. conicum.* Serial sections from paratype F 2437. Note peripheral withdrawal of septa. Fig. 22 is from a very thick section; fig. 25 shows a slight development of the *Naos* trend, and fig. 28 a slight axial withdrawal of the septa.

Figs. 32–33. *A. conicum.* Sections from paratype F 2498 showing dilation and peripheral withdrawal of the septa.
Figs. 34–36. *A. conicum.* Sections from paratype F 2436.
Figs. 37–40. *A. conicum.* Sections from paratype F 2445 showing peripheral dilation of the septa. Fig. 40 is through the calyx.
Figs. 41–48. *A. conicum.* Sections from paratype F 2942 showing the *Naos* trend well developed. Figs. 47–48 are calical.
Figs. 49–50. *A. sp. near conicum.* Sections from F 2449.

PLATE IX.

All figures natural size. Except where otherwise indicated specimens and slides are in the University of Queensland collection.

Figs. 1 – 2. *Amygdalophyllum inopinatum* (Etheridge fil.), a diseased individual F 2465 from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. *See* p. 32.
Figs. 3 – 4. *Aphrophyllum hallense* Smith. Sections from F2953 from the Viséan Burindi limestones of the Parish of Hall, 16 miles south of Bingara, New South Wales. Note the *Naos*-like modification of the septa.
Fig. 5. *A. hallense.* R 29634, British Museum, from the Viséan Burindi limestones, Quarry at Taree, New South Wales.
Figs. 6 – 8. *Aphrophyllum foliaceum* sp. nov. Sections from F 2954 from the Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, Q. Figs 6 and 8 are the upper and lower surfaces respectively of fig. 7. Note paliform lobes (?) axial structure, and *Naos* septal modification.
Fig. 9. *A. foliaceum.* Section along lower surface of fig. 16, from paratype F 2955, from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Most of the peripheral zone of dissepiments is destroyed.
Fig. 10. *A. foliaceum.* Tr.S. from F 2536. Horizon and Locality as for figs. 6–8. Note septal dilation and plaiform lobes (?). Periphery destroyed.
Fig. 11. *A. foliaceum.* Tr.S. from young stage of paratype F 2956.
Fig. 12. *A. foliaceum.* Tr.S. from paratype F 2957. Peripheral zone of dissepiments partly preserved. Note uneven septal dilation and length of minor septa.
Figs. 13–14. *A. foliaceum.* Sections from paratype F 2502.
Fig. 15. *A. foliaceum.* Tr.S. from paratype F 2958. Most of the peripheral zone of dissepiments destroyed.
Fig. 16. *A. foliaceum.* M.V.S. from paratype F 2955. *See* fig. 9.
Figs. 17–19. "*Chonophyllum perfoliatum*" auctt. Tr.S., M.V.S., and Tg. V.S. respectively. A 5495b-d Sedgwick Museum. from the Middle Devonian, of Ramsleigh Quarry, Torquay, Devon, showing well developed *Naos* modification of the septa.

PLATE X.

All figures natural size. Except where otherwise indicated specimens and slides are in the University of Queensland collection.

Figs. 1 – 2. *Carcinophyllum patellum* sp. nov. External view and Tr.S. of the holotype F 2534 from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland.
Figs. 3 – 4. *C. patellum.* Sections from paratype F 2386.
Fig. 5. *C. patellum.* Tr.S. from paratype F 2432. Note budding.
Figs. 6 – 7. *C. patellum.* Sections from paratype F 2505, a very stereoplasmid individual.
Figs. 8–11. *C. patellum.* Sections from paratype F 2960. Note the lonsdaleoid dissepiments.
Figs. 12–13. *C. patellum.* Tr.Ss. from paratype F 2961.
Figs. 14–17. *C. patellum.* Sections from paratype F 2460, a less stereoplasmid individual.
Fig. 18 *Lithostrotion columnare* Etheridge fil. Tr.S. from topotype, A 5493 in the Sedgwick Museum, from the Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, Queensland, showing typical aspect.
Fig. 19. *L. columnare.* M.V.S. from topotype F 2962, showing typical aspect.
Fig. 20 *L. columnare.* M.V.S. from topotype F 2538, showing tabellae in two series.

Figs. 21–22. *L. columnare.* Sections from F 2521 from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland, showing aspect typical of this locality.

Fig. 23. *L. columnare.* Tr.S. A.M. 331 from F 6543 in the Australian Museum, from the Viséan limestone of the Horton R., between Eulowrie and Pal Lal, New South Wales, showing septa withdrawing from the periphery.

Fig. 24 *L. columnare.* M.V.S. A.M. 186 from F 6541 in the Australian Museum; horizon and locality as for fig. 23. Shows typical incomplete tabulae in two series.

Fig. 25. *L. columnare.* Tr.S. from topotype F 2962 (*see* fig. 19) showing disappearance of epitheca between corallites.

Fig. 26. *Lithostrotion stanvellense* Etheridge fil. Tr.S. from F 2963; horizon and locality as for figs. 21–22, showing septa typically in contact with the columella.

Fig. 27. *L. stanvellense* . Tr.S. A 5061 in the Sedgwick Museum; horizon and locality as for figs. 21–22. Septa not confluent with columella, and individual of large size.

Fig. 28. *L. stanvellense.* Tr.S. from F 2391; horizon and locality as for figs. 21–22. Bud and parent have a common epitheca.

Fig. 29. *L. stanvellense.* M.V.S. from F 2964; horizon and locality as for figs. 21–22. Shows typical incomplete tabulae.

Fig. 30. *L. stanvellense.* M.V.S. from large phaceloid corallum F 2383; horizon and locality as for figs. 21–22; fig. 27 is also from this corallum.

Fig. 31. *L. stanvellense.* Tr.S. from F 2965; horizon and locality as for figs. 21–22; note the beginning of the diphyphylloid trend in the withdrawal of the septa from the axis, and the associated parricidal gemmation.

Figs. 32–33. *L. stanvellense.* Sections F 2966, from the Viséan Burindi limestone of Hall's Ck., Parish of Hall, near Bingara, N.S.W. Shows much, stereome.

Figs. 34–35. *Lithostrotion arundineum* Etheridge fil. Sections from topotype F 2967; horizon and locality as for fig. 18; shows septa both confluent with and withdrawn from the columella, and tabellae in two series.

Fig. 36. *L. arundineum.* Tr.S. A.M. 184 from F 6546 in the Australian Museum, from the Viséan Burindi limestone near Eulowrie, N.S.W. Note peripheral withdrawl of minor septa.

Figs. 37–38. *L. arundineum* near *Cionodendron columen* Benson and Smith. Sections A.M. 565 from F 6544 in the Australian Museum; horizon and locality as for fig. 23. Note the dilation of septa and columella. Tabulae as in *L. arundineum.*

Figs. 39–40. *Ciondendron columen* Benson and Smith. Sections in the possession of Dr. Stanley Smith from the holotype; from Viséan Burindi limestones at Slaughterhouse Ck., near Gravesend, N.S.W.

PLATE XI.

All figures except 19–29 natural size. Except where otherwise stated, specimens and slides are in the University of Queensland collection.

Figs. 1 – 2. *Lithostrotion* sp. (*Diphyphyllum* sp.). Sections A 5494 in the Sedgwick Museum, from specimen 4510 (or 4515) in the collection of the Geological Survey of New South Wales, from the Viséan Burindi limestone of the Parish of Moorawarra, near Somerton, N.S.W.

Figs. 3 – 4. *Lithostrotion* sp. (*Diphystrotion mutabile* sp. nov.) Sections from the holotype F 2387 from the Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, Q. Note the sporadic nature of the variation.

Fig. 5. *Orionastraea lonsdaleoides* sp. nov. Weathered aspect of paratype F 2529 from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Q.

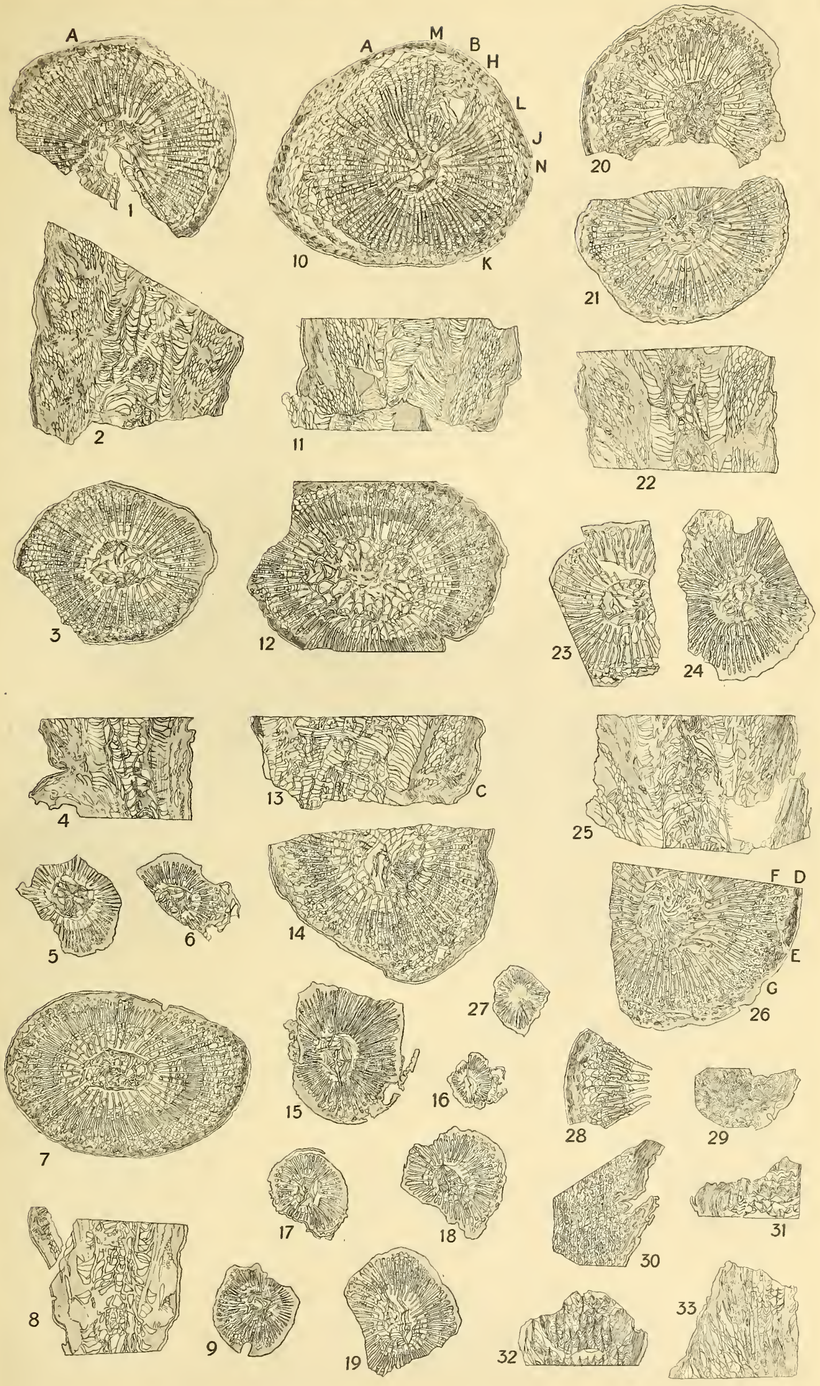
Figs. 6 – 8. *O. lonsdaleoides.* Sections from the holotype F 2938; notefrequent weak columella and rare extension of septa to periphery. Specimen partly macerated.

Fig. 9. *O. lonsdaleoides.* V.S. from paratype F 2533.

Figs. 10–11. *O. lonsdaleoides.* Sections from paratype F 2524. Specimen transitional from *Lithostrotion columnare* Eth. Note relics of epitheca and columella.

Fig. 12. *Aulina simplex* sp. nov. M.V.S. from paratype A 5488 in the Sedgwick Museum; horizon and locality as for fig. 5; note rare dissepiments.

Figs. 13–29. *A. simplex.* Sections from holotype F 2939; figs. 19–29 $\times 2$ diameters; fig. 14 shows weak expression of londsdaleoid trend, and figs. 21–27 a root process.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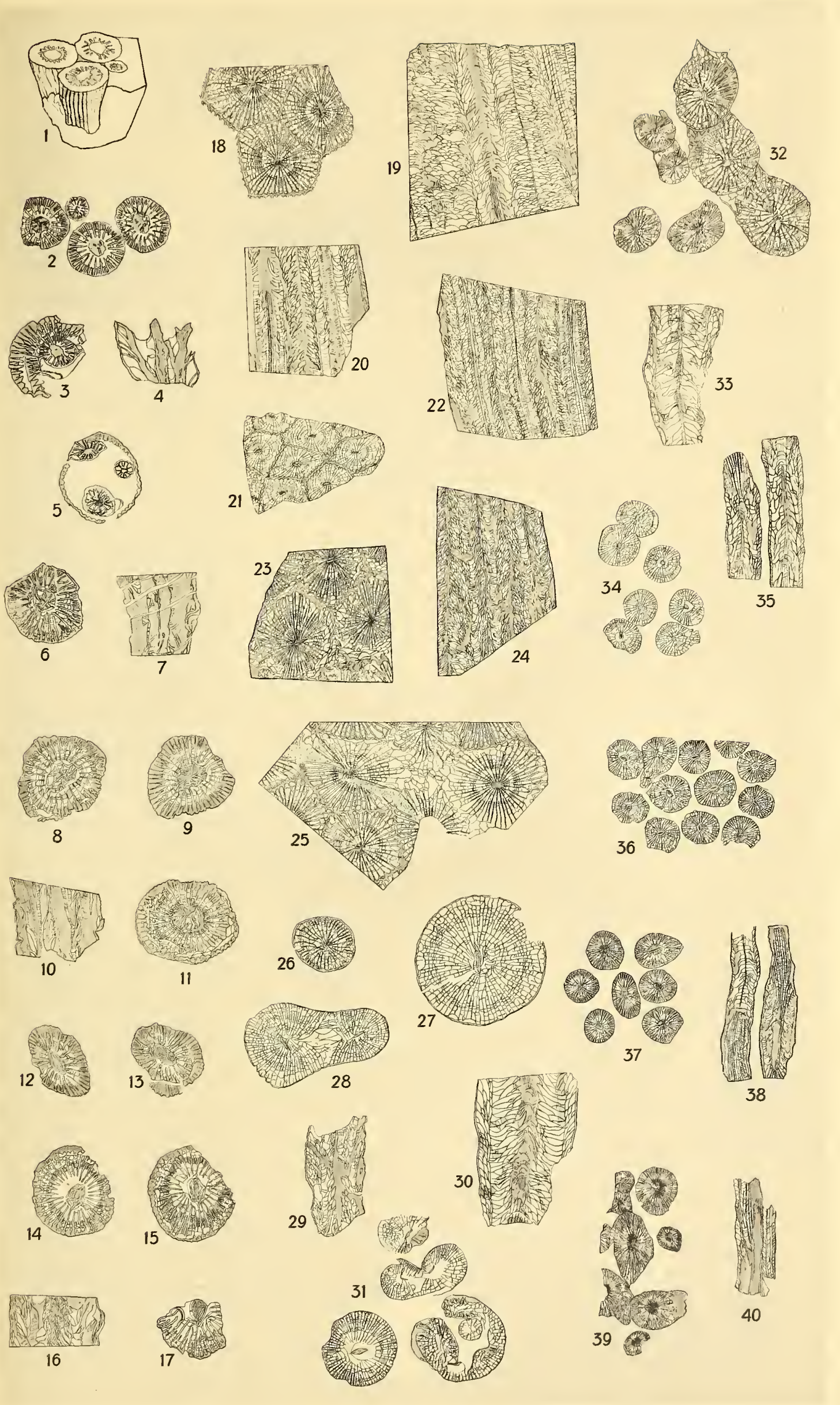
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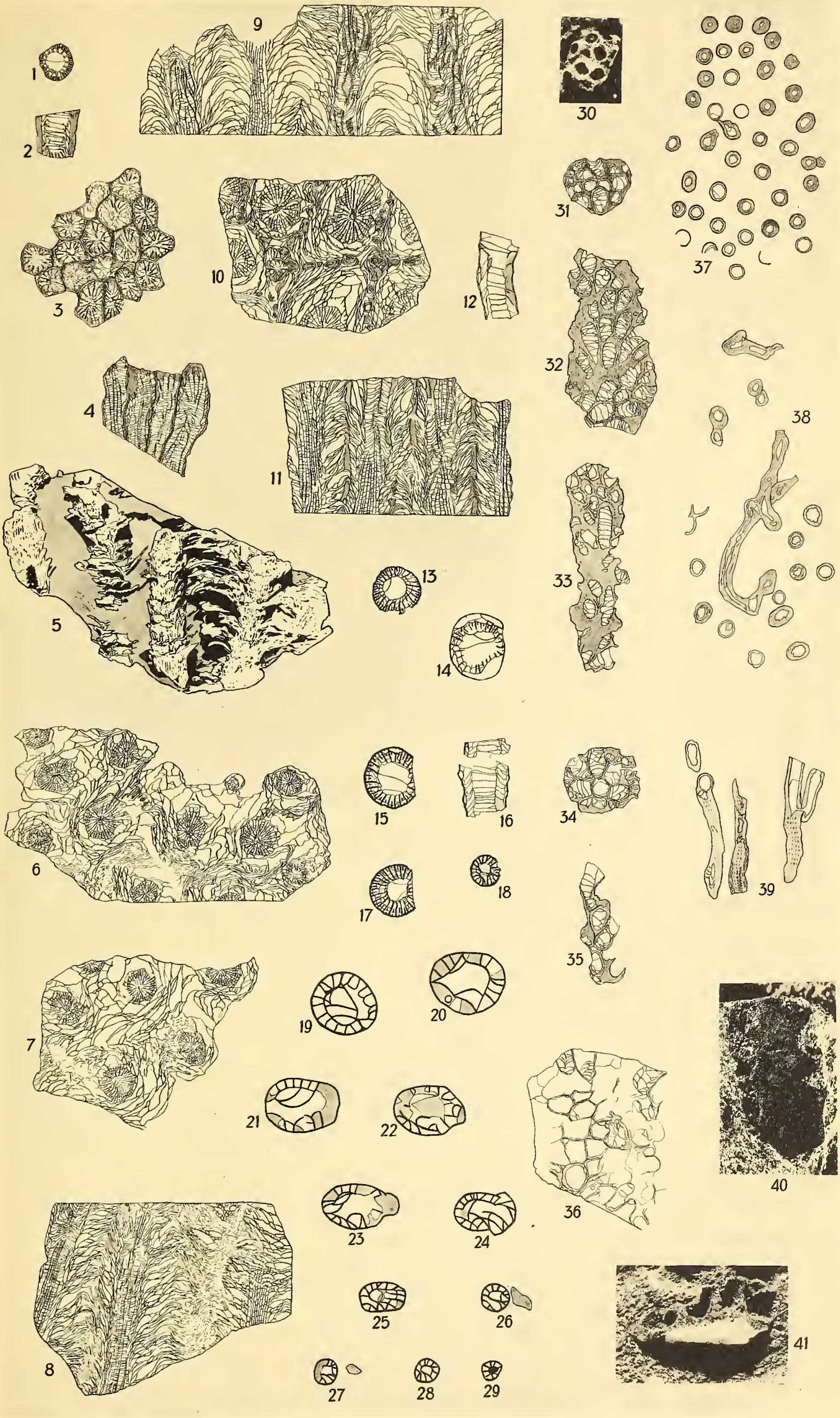
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Fig. 30. *Michelinia dendroides* sp. nov. View of calices on stunted branch, paratype F 2968. Note pitted stereome. Horizon and locality as for fig. 5.
Fig. 31 *M. dendroides.* Tr.S. from paratype F 2969.
Fig. 32 *M. dendroides.* V.S. from paratype F 2970.
Fig. 33. *M. dendroides.* V.S. from paratype F 2971. Note septal spines.
Fig. 34. *M. dendroides.* Tr.S. from paratype F 2972. . Note spines.
Fig. 35 *M. dendroides.* Tg. V.S. from paratype F 2971. *See* fig. 33.
Fig. 36. *Michelinia* sp. Section through F 2973 ; horizon and locality as for figs. 3–4. What appears in the drawing is all that can be made out from the slide.
Fig. 37. *Syringopora syrinx* Etheridge fil. Tr.S. from topotype F 2974 ; horizon and locality as for figs. 3–4. *See* fig. 39.
Fig. 38. *S. syrinx.* Section from F 2975 ; horizon and locality as for fig. 5.
Fig. 39. *S. syrinx.* V.S. from topotype F 2974 ; *see* fig. 37.
Fig. 40. *Palaeacis* sp. cf. *cuneiformis* Haime. External view of F 2976 from ? Viséan oolitic limestone in Portion 193, Parish of Mundowran, County of Yarrol, near Mundubbera, Q. An abornmally large specimen.
Fig. 41. *P.* sp. cf. *cuneiformis.* External view of F 2977 ; horizon and locality as for fig. 40. A typically wedge shaped specimen.

APPENDIX.

Australian Lower Carboniferous Coral Types in British Museums.

B.M.=British Museum of Natural History, South Kensington, London. List supplied by Dr. H. Dighton Thomas.

S.M.=Sedgwick Museum, Cambridge. List supplied by Mr. A. G. Brighton. Type localities may be found by reference to the text.

Symplectophyllum mutatum Hill. Paratype, S.M. A 5470 ; metatypes, S.M. A 5469, A 5471–3.

Amygdalophyllum etheridgei Dun and Benson. Part of holotype, B.M. R 22072 ; paratype, B.M. R. 21997.

A. conicum Hill. Metatypes, S.M. A. 5474-6.

Aphrophyllum hallense Smith. Parts of holotype, B.M. R. 19747, S.M. A. 5051; paratype, B.M. R. 19748.

A. foliaceum Hill. Metatypes. S.M. A. 5477–9.

Carcinophyllum patellum Hill. Metatypes, S.M. A. 5480–4.

Lithostrotion columnare Eth. fil. Topotypes, B.M. R. 19738–9, R. 19744, S.M. A. 5057–9 A 5493.

L. stanvellense Eth. fil. Topotypes, B.M. R. 19749, S.M. A. 5053.

L. arundineum Eth. fil. Topotypes, B.M. R. 19745, S.M. A. 5055.

Lithostrotion sp. *Diphystrotion mutabile* Hill. Part of holotype, S.M. A. 5492.

Cionodendron columen Benson and Smith. Sections of the holotype, B.M. R. 21999–22001.

Orionastraea lonsdaleoides Hill. Part of the holotype, S.M. A. 5485 ; paratype, S.M A. 5486.

Aulina simplex Hill. Paratype, S.M. A. 5488 ; metatype, S.M. A. 5487.

Michelinia dendroides Hill. Plaster cast of holotype, S.M. A. 5491 ; paratypes, S.M A. 5489–90.

Syringopora syrinx Eth. fil. Topotypes, B.M. R. 20874-5, R. 20878–9, S.M. A. 5062.

Note.—In the Clarke collection in the Sedgwick Museum described by M'Coy (1847) there are a few additional Lower Carboniferous Corals which are now being redescribed by the present author.

The Royal Society of Queensland

Report of the Council for 1932.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its report for the year 1932.

Eleven original papers were read before the Society and published during the year. On the 26th April, Mr. W. Davies, M.Sc., from the Welsh Plant Breeding Station at Aberystwyth delivered a lecture on " Pasture Studies " ; on the 30th May, Mr. C. A. Sussmilch, Director of Technical Education, Sydney, gave an address on " The Evolution of the Highlands of Eastern Australia " ; on the 29th August, Dr. J. Vickery, Officer in Charge, C.S.I.R. Research Laboratories at the Brisbane Abattoir, gave a lecture on " The Application of Scientific Methods to the Preservation and Transport of Meat."

On the 25th July, the evening was devoted to a discussion on the history, botany, and geology of Mt. Barney, the leaders being Professor Cumbrae Stewart, Mr. C. T. White, and Dr. Bryan. It was felt that such an evening would interest most members of the Society in spite of the fact that many specialise in one particular science. It was so successful that it is the intention of the Council to hold one or two evenings of a similar nature during 1933.

During the year the Australian and New Zealand Association for the Advancement of Science met in Sydney, and was attended by several members of the Society. Dr. Bryan and Mr. Bick represented the Society and on their return gave a report of the main features of the Congress.

A conference of representatives from the Royal Societies of Australia was held in Sydney in August, Professor Richards and Dr. Herbert representing the Society. At this conference the following motion was carried unanimously : " That in the opinion of this meeting no amalgamation of the Royal Societies is desirable at present but recommends a loose confederation through the appointment of a representative of the Royal Societies and Linnean Society on the executive of the A.N.R.C."

Owing to the number and length of the papers read before the Society, the cost of printing the Proceedings was rather high, with the result that the funds available for printing in 1933 will be very limited. Your Council trusts that all members, realising the difficult position of the Society, will strive 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 the only source of income is from the subscriptions, and practically the whole of the income is utilised in the publication and distribution of the Proceedings.

It is very pleasing to be able to report that, owing to a generous donation of £15/15/- by Dr. J. V. Duhig, about 60 volumes of the Proceedings of the Royal Society of London have been bound.

The Council wishes to express its appreciation to the University of Queensland for housing the library and providing accommodation for meetings. The Society is indebted to the Assistant Librarian of the University, Miss McIver, for superintending the lending of periodicals from the library.

The membership roll consists of 5 corresponding, 7 life members and 170 ordinary members. During the year there were 6 resignations, 2 names were removed from the list under Rule 13, and 6 new members were elected. It is with deep regret that the death is reported of Mr. G. J. Saunders, M.Sc., B.E., Dr. W. Love, and Mr. R. A. Wearne, B.A., all of whom were old and valued members of the Society.

There were eleven meetings of the Council during the year, the attendance being as follows :—E. W. Bick, 9 ; W. H. Bryan, 10 ; R. W. Cilento, 3 ; W. D. Francis, 8 ; J. B. Henderson, 7 ; D. A. Herbert, 10 ; L. F. Hitchcock, 10 ; T. G. H. Jones, 10 ; J. S. Just, 6 ; E. O. Marks, 8 ; F. A. Perkins, 11 ; H. C. Richards, 11 ; and C. T. White, 10.

T. G. H. JONES, President.

F. A. PERKINS, Hon. Secretary.

THE ROYAL SOCIETY OF QUEENSLAND.

Cr. STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDING 31ST DECEMBER, 1932. Dr.

RECEIPTS.	£	s.	d.	EXPENDITURE	£	s.	d.
Bank Balance, 31st December, 1931	117	16	0	H. Pole & Co., Balance on 1931 Volume (Printing)	21	17	1
Subscriptions	142	16	0	H. Pole & Co., Printing 1932 Volume	176	8	3
Donations, Dr. J. V. Duhig, 2/2/-; W. D. & H. O. Wills, 2/2/-	4	4	0	H. Pole & Co., Bookbinding	16	10	0
Sale of Volumes and Reprints	2	3	7	H. Pole & Co., Printing, Abstracts and Stationery	6	4	10
Bank Interest	4	5	10	Hon. Secretary, Postages	12	0	0
Exchange	0	5	8	Hon. Librarian, Postages	1	10	0
Cash in Hand	2	2	0	Hon. Treasurer, Postages	1	0	0
				State Government Insurance on Library	0	13	0
				Balance in Bank	37	9	11
	£273	13	1		£273	13	1

Examined and found correct.

JOHN S. JUST, Hon. Auditor.

E. W. BICK, Treasurer.

2/3/33.

Abstract of Proceedings, 27th March, 1933.

The Annual Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 27th March. The President, Dr. T. G. H. Jones, occupied the chair, and about forty-five members and visitors were present. Apologies were received from His Excellency the Governor, Professor E. J. Goddard, Dr. Vickery, and Messrs. Just, Hines, Bailey, and White. The minutes of the previous Annual Meeting were read and confirmed. Mr. C. Sankey Fraser was proposed for ordinary membership by Messrs. Hulsen and Perkins. The Annual Report and Balance Sheet were adopted.

The following officers were elected for 1933 :—President, Dr. R. W. Cilento ; Vice-Presidents, Dr. T. G. H. Jones (*ex officio*), and Mr. J. S. Just ; Hon. Secretary, Mr. F. A. Perkins ; Hon. Treasurer, Mr. E. W. Bick ; Hon. Librarian, Mr. W. D. Francis ; Hon. Editors, Dr. W. H. Bryan and Mr. L. F. Hitchcock ; Hon. Auditor, Mr. J. S. Just ; Members of the Council, Mr. C. T. White, Professor H. C. Richards, Mr. H. A. Longman, Dr. E. O. Marks and Dr. D. A. Herbert.

Dr. T. G. H. Jones delivered his Presidential Address entitled " The Elements and their Relationships."

A vote of thanks to the retiring President, moved by Professor Bagster and Professor Richards, was carried by acclamation.

Abstract of Proceedings, 24th April, 1933.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 24th April. The President, Dr. R. W. Cilento, occupied the chair, and about eighty members and visitors were present. The minutes of the previous meeting were read and confirmed. Mr. C. Sankey Fraser was unanimously elected an Ordinary Member of the Society. The following were proposed for Ordinary Membership :—Mr. D. Stewart, B.V.Sc., by Messrs. Hines and Perkins ; Mr. Wiley, B.Sc., by Dr. Jones and Mr. Hines ; Mr. F. O. Bosworth, B.A., by Messrs. Francis and Perkins. Mr. H. G. Cribb was proposed for Associate Membership by Mr. Perkins and Dr. Herbert.

The main business of the evening was a series of short addresses on the history, geology, botany, and zoology of the Glass Houses.

Professor Cumbrae Stewart said that the Glass Houses were discovered by Captain Cook in May, 1770, and were named by him from their resemblance to the shape of the buildings used for making glass. They were examined in July, 1799, by Lieut. Flinders, R.N. Landing in Pumice Stone Channel, Flinders walked towards a flat-topped peak, considerably nearer than the highest Glass House, but seeing a round mount with sloping sides still nearer, he climbed it, finding it to be a pile of stones of all sizes thickly covered with long but, rather spindly grass. Near the top, the stones were mostly loose. From the summit, he obtained an extensive view of the bay and surrounding country. Next day he proceeded to the flat-topped peak but was unable to climb it, owing to its steep sides. This ended this examination. In November, 1823, John Oxley made an examination of Moreton Bay, which led to the establishment of the Penal Settlement the following year. He noted the Glass Houses as a sea mark. In 1839, the Penal Settlement was broken up. A Trigonometrical survey was then begun. On 13th July, 1839, Robert Dixon, of the Survey, took the angles of the Glass Houses with the windmill from Mt. Petrie, and made a sketch of their outline in his Field Book, preserved in the Survey Office. A map by Dixon in the Survey Office, No. M33-3370, dated November, 1840, shows a station on Beerwah, the highest Glass House and bearings from it. In 1841, the station on the Upper Stanley, Durundur and Kilcoy were formed, and a road made from them over the Coast Range to Brisbane. Their road passed close to the Glass Houses and rendered them accessible from Brisbane.

Dr. F. W. Whitehouse said that Leichhardt, the explorer, who visited the area about the year 1844, was the first geologist to describe the Glass Houses. His work, privately printed in Germany in 1855 (some time after his death), is very rare and has been overlooked by later workers. It is interesting to note that his descriptions are more accurate than those of all later writers, until Dr. Jensen began to investigate the rocks by modern methods. Jensen's work, published in the years 1903, 1906, and 1909, is the last and the most important work on the subject.

In the Glass Houses there are ten main peaks, varying in height from 750 to 1760 feet above sea level, as well as a few minor hills. They are composed of trachytes and alkali rhyolites and rise in sharp, striking masses from the undulating plain. The plain, which has an average height of from 100 to 150 feet above sea level, is composed of sandstones of Lower Mesozoic age. In several places there is clear evidence of the igneous rocks having been intruded through the sandstones. They are volcanic necks but whether all of them represent the cores of old volcanoes, from which the fragmental masses of the cones have worn away, or whether some of them are mamelons (*i.e.*, masses of viscous lava forced out in bulk and solidifying at once) is problematical. In addition to these peaks there are some other exposures of similar rocks in the area that do not rise into hills. These rocks vary considerably. Some (like those of Beerburrum and Micketeebumulgrai) are prominently porphyritic, with striking tabular phenocrysts of sanidine. Others are fine-grained. The largest mass (that of Beerwah) tends to be holocrystalline and has fluxion structure. The phenocrysts in the rocks are felspars (varieties of orthoclase), quartz and the soda-rich amphiboles. Most excellent columnar jointing characterises the rocks of many of the peaks, reaching its best development in Conowrin. Jensen has called attention to the arrangement of these peaks in roughly a lattice fashion and has suggested that they may have been extruded at weak structural points representing the intersections of two systems of faults, apparently at right angles. Exposures of the sandstones are too rare to allow this theory to be tested. Subsequent to this phase of volcanic activity dacites were extruded, containing fragments of the trachytes. In the north of the area are basalts that are later than the trachytes and are probably the latest volcanic rocks of the area.

Mr. C. T. White showed mounted specimens of some of the outstanding plants of the region. Three plants—*Eriostemon glasshousiensis* (a Wax Flower), *Agonis Luehmannii* (a Tea Tree), and *Dodonaea* *rupicola* (a Hop Bush)—are, so far as known, not found outside the Glass House Mountains area, though none is confined to any particular mountain. Vegetation, for the most part, is strictly Australian, the families *Tiliaceae*, *Rutaceae*, *Leguminosae*, and *Myrtaceae* perhaps predominating. The flat top of Ngun Ngun is covered with large mat or carpet-like patches of the very interesting grass, *Micraria subulifolia*.

Mr. H. A. Longman said that the results of collecting in the district had been meagre, but no intensive work had been done. The vertebrate fauna, recorded in the Queensland Museum registers, had no distinctive features, and all the species had a wide range and were well known. There were records of fifteen species of marsupials, ten species of snakes and twenty-one species of lizards. In the Queensland Naturalist, Vol. 1, No. 6, 1910, W. Weatherill listed thirty-five birds, including the Blue-winged Kookaburra, a wide-ranging northern species occasionally found south. The late Andrew Petrie recorded that emus were common near the Glass Houses in early days.

A vote of thanks to the speakers, moved by Professor H. C. Richards, was carried by acclamation.

Abstract of Proceedings, 29th May, 1933.

The Ordinary Monthly Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 29th May. The President, Dr. R. W. Cilento, occupied the chair, and about forty five members and visitors were present. Apologies were received from Professor Bagster, Dr. Bryan, and Mr. Simmonds. The minutes of the previous meeting were read and confirmed. Messrs. D. Stewart, W. Wiley, and F. O. Bosworth were elected Ordinary Members of the Society, and Mr. H. G. Cribb was elected to Associate Membership. The following were proposed for Ordinary Membership: Dr. E. Hirschfield, by Messrs. White and Francis; Mr. W. Ranger, by Dr. Bagster and Mr. Perkins; Dr. Phyllis Cilento, by Drs. Cilento and Marks. Mr. G. Hall was proposed for Associate Membership by Mr. Perkins and Dr. Bryan.

Professor H. C. Richards exhibited (A) specimens of natural rock glass from the Meteorite Craters at Henbury, Central Australia. Associated with the meteoric craters at Henbury, Central Australia, there have been found fragments of a dull black natural glass which Dr. L. J. Spencer, F.R.S., of the British Museum considers throw an interesting light on the origin of Australites. The specimens exhibited were obtained from Professor Kerr-Grant and Mr. C. T. Madigan of the University of Adelaide and illustrated the different varieties of form under which the glass occurs. It is believed that the glass is caused by fusion of surface material following upon the impact of the meteorite. (*b*) A specimen of Agate and Amethyst from Kungurri obtained from Mr. Barenthien, which illustrated the crystallisation of quartz in amethystine form around and about finger-like stalactites of light coloured agate. (*c*) A nodule of Fluorspar from Mungana obtained from Mr. Barker, which illustrated well the concentric arrangement about a central nucleus.

Mr. H. A. Longman exhibited a microcephalic cranium of an aboriginal found on the property of Mr. H. W. Kleidon at Brigalow, which had been presented to the Museum through the Commissioner of Police. It was that of an aged female, and the dimensions were practically identical with those of the Jervois skull recorded by Sir Colin Mackenzie. The specimen was very prognathous, and the teeth showed unusual wear. It was one of three microcephalic crania in the Museum the capacity of which was less than 1,000 cc.

Mr. F. A. Perkins exhibited several species of living fruit flies which he had bred from native and cultivated fruit.

Mr. R. Veitch exhibited two show cases prepared by Mr. Helmsing, which portrayed the life histories of *Phylloxera vastatrix* and the Buffalo Fly (*Lyperosia exigua*).

Dr. D. A. Herbert exhibited albino seedlings of *Mandevillea suaveolens* raised in the Brisbane Botanic Gardens, and kept alive by being supplied with glucose solution.

Mr. J. H. Simmonds exhibited fruits of (*a*) White passion flower (*Passiflora alba*) showing symptoms of a virus disease which is probably identical with that causing the woodiness disease of the cultivated passion fruit. The presence of a possible alternate host as common as the white passion flower greatly complicates the control of this disease. (*b*) *Sorghum* attacked by covered smut (*Spacelotheca sorghi*) showing almost total replacement of seed by smut balls.

Mr. C. T. White exhibited examples of wood of Queensland Sandalwood, *Santalum lanceolatum* R.Br., and *Eremophila Mitchellii* Benth., collected in the neighbourhood of Dalby. Until recently it was always understood that the wood of *Santalum lanceolatum* R.Br. only developed a typical Sandalwood odour in the tropical parts of the State. Several examples from the South and South-west of Queensland, however, have recently demonstrated that the heart-wood at least of old trees in the more Southern parts of the State is just as highly scented as that from the North. *Eremophila Mitchellii* Benth., is one of the commonest trees of Western Queensland. The wood is rich in oil with a heavy " oriental " odour and may prove of considerable commercial value in the future. The oil has been investigated by Mr. A. R. Penfold, in conjunction with Dr. A. E. Bradfield and Professor J. L. Simonsen. Mr. White also exhibited specimens of *Homalocalyx polyandrus* F.V.M., collected between Dalby and Tara, where it was found to be very common. The plant was previously only known from fragmentary material collected by Dr. Leichhardt.

Dr. J. Vickery exhibited the following micro-organisms which were isolated at the Brisbane Abattoir from beef held for a period of 60 days at a temperature of -1 degree C. Each is capable of relatively rapid growth at this temperature, chiefly on muscle and connective tissue, and, to a lesser extent, on fat :—(*a*) *Penicillium expansum*, a mould which, when mature, produces bluish-green colonies reaching a diameter of 1.5cm. in 60 days. (*b*) *Thamnidium chaetocladiodes*, a mould, which, under favourable conditions, produces so-called " whiskers," due to abundant growth of aerial hyphae. (*c*) *Pseudomonas* (unnamed species), a slime producing bacterium which causes a sour odour in affected areas. (*d*) *Achromobacter* (unnamed species), a bacterium which multiplies very rapidly at a temperature of —1 degree C with the formation of superficial nodules.

Mr. J. H. Reid exhibited specimens of auriferous plumbago shale from Gympie and fibrous quartz, pseudomorphous after asbestos, from Kilkivan. The plumbago formation is characteristic of the productive goldmining areas of the Gympie field and has caused enrichment of reefs where the latter intersect such beds. In the discussion on the quartz pseudomorph Mr. A. K. Denmead pointed out the similarity of occurrence to that of the mineral Crocidolite.

Abstract of Proceedings, 26th June, 1933.

The Ordinary Monthly Meeting of the Society was held in the Biology Lecture Theatre of the University at 8 p.m., on Monday, 26th June. The President, Dr. R. W. Cilento, occupied the chair, and about 70 members and visitors were present. Apologies were received from Dr. W. N. Robertson and Dr. T. G. Jones. The minutes of the previous meeting were read and confirmed. Dr. E. Hirschfeld, Dr. Phyllis Cilento, and Mr. W. Ranger were unanimously elected Ordinary Members of the Society, and Mr. G. Hall as an Associate Member. Mr. L. J. Lynch was proposed for Associate Membership by Mr. Perkins and Dr. Herbert.

Dr. D. A. Herbert exhibited a double Nasturtium of the Golden Glow variety with the spur turned inside out, and with beads of nectar on the surface of the column so produced.

A paper entitled "Notes on Australian Syrphinae," by G. H. Hardy, was laid on the table.

Mr. C. T. White showed a series of lantern slides of the vegetation of New Guinea and New Caledonia and photographs by means of the epidiascope of the vegetation of the Solomon Islands. The photos were taken by Messrs. F. Kajewski and L. Brass during botanical explorations on behalf of the Arnold Arboretum (Harvard University) during the years 1929-1932.

Dr. R. W. Cilento showed a series of very interesting slides illustrating the different types of native found in Melanesia, the evolution of the Lakatoi, and several peculiar native customs.

A vote of thanks to the lecturers moved by Dr. Herbert was carried by acclamation.

Abstract of Proceedings, 31st July, 1933.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University at 8.15 p.m. on Monday, 31st July. Dr. D. A. Herbert occupied the chair, and about 40 members and visitors were present. Apologies were received from Professor Richards, Dr. Cilento, Dr. Jones, Mr. Kyle, Dr. E. O. Marks, Mr. Tryon, and Dr. Bryan. The minutes of the previous meeting were read and confirmed. Mr. L. J. Lynch was unanimously elected an Associate Member of the Society. The following were proposed for ordinary membership: Mr. S. J. Kajewski, by Messrs. White and Francis, and Dr. H. A. Goldfinch by Messrs. Longman and Perkins. Mr. C. L. Knight was proposed for associate membership by Professor Richards and Dr. Bryan.

Professor Cumbrae Stewart read copies of two letters which had been sent to him by Mr. A. Archer. The letters were written by Ludwig Leichhardt to Mr. Archer's uncle on the 14th May and 19th November, 1846.

A paper by Dr. J. V. Duhig on " Serum Inhibition of Haemolysis " was laid on the table.

Mr. C. T. White communicated a paper by Professor U. Martelli on " Two Australian Species of *Pandanus*."

The main business of the evening was a very interesting address by Dr. E. Hirschfeld on " Biological Problems in Western Queensland." A vote of thanks moved by Mr. White and Mr. Henderson and supported by Messrs. Hines, Jones and Longman was carried by acclamation.

Abstract of Proceedings, 28th August, 1933.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 28th August. Dr. D. A. Herbert occupied the chair, and about 40 members and visitors were present. An apology was received from Dr. Cilento. The minutes of the previous meeting were read and confirmed. Mr. S. J. Kajewski and Dr. H. A. Goldfinch were unanimously elected Ordinary Members of the Society. Mr. C. L. Knight was elected an Associate Member. Dr. W. M. Sinclair was proposed for Ordinary Membership by Professor Bagster and Dr. Jones.

A paper entitled " The Genus Pleiogynium in Papua " by Mr. C. T. White was laid on the table.

Dr. J. V. Duhig gave an account of the main features of his paper on " Serum Inhibition of Haemolysis."

Mr. W. W. Bryan delivered a very interesting address on "Maize Breeding in Queensland."

In a brief discussion of plant breeding methods in general, under the heads of introduction, selection, and hybridisation, it was pointed out that in self-fertilised crops pure lines are rapidly and automatically developed even following a cross between genetically diverse types, while in cross-fertilised crops this is not the case, a definite and usually large proportion of heterozygotes being present.

This necessitates the use of special methods in the improvement of crossed crops such as maize, the method of selection within self-fertilised lines followed by hybridisation being the most important. This method was discussed in some detail, particular emphasis being placed on the difficulty of determining upon which lines to concentrate in crossing programmes when a large number of homozygous selfed lines are available.

The time aspect is important, 5-8 years being required to obtain homozygous lines and another 6-7 years to set up and test crosses between them. The various types of cross-single, double, and multiple —were mentioned. The commercial possibility of raising large seed stocks of crosses was indicated. Results were given from U.S. stations and from Queensland to indicate the worth of methods in use in this State.

A vote of thanks moved by Professor J. K. Murray, supported by Messrs. White, Bennett, and Gurney, was carried by acclamation.

Abstract of Proceedings, 25th September, 1933.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 25th September. The President, Dr. R. W. Cilento, occupied the chair, and about 50 members and visitors were present. The minutes of the previous meeting were read and confirmed. Dr. W. M. Sinclair was elected an Ordinary Member of the Society.

Dr. E. Hirschfeld exhibited (*a*) specimens of Brigalow Grass and (*b*) a Dew Gauge which was used by him in his experiments in Western Queensland.

After a brief account of the known facts of colour-blindness, Mr. Kyle exhibited apparatus for the psychological examination of the phenomenon. The apparatus included the Holmgren Wool Test, the Edridge-Green cards and colour-perception lantern, the Ishihara test and the colour-mixer for the determination of colour equations. Actual results of some of the tests given in the psychological laboratory of the University were shown, mainly the wool test, and certain matches of colour made by red-green blind subjects were exhibited.

Dr. Bryan, Dr. Cilento and Mr. Hulsen took part in the discussion which ensued and Professor Richards moved a vote of thanks which was carried by acclamation.

Abstract of Proceedings, 30th October, 1933.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 30th October. Dr. T. G. H. Jones occupied the chair, and about 40 members and visitors were present. An apology was received from the President, Dr. Cilento. The minutes of the previous meeting were read and confirmed.

Dr. D. A. Herbert exhibited (1) *Peronospora effusa*, a downy mildew attacking *Chenopodium album*, collected at Gatton, October, 1933, and (2) the aecidial stage of a rust fungus referred to *Puccinia aucta* by McAlpine, collected at Gatton, on *Pratia erecta*, October, 1933.

A paper by Messrs. F. A. Perkins and H. J. G. Hines, entitled " A Note on some Preliminary Experiments with Ammonia as a Lure for the Queensland Fruit Fly (*Chaetodacus tryoni*) " was laid on the table.

Mr. C. T. White delivered a very interesting address on Queensland Grasses which was followed by a discussion in which the following took part :—Dr. Herbert, and Messrs. Gibson, Gurney, Bailey, Bennett, Jones, and Bick.

A vote of thanks to Mr. White was carried by acclamation.

Abstract of Proceedings, 27th November, 1933.

The Ordinary Monthly Meeting was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 27th November. The President, Dr. R. W. Cilento, occupied the chair, and about 45 members and visitors were present. Apologies were received from Professor Richards and Dr. Vickery. The minutes of the previous meeting were read and confirmed. Mr. G. Roscoe, M.A., was proposed for Ordinary Membership by Messrs. Kyle and Perkins, and Mr. L. Thomas, M.Sc., by Messrs. Perkins and Herbert.

Dr. F. W. Whitehouse exhibited a very interesting collection of rocks from West Queensland.

The following papers were laid on the Table :—

1. "Reactions of Tagetone," by T. G. H. Jones, D.Sc.
2. "Notes on Australian Muscoidea (Calyptrata)," by G. H. Hardy.
3. "The Constitution of Campnospermonol," by T. G. H. Jones, D.Sc.
4. "New Australian Trypetidae," by F. A. Perkins, B.Sc., Agr.

The main business of the evening was an address by Dr. A. J. Turner entitled "Observations on the Nutrition of our Western Children." The following took part in the discussion which ensued :—Drs. Hirschfeld, White and Duhig, and Messrs. Bennett, Hines and the President. A vote of thanks to the lecturer was carried by acclamation.

A Special Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m., on Monday, 31st July, 1933.

The business of the meeting was the amendment of Rule 19, by the addition of the following clause—

> "*The Senior Ordinary Member of the Council shall retire annually, and not be eligible to hold any office in the Society for twelve months.*"

The amendment was carried unanimously.

Publications have been received from the following Institutions, Societies, etc., and are hereby gratefully acknowledged :—

ALGERIA—
Societe de Geographie et d'Archaeologia 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 Janerio.

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'Historie Natural, Paris
Societe Botanique de France
Societe Geologique et Mineralogique de Bretagne
Societe de Geographie de Rochefort.

Germany—
Zoologische Museum, Berlin.
Gesellschaft fur Erdkunde Berlin.
Deutsche Geologische Gesellschaft, Berlin.
Naturhistorischer Verein der preus Rheinland und Westfalens, Bonn.
Naturwissenschaftlichen Verein zu Bremen.
Senckenbergischen Bibliothek, Frankfurt a. Main
Kaiserlich Deutsche Akademie der Naturforscher, Halle.
Zoologischen Museum, Hamburg.
Naturhistorisch-Medizinischen 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.

—
Koninklijk Naturkundige Vereinginig, Weltvrenden.
Department van Landbouw, Buitonzorg.

Mexico—
Instituto Geologico de Mexico.
Sociedad Cientifica "Antonio Alzate," Mexico.
Secretario de Agriculture y Fomento, Mexico.
Observatorio Meterorologico Central, Tacaibaya.

New Zealand—
Dominion Museum, Wellington.
New Zealand Institute, Wellington.
Auckland Institute and Museum.
Dominion Laboratory, Wellington.
Council for Scientific and Industrial Research, Wellington.
Geological Survey of New Zealand.

Peru—
Sociedad Geologica del Peru, Lima.

Philippines—
Bureau of Science, Manila.

Poland—
Polskie Towarzystwo Przyrodnikow im Kopernika, Lwow.
University of Poland.
Societes Savantes Polonaises.

Portugal—
Academia Polytechnicada, Oporto.
Sociedade Broteriana, Coimbra.
Institut Botanico, Coimbra.

Russia—
Academie des Sciences Russie, Leningrad.
Bureau of Applied Entomology, Leningrad
Publications of the Institute of Plant Industry, Leningrad.

Spain—
Real Academia de Ciencias y Artes de Barcelona.
Real Academia de Ciencias, Madrid.
Museo de Historia Natural, Valencia.
Academia de Ciencias de Zaragoza.

Sweden—
Geological Institute of Upsala.

Switzerland—
Societe de Physique et d'Historie Naturel, Geneve.
Naturforschenden Gesellschaft, Zurich.
The League of Nations, Geneva.

South Africa—
Geological Society of South Africa, Johannesburg.
South African Museum, Capetown.
Durban Museum, Natal.
Transvaal Museum, Pretoria.

United States of America—

United States Geological Survey, Washington.

Natural History Survey, Illinois.

Lloyd Library, Cincinnati.

Wisconsin Academy of Arts, Science and Letters, Madison.

California Academy of Sciences.

Cornell University, Ithaca, New York.

University of Minnesota.

University of California.

Library of Congress, Washington.

Field Museum of Natural History, Chicago.

American Museum of Natural History, New York.

Buffalo Society of Natural History.

Boston Society of Natural History.

American Philosophical Society, Philadelphia.

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Smithsonian Institute, Washington.

Carnegie Institute, Washington.

United States Department of Agriculture, Washington.

Oberlin College, Ohio.

National Academy of Science, Washington.

Rochester Academy of Sciences.

Academy of Natural Sciences, Philadelphia.

New York Academy of Science.

Indiana Academy of Science.

American Academy of Science and Arts, Boston.

Institute of Biological Research, Baltimore.

John Crerar Library, Chicago.

Ohio Academy of Science, Columbus.

Arnold Arboretum, Jamaica Plains.

Michigan Academy of Arts, Science, and Letters.

University of Michigan.

Minnesota Geological Survey.

New York Zoological Society.

Wistar Institute of Anatomy and Biology, Philadelphia.

Portland Society of Natural History.

San Diego Society of Natural History.

Puget Sound Biological Station, Seattle

Missouri Botanic Gardens, St. Louis.

University of Illinois, Urbana.

State College of Washington, Pullman.

Bureau of Standards, Washington.

National Research Council, Washington.

United States National Museum, Washington.

Public Health Service, Washington.

Peabody Museum of Natural History, Yale.

Lawde Observatory, Arizona.

The University of California, Los Angeles, California.

List of Members.

Corresponding Members.

Barton, E. C., A.M.I.C.E.	c/o Decimal Assoc., Finsbury Pavement, Moorgate, London, E.C. 2.
David, Professor, Sir T. W. E., F.R.S.	The University, Sydney, N.S.W.
*Domin, Dr. K.	Czech University, Prague
*Maitland, A. Gibb, F.G.S.	Melville Place, S. Perth, W.A.
*Skeats, Professor E. W.	The University, Melbourne, Vic.

Ordinary Members, Etc.

Atherton, D. O., B.Sc.Agr.	Department of Agriculture and Stock, Atherton
Bage, Miss F., M.Sc.	Women's College, Kangaroo Point, Brisbane
†Bagster, L. S., Prof., D.Sc.	The University, Brisbane.
*†Bailey, J. F.	Maynard Street, Woolloongabba, S. Brisbane
Ball, L. C., B.E.	Geological Survey Office, Brisbane
Barker, F.	Railway Audit Office, Brisbane
Barker, G. H.	Adelaide Street, Brisbane.
Beckman, G. H., B.Sc.	Crook Street, Northgate, Brisbane
*Bennett, F., B.Sc.	State School, Toowong, Brisbane
Bennett, F. C., B.Sc.	Pharmacy College, Brisbane
Bick, E. W.	Botanic Gardens, Brisbane
Blumberg, B., M.Sc.	Inkerman Street, South Brisbane
Bostock, J., M.D., B.S., D.P.M., M.R.C.S., L.R.C.P.	Wickham House, Wickham Terrace, Brisbane
Brigden, J. B., M.A.	Department of Labour and Industry, Brisbane
Briggs, Mrs. C.	First Avenue, Eagle Junction, Brisbane
Brown, Jas., B.A., M.D., Ch.B. (Edin.), D.Ph. (Cambridge)	"Widmoorene," Margaret Street, Toowoomba
*Bryan, W. H., M.C., D.Sc.	The University, Brisbane
Bryan, W. W., B.Sc., Agr.	Agric. High School and College, Gatton.
Bosworth, F. O., B.A.	Agric. High School and College, Gatton.
Butler-Wood, F., D.D.S.	Permanent Chambers, Adelaide Street, Brisbane
Buzacott, J. H., B.Sc.	Sugar Experiment Station, Meringa, *via* Gordon Vale.
Cameron, Colonel Sir Donald, C.M.G. D.S.O.	Cooksley Street, Hamilton, Brisbane.
Cameron, W. E., B.A.	Tattong, *via* Benalla, Victoria
Carson-Cooling, Geo., M.Sc.	Boys' Grammar School, Brisbane
Cayzer, A., B.Sc.	The University, Brisbane

†Life Members.

*Members who have contributed papers to the Society.

Chamberlain, W. J., M.Sc.	Water Supply and Sewerage Department, Brisbane City Council
Cilento, Phyllis, M.B., B.S., ...	487 New Sandgate Road, Clayfield.
Cilento, R. W., M.D., B.S.	Dept. of Health, Canberra, F.C.T.
Cottrell-Dormer, W., B.Sc.Agr. ..	Department of Agriculture and Stock, Brisbane
Crawford, Miss L.	Children's Hospital, Brisbane
Cribb, H. G.	"Warham," Quarry Street, Ipswich.
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PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

QUEENSLAND.

FOR 1934.

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VOLUME XLVI.

Vol. XLVI., No. 1.

Proceedings of the Royal Society of Queensland.

Presidential Address.

BY

R. W. Cilento, M.D., B.S. (Adel.), D.T.M. & H. (Eng.).

(*Read before the Royal Society of Queensland in the absence of the President by Professor H. C. Richards, 26th March,* 1934.)

The report which has been submitted to you shows that the work of the Royal Society during the past year—the fiftieth year of the Society's activities—covers a wide field. The volume itself is not massive, but its interest is many-sided, and it is evidence of a manifold concern in the various aspects of applied science that goes far beyond its obvious manifestation.

During the year we have lost three of our members—Dr. T. L. Bancroft and Messrs. B. Dunstan and D. W. Gaukrodger. They lived full and useful lives, contributed to scientific knowledge in different fields—medicine and natural history, mining and geology, and ornithology—and have passed on. We deplore their loss as friends and as members.

It is a curious and illuminating experience to read through the titles of the subjects and the names of the authors who have presented them to this scientific body during the half-century of its existence, and an outstanding matter of gratification to know that we still have with us some of those who were foundation members at that meeting in January, 1884, from which it originated. They have honoured us with membership a life long; the Society honours them with grateful recognition and life membership.

If the blood of the martyr who dies for his faith is the seed of the Church, it is no less true that the devotion of those who live for Science is the vital pulse of progress.

I am honoured that it has fallen to my lot to give the Jubilee Address of the Royal Society of Queensland, though I regret antecedently the discursive nature of what must be an unscientific essay; I regret, too, that my frequent absences on official business have handicapped me in the full discharge of the duties of the post of President up to this present necessity; but I am glad that they have given me a legitimate opportunity to express my gratitude and appreciation for the continual co-operation and loyal assistance of the members of the Council and, in particular, of the Secretary.

JUBILEE ADDRESS.

In the *Brisbane Courier* of 9th January, 1884, there appeared this announcement:—

> "The inaugural meeting of the Royal Society of Queensland was held yesterday evening in the Laboratory of the Museum, when a large gathering of members was present, together with His Excellency Sir Anthony Musgrave, the Patron of the Society. The President, the Honourable A. C. Gregory, read an interesting address which will be found in another column, and among the speakers were Sir Anthony Musgrave, the Hon. J. Douglas, and Mr. A. J. Duffield."

Gregory was, of course, Gregory the explorer, and the meeting was held in the laboratory of the Museum, among other reasons, because the Royal Society had developed largely from the pre-existing Philosophical Society (which had been materially responsible for the foundation of the Museum itself), whose members contributed fourteen of our original number.

From the "other column" to which reference is made we learn that the Royal Society had selected as its field of endeavour, "Natural Science and its Practical Applications," and the young and energetic secretary of the new body was our old friend Mr. Henry Tryon.

In his opening address the Honourable A. C. Gregory referred to that active development seen in all branches of human industry and knowledge (which, in retrospect, was indeed so characteristic a feature of that period), and mentioned in particular the recent advances in the knowledge of electricity which had permitted the introduction of the telegraph, the telephone, and was attracting attention towards the possibilities in respect of electric light and electric motors. Some, said Gregory, had even been led to suppose that electricity would supersede steam power and gas light. He mentioned, nevertheless, that the public, and particularly the working public, was very slow to accept the advances and advantages of Science.

> "'I have seen,' he said, 'crowds of men assembling to destroy threshing machines; have known them to disable reaping and other labour-saving machines under the impression that machinery decreases the demand for manual labour; and it is not so many years since agricultural machines, railways, and sewing machines were held to be equally subversive to the public weal.'"

It is somewhat startling to realise that we have with us to-night men who span the gap between us and this man who had actually seen that destruction of threshing machines and the end-results of those Luddite riots which to us seem almost mediæval in their remoteness! It is equally strange to realise what contrasts are provided by a review of 1884 and the decade that followed in terms of the present day.

I ask your indulgence if my address should seem rambling and inconsequential, for the events of the day betray, more, perhaps, than anything else, the possibilities and the handicaps of Science, its study, and its application. Imagine the profound changes that have occurred in the everyday environment of the individual during these two generations!

Gregory's reference to the possibilities of electric light arose from the fact that the Government Printing Office here had just been lighted by electricity, a circumstance regarded as a most freakish experiment, extravagantly wasteful of public money, by people who had seen only within the fewest previous years the lighting of several of Queensland's provincial cities for the first time with gas. Electricity was considered a scientific toy, and when, on 13th March, 1884, the *Courier* offices were lighted with electricity also, it was regarded as an affectation that would doubtless recoil upon the heads of the vainglorious promoters.

It had been in 1877 that the first motor-car had been tried out abroad, but no fuel had been found suitable for its utilisation, and conventional patriarchs were thundering sternly about the wrath of God which would most certainly fall upon those impious innovators who harnessed the lightning to the service of glare and speed!

It was an age of experiment and transition; of age-old conventions rejected and defended, shibboleths in purple and vellum, truth in defiant rags and illicit printing presses; the sap of a new Spring was running through the dry wood of civilisation with a ruffle of immature green on every branch.

The whole world was being parcelled out with avidity in the search for new markets for a continually growing industrial output, and critical occasions followed every new endeavour.

England had just finalised the trouble arising from the brutal Phœnix Park murders of 1882, in Ireland, and the Irish Land Act, among other things, was being introduced in the hopeless quest of "pacification." A policy of pacification was also being attempted in Egypt, where the army of Hicks Pasha had been annihilated in November, 1883, at Obeid; and where, before 1884 had run its course, "Chinese" Gordon, waiting hopelessly for the arrival of relief forces, was to die under the spears of the troops of El Mahdi. In South Africa, Cetewayo was producing difficulties little short of war; and the Boers were increasingly dissatisfied with their Convention, which was to lead to the Boer War in a further fifteen years. The conflicting claims of the French, the English, and the Egyptians were producing a crisis in respect of the Suez Canal, and de Lesseps was speculating on the possibilities of Panama, a project that was to break him, to cost the lives of 30,000 Frenchmen, and to yield only to the microscope, quinine, and mosquito conquest. In India, the Ilbert Bill, giving power to native officials, had raised a storm of opposition and warning that is curiously interesting to-day, when, as a recent cable informs us, three Indians are acting as Vice-Governors of three great Indian States during the absence of the English appointees.

France, who, after the death of Gambetta, had appeared to invite the hostility of several European countries, was engaged upon a policy of active conquest and annexation in Asia and in Africa. She was pushing into the Congo, was involving Madagascar more and more in the toils that were to bind her as a colony, and had seized Tonkin which was to be the basis of the great province of French Indo-China. She had, moreover, informed China that she would hold her responsible for the costs of any war that might result from her natural indignation. Her activities in regard to Formosa and Siam at a later period were to produce a serious situation with Great Britain. She was active also in the Pacific.

Germany, too, was rapidly extending her activities in the Pacific, and was watching with a keen eye the internecine struggle in Samoa, of which, with America, she was soon to take advantage. In Russia outrages upon the Jews had created a body of antagonistic European opinion intensified by the active plotting that was going on in the Balkans regarding the Danubian provinces. In South America a fierce and merciless war between Peru and Chile, late allies for emancipation from Spanish rule, had drawn to a close; while the United States of America was beginning dimly to apprehend her future greatness, though her pre-occupations were as yet rather of the domestic type. (We note, for example, a report that the New England Reform League had seriously undertaken the correction of a surprising increase in divorce which had lately made its appearance throughout the United States!)

The white man's star was everywhere dominant: his ships, his machines, his weapons, his culture encompassed the earth, and his power partitioned it directly or expressed itself in the indirect fiction of extra-territoriality. The subjects of Great Britain, for example, in 1884 were under the protection of their consuls abroad in Eastern lands, free from arrest, their houses inviolate, and their property free from taxation. We have seen the turn of the wheel that led to the end of this extra-territorial jurisdiction in Japan in 1899, in Turkey in 1923, in Siam in 1927, in Persia in 1928, and more recently in China.

Indeed, side by side with imperialistic adventure, there has grown up, as international relationships became increasingly complex, a body of world opinion demanding an equitable and accepted method of settling disputes of a legal nature and a demand that nations should be prepared to submit their causes readily to arbitration, and should loyally follow the decisions of what, in effect, is an international judiciary—the germ of universal co-operation.

From the Hague Conference of 1899 to that of 1907, with their conventions dealing specifically with the subjects of good offices and mediation, international commissions of inquiry, and international arbitration, the war of 1914-18 led abruptly to the covenant contained in the Peace Treaty of Versailles (1919), the League of Nations (1920), and the Permanent Court of International Justice—august tribunals seeking a seat of security amidst the froth of human prejudices and particular interests. Can the logic of Science, in the final analysis, be the logic also of conduct?

But let us turn again to 1884 and the local and general affairs of Queensland and of Australia. The period was one of partial drought—so severe in January that what was described as "liquid mud" was sold at Muttaburra for 6s. 6d. per barrel. In the agricultural and pastoral industries, as a consequence, prospects were doubtful, though farmers and squatters were optimistic. In spite of heavy floods in February the State was actually entering upon a series of poor years that were to culminate in the disastrous climax of the 1900-02 period. The mining fields were booming and between 500,000 and 600,000 oz. of gold were being won annually from the country.

These facts together had a profound effect upon policy questions. Population poured into the country, but rejected the fields for the mines. The city and the growing coastal towns were flooded with incoming Europeans, Asiatics, and South Sea Islanders seeking employment, with consequent chaos and racial conflicts. Conditions were so bad that from the point of view of health these years are called the "Dreadful Eighties," and in the actual year of the founding of this Society the death rate per 100,000 for Queensland was 50 per cent. in excess of that of the other States!

From the disorderly clamour of the times emerge several distinct demands: A "White Australia," a Federated Australia, and an Australia dominant in the South-West Pacific on the one hand, and, on the other, local government and self-determination, freedom of contract, unity among the labouring classes, and betterment of conditions, of facilities, and of communications. It was fortunate that the occasion produced the men.

Sir Thomas McIlwraith had seen, in 1883, the defeat of his Transcontinental Railway policy and had resigned his power to an equally dynamic opponent, Mr. (afterwards Sir) Samuel Griffith. McIlwraith had left the impress of definite power and personality on Queensland, and had for the first time guided her into prominence. It was his pardonable ambition to make her the foremost colony of the Australasian group, and the people of the State had been inspired to a new optimism by the great increase of coastal, intercolonial, and overseas steam vessels, by new postal facilities that made up for the defects of the British India Company's services and multiplied and strengthened the links with other lands, by the great masses of white men who were immigrating into the country, and by a positive crop of newly inaugurated railway lines which were reaching tentative fingers along the coasts and towards the isolated inland communities and were ultimately to make an enormous difference to the distribution of the population.

In Brisbane itself the new Treasury building was going up, with the usual squabbles and recriminations as to the accepted plan. The Gold Creek Reservoir was about to be built to supplement the supply from the Enoggera Reservoir—both soft waters and plumbi-solvent, of which we shall have more to say later. (It has often been suggested that the water was little used in these early days owing to the high degree of organic matter contained and its consequential foul odour. Though complaints were frequent, especially towards the end of each year, nevertheless the water returns for 1882-3 amounted to £14,395, and there was £427 charged on account of water supplied to public offices. This was a very reasonable average for a city of the size of Brisbane at that time.)

Arrangements were being made to provide a tramway for the city, and a correspondent had suggested that, on account of the importance of Queen street as the main thoroughfare of the city and its liability to congestion, the trams should follow a parallel path in the streets parallel to the main street, connecting at Circular Quay and also at the eastern end.

On 20th May, 1884, the first successful shipment of frozen meat to meet a new demand had been made to England by the "Dorunda" from the Queensport Works, Brisbane. (On the 14th December this vessel returned with cholera on board. This was the only occasion on which cholera has been brought into an Australian port in this form.) Recently we saw despatched the first shipment of chilled meat to meet a newer demand.

We note also in passing the first direct shipment of sugar from Queensland to England ($9\frac{1}{2}$ tons), which was sent from the Pioneer Works by the "Merkara," on 9th October, 1885. By 1891 the average shipment to England in the four months of the season was 1,000 tons. The situation to-day is one with which you are all familiar. On 17th May, 1893, the Ipswich cotton factory made the first piece of twill sheeting ever manufactured in Australia.

The estimated population of the whole State at 31st December, 1883, was 248,255—not much more than two-thirds of the present population of Brisbane alone—but such was the attraction of the gold finds that within five years it had increased over 50 per cent. to a total of 384,000.

Immigrants were pouring into the country, but there were many complaints from the established settlers that under no persuasion would they leave the cities to go into the undeveloped outback and, as a matter of fact, this was not surprising when it is considered that the immigrants were as a rule totally unfitted for outback labour, a type of work foreign to their education and upbringing. Unemployment in the city was consequently rife, and this led, as has been mentioned, to fierce agitation against the kanaka and Chinese labour which also was pouring into the country. The Polynesian labour trade which had been and was to be severely censured by Royal Commissions had produced the impression upon the public mind that it was a disgrace to the colony which no restrictive measures would ever deprive of its inhuman features. Though strict regulations had been introduced with regard to "blackbirding," little attempt to enforce them was made or was, indeed, possible. The Queensland vessels broke the law with greater willingness because their reputation was continually besmirched by the murderous activity of Fijian, Samoan, Hawaiian, German, and American slaving vessels which, being utterly uncontrolled, recruited with the aid of liquor and firearms with impunity, and for whose atrocities and depredations Queensland crews, some of them guiltless, suffered in public esteem and also occasionally in loss of life and loss of vessel.

A young Melbourne University student, in 1884, trenchantly criticised the whole system of black labour in Queensland with a wealth of detailed evidence and a series of sound recommendations for the correction of abuses. Had Queensland recognised the able administrative mind at her disposal at that juncture a very ugly chapter of her history might have been cut short, but it saw only a "university student" and an "academic theorist aiming at a little cheap notoriety." Moreover, it said, was not the matter in the hands of "practical-minded business men" who had no theories to air, nor stupid sentimentalities about the black, nor about the relation between the work obtainable from him, the food he got, and the living conditions he preferred and enjoyed? So said the Premier; so said the professional paragraphists who provided the daily opiate for the public conscience then as now; and George Ernest Morrison passed on and out of Queensland life to become one of the ablest British administrative officers China ever knew. Every year in Canberra, at the cost of citizens of the oldest and greatest Empire of the East, Australia and China recall in unison the memory of "Chinese" Morrison, whom

Queensland rejected as too academic-minded for a business that should, it was tacitly felt, be ignored or excused rather than submitted to examination for correction.

Was it not John Stuart Mill who wrote—

> "In sober truth, whatever homage may be professed or even paid to real or supposed mental superiority, the general tendency of things throughout the world is to render mediocrity the ascendant power among mankind."

Sir Samuel Griffith had meanwhile rejected the offer of coolie labour indentured from India, because already the coloured labour problem was assuming a gravity that must inevitably lead to trouble, and the *Brisbane Courier* of the 2nd January, 1884, summed up the general feeling of the community when it said—

> "On the other hand the alternative of flooding the colony with Malays, Chinese, and other Asiatic races *without either restriction or regulation* is one greatly to be deprecated. Yet this is what has really begun in the North, and is assuming such formidable proportions that the Government, despite their determination not to touch the question, will be forced by public opinion to take effective measures of some kind. . . . Whatever happens, it is certain that the public of the colony will not permit its hospitals and gaols to be filled with the scum of 'eastern civilisation,' which Europeans justifiably term 'barbarism.' "

In the rank growth of colonisation, prudence demanded a heavy weeding.

The increasing agitation against coloured labour showed itself from 1884 onwards in violent anti-Chinese meetings at Charters Towers, Croydon, and elsewhere, and in menacing attacks upon concentrations of native people which led the Chinese of Mackay to petition to the Chinese Ambassador for protection in 1886. In the following year the agitation reached a new height in Brisbane and continued for twelve months, and in 1887 it culminated in a riot when the windows of all the Chinese shops were smashed and the large body of Chinese living at Kelvin Grove petitioned Pekin. So serious did the matter of Asiatic intrusion become in all States that in 1888 it brought Australia closer to armed resistance to Great Britain than ever before or since, and Sir Henry Parkes had the whole country behind him when he publicly declared that the Australians were not school children who could be called to account by the Prime Minister of England, and added—

> "Neither for Her Majesty's ships of war nor for Her Majesty's representatives, nor for the Secretary of State, do we intend to turn aside from our purpose, which is to terminate the landing of the Chinese on these shores for ever."

In that year the matter went to the English courts in connection with the case *Musgrove v. Chun Teeong Toy*. The respondent was a Chinese of Hong Kong who claimed the right to land in Australia in defiance of the Collector of Customs of Victoria and had gained his point in the Victorian courts. But the legal right of Victoria, or any land, to exclude any foreign national was affirmed by the decision of the Judicial Committee of the Privy Council which declared that neither in law nor comity is a State prohibited from limiting or regulating the admission of aliens into its own territory. Exclusion Acts were immediately introduced and enforced in all States, and "White Australia" passed from the ambit of theoretical abstraction to the verge of the practical.

One stage in the endless struggle towards that security which is the goal of all men was achieved; another, longer and as bitter, was in active progress. I mention it because at that stage a description of the terrain is more illuminating than the players themselves in demonstrating our growth towards adolescence and maturity.

On 1st September, 1884, the first Trades and Labour Council for Queensland was formed in Brisbane, and active agitation upon labour matters began to crystallise towards effective representation of labour in industry and in Parliament.

Throughout the whole fifty years of our existence as a Society this search for a *modus vivendi* has gone on with increasing intensity. Adequately presented, it was apparent that civilisation needed organisation and that this age of machinery and this untouched country offered extraordinary facilities for experimental legislation along democratic lines. The correction of the disparity between production and distribution, between available employment and available labour, the ideal of regular work and utilised leisure appealed to the enlightened as attainable objectives.

In 1893 financial disaster swallowed up dissension in a universal distress: in April there was an orgy of bank closings, the greatest flood in Brisbane's history marked the same year, and on 9th May a relief scheme was introduced by which one week's rations might be won by one day's work. Between July and December a further shearers' strike—one of the disastrous series of the 'nineties—was fomented, which resulted eventually in the passing of a most drastic Peace Preservation Act, with extraordinary powers and penalties, carried amidst scenes unparalleled in Parliament up to that time.

Thirty years have passed, and to-day the opposing parties, almost unrecognisable as the direct descendents of their prototypes, gaze somewhat blankly at each other across a waste of economic panaceas, realising, perhaps, as Goethe says—

> "How difficult it is to get men to balance present sacrifice with a future advantage . . . . to get advice listened to, especially by the many, who are sensible enough in matters from day to day, but can seldom see beyond the morrow, and if it come to a point where in some general arrangement one will gain and another will lose, they find it impossible to strike a balance."

But again this discursive summary of the environment in which our Society has lived its life tempts me to digress unpardonably.

To return to Queensland in 1884: there were three further causes, already mentioned, dear to the public heart—new States and local determination, the federation of all the States, and a growing Imperialism in respect of the Pacific.

The agitation for separation of the Central and Northern provinces of Queensland was one resisted by the South of Queensland with the same violence and very much the same arguments as had caused such indignation in Brisbane when advanced in New South Wales prior to 1859 against the separation of Queensland from that State. Shrewd advantage was taken of the local jealousies of individual coastal towns and of the lack of knowledge of political manœuvring displayed by the exponents of Separation. In 1890, with better organisation, projects for the separation of Central and Northern Queensland actually reached Parliament.

Sir Samuel Griffith advanced a Decentralisation Scheme to solve all difficulties, but it was defeated by the House because of the powers which it proposed to confer upon provincial parliaments. On 23rd June, 1892, he presented again his Provincial Separation Scheme, for three autonomous provinces with a central government. The scheme was lost by an amendment which insisted upon two provinces only—a North and a South—and this compromise being unsatisfactory to all, local jealousies were easily worked upon to defeat the whole scheme, which was thrown out by the Upper House. A further attempt to obtain Central Separation was negatived in 1893, and the scheme lost standing, save for an occasional murmur of revival.

Federation was helped by several factors of which some were at the outset accidental.

On 23rd October, 1884, the establishment of a Protectorate over British New Guinea (now the Territory of Papua) which was soon to ripen into annexation signalised the inglorious termination of the bold venture of McIlwraith, who had annexed the whole of Eastern New Guinea in 1883 only to have his action disavowed by Great Britain. It is common to assume that England was entirely at fault in this venture, but, as Ernest Scott points out, the blame was at least partly Australian.

Prévost-Paradol, a French author who wrote on the French colonies, predicted in 1868 that—

> "Some day a new Monroe Doctrine would prevent old Europe, in the name of the united states of Australia, from setting foot upon a single isle of the Pacific."

But though a colonial convention meeting in Sydney in 1883 did enter its protest against any foreign power being permitted to acquire fresh territory in the Pacific south of the Equator, and though at various times the separate States advocated the annexation of Melanesia and of Polynesia in a sweeping resolution or so, the future interest of Australia in the three great strings of islands powdered over the seas parallel to her eastern coast was lost in a mass of local interests, most trivial but more immediate.

Theoretically the coast of Eastern Papua was British from 1793, when two merchant adventurers of the East India Company annexed it; or from 1846, when Lieutenant Yule, in H.M.S. "Bramble," hoisted the Union Jack; or from 1873, when Captain Moresby, in H.M.S. "Basilisk" took possession pending the decision of the British Government. Had there been a clear intimation of Australia's desire to acquire the land at that juncture there was nothing to prevent our obtaining the whole of the area not occupied by the Dutch, but some of the colonies were lukewarm, others feared the cost, and even Queensland was so little apprehensive that Governor Cairns was able to write—

> "But little interest is taken as yet in the destiny of New Guinea by either the Ministry or the outside public of the colony."

In 1876 gold was discovered in Papua, and in 1877 a Government office established to protect British interest—in Fiji! Queensland's representations fell on deaf or indifferent ears, and McIlwraith's *coup d'état* of 4th April, 1893, was promptly disavowed.

When, under the persistent pressure of the whole of the Australian Colonies, the British Cabinet had decided on annexation, a conference was called by Bismarck, and the British vessel that was to make the annexation was temporarily held up, but while the conference was actually in progress a German vessel was speeding to plant her flag along the north-east coast and archipelago. It was not until September, 1914, that Australia was to win back by force of arms and by the first Australian blood shed in the Great War the territory that was hers by exploration, exploitation, and natural propinquity. To-day she holds under mandate in the Territory of New Guinea and as a possession in the Territory of Papua the two areas which together McIlwraith boldly claimed in 1883. Though his action was disavowed there is no doubt that it had been potent for good. It put Australia on the international map. It resulted in France being warned off the New Hebrides (which she purposed to annex) and produced so general a development of indignant Australian national feeling that the federation of the colonies assumed an aspect of popular urgency.

Parkes's suggestion for the creation of a Federal Council was put into concrete shape by Griffith, and a Bill authorising the establishment of such a Council was passed by the Imperial Parliament in 1885. It gave power to the six Australian Colonies and also to New Zealand and Fiji to pass Acts enabling the colonies to send two representatives each to a Federal Council. Fiji sent her representatives to the first meeting in 1886, but not subsequently. New Zealand never participated, and the defection of New South Wales shortly afterwards ruined the scheme.

Parkes reopened the Federal question in 1889, and in 1890 succeeded in bringing together a conference of Ministers to consider means of preparing a Constitution. This resulted in the holding of the first Australasian Federal Convention in Sydney in 1891, which prepared the first draft Constitution but failed to impress itself upon the people of the various colonies and seems to have resulted in failure. Popular leagues were formed to advance the common cause and a conference of these bodies held at Corowa in 1895. From the initiation of this scheme, in 1893, the Federal movement marched to irresistible victory. The Convention held three sessions on the draft of the 1891 model, and was finally successful in winning an Australian-wide approval and an Imperial sanction that became operative on New Year's Day, 1901.

I have deliberately emphasised the march of local and general events rather than the progress of scientific achievement or its application in order to show how definitely that epoch was one of transition—of discarded beliefs and relationships and of new individuality and experiment.

The medical picture was no less arresting, no less heartening in the wealth of its discoveries, no less puzzling in the uncertainty of its ultimate problems. The imperialistic progress of our culture was tremendously assisted by the new study of bacteriology and by the newer branch of tropical medicine and hygiene. In 1872 Lewis, in India, discovered that the microfilaria lived normally in the blood of persons infected with filariasis and the fever that accompanied it, and, in 1876-7, Dr. Bancroft, the second President of our Society, discovered the mature filaria associated with his name. In 1873 Obermeier saw first the spirochæte that is the essential cause of relapsing fever, and, in 1874, Hansen demonstrated the bacillus of leprosy. In 1878 Manson, the "Father of Tropical Medicine," effected a revolution in medical thought by demonstrating that a mosquito—an insect—was the indispensable vector that conveyed filariasis from man to man, and thus for the first time introduced into medical and scientific thought the enormous range of possibilities associated with that discovery.

> "From 1880 to 1894 there were determined among other things the causative organisms of suppuration, typhoid fever (1880), malaria (1880), glanders (1882), tuberculosis (1882), cholera (1883), diphtheria (1883-4), tetanus (1884), undulant (Malta) fever (1887), cerebro-spinal meningitis (1887), and plague (1894); and man, running hotfoot in the sudden consciousness of victory, soon discovered how to outwit Nature by protective inoculation against anthrax, tetanus, hydrophobia, cholera, diphtheria, and typhoid.
>
> "Three years later (1897) Shiga and Kruse had detected the germ cause of bacillary dysentery, and Tictin had found that relapsing fever was conveyed by the bed bug, the louse and the tick being incriminated also later. But in that year (1897-8) Ronald Ross, on Manson's advice and with his encouragement, finally demonstrated the rôle of the mosquito in the transmission of malaria, and for the first time laid down the measures that would ultimately vanquish that 'principal and gigantic ally of barbarism.' "

But Queensland was fortunate indeed. The year of the foundation of our Society saw one of the last of the epidemics of Asiatic cholera sweep across Asia and Southern Europe, to revive in 1892-4, and to produce a few sporadic outbreaks in Russia in 1905 and 1908-10. In all Australia, where the results might have been so disastrous, the slow transport of those days and our consequent isolation saved us from any threat but that visit of the "Dorunda" in 1884, to which reference has already been made. Malaria, which had rendered uninhabitable many of the richest parts of the East, was introduced to these shores only a few years before its cause was discovered, and only became of importance when the means for its prevention were already recognised. Smallpox, the dysenteries, plague, and other destructive diseases had found no permanent footing in this virgin continent, and the tide of colonisation that crept through Queensland met only difficulties incidental to its ignorance of the new climate and to the faulty living conditions to which its people clung (and cling).

It is true that while the country had been flooded with kanaka and Chinese labour these, as usual, had brought with them the diseases incidental to the low economic standards of life and the high disease incidence in their countries of origin—leprosy, dysentery, hookworm, malaria, filaria, and so forth—and some remained endemic.

And Brisbane, itself, was remarkable for the low state of its sanitation which, in the heyday of immigration and mining, was chaotic. The drains and earth closets were shamefully neglected, and were a source of continual nuisance and indignant agitation. The Brisbane City Council of that day, in spite of huge piles of rubbish and filth that, it is said, smelled to high heaven outside the very windows of the Council chamber, announced that their inspectors had failed to find evidence of any nuisance and that they, themselves, were quite satisfied with the provision made for the health of the community.

Immigrant vessels, such as the "Berwick Law," were continually arriving grossly infected with typhoid and typhus, and quarantine was almost a routine matter in some degree. Typhoid became exceedingly rampant throughout the country, and many of the antiquated doctors of the day struggled hard against the suggestion that the disease was due to germs. In fact, the evidence on that head given before a Royal Commission is a matter of the utmost astonishment to a reader of to-day. It need scarcely be added that the standard of the medical profession was extremely low. The scrutiny of degrees and credentials was perfunctory, though from 1884, the year of the founding of the Medical School at the Sydney University, popular agitation for the examination of qualifications and legislation for the exclusion of fraudulent degrees and the regulation of quackery were more favourably regarded. Bancroft had advocated a University in 1885 in his Presidential Address, and 1910 saw its partial achievement, but much yet remains to be done.

The medical problems of Queensland were large and vague, like the great plains of the State. Except in a few instances they still remain incompletely defined, incompletely examined, and incompletely controlled. Perhaps there is no handicap so greatly felt and regretted in this respect as the absence of a medical school—the absence of any peg on which to base medical knowledge and research—to act as a continual source of inspiration to graduates of its own and as a stepmother to the graduates from other States to whom we are content to-day to entrust our health.

Hookworm, leprosy, filariasis, sporadic malaria in the Far North, undifferentiated coastal fevers (including at least five and probably seven separate entities), aboriginal diseases, the trachoma of the edge of outback, the chronic nephritis of young people in Brisbane, and the food deficiencies that hamper the West, the North, and half Brisbane itself are more than incidentals—some of them are strategic posts held against white survival. Of hookworm we need not speak, malaria is a latent problem, filariasis a widespread but relatively unimportant coastal relic of the South Sea Islanders, but food deficiency is fundamental.

I have no personal doubt, and some actual evidence, that a food factor affects the incidence of trachoma here, as it affects eye diseases in the Pacific, and that it is disguised behind many a diagnosis of "mild lead-poisoning" in this very city, apart from all the ravages of actual dietetic insufficiency in quality and quantity in the West and North.

When, fifty years ago, scientists began to capture and identify, one by one, the germ-causes of diesases, it seemed that it would be but a few years before each was determined, an anti-serum prepared for every one, and mankind freed from the menace of disease for ever. Just in the same way, as Professor Parnell pointed out in his Presidential Address of 1929, it seemed in 1881, when J. J. Thomson proved theoretically that a moving charged particle possesses additional kinetic energy and therefore additional mass by virtue of its electric charge, that it was but a step to the assumption that all mass was electrical in origin. But Lorentz's subsequent experiments, and then those of Einstein, to the astonishment of those who looked already for an ever-increasing simplification that would explain the more complex in terms of the less, actually revolutionised the foundations of classical physics.

> "Mass lost its essential character of constancy and matter ceased to be a fundamental entity, time and space could no longer be regarded as having independent existence, and our three-dimensional space, with time as an independent variable, was replaced by a four-dimensional world . . . . in which only the highly expert mathematician can find his way."

So it was also in the speculative and experimental realm of medicine. Into what had appeared the clear-cut field of bacteriology came every element of confusion and modification, from individual immunisation or susceptibility to the new studies of endocrinology, dietetics, and mental hygiene; time and space factors, variable virulence and cyclic epidemicity; virus diseases, bacteriophages, and many another.

In 1925, in New Guinea, we found that cod-liver oil doubled the healing rate of the tropical ulcer (the commonest of sores when food-stocks are low in quantity or quality), and that eye diseases on the north coast of New Britain that often went on to blindness yielded at once to the same treatment. Madmen running amok were controlled, not by violence, but by quinine, a dozen apparently separate crippling disorders responded to intravenous injection of organic arsenic, and mass treatment for hookworm halved the death-rate for pneumonia.

Again, to quote Parnell, "the loss of the illusion of definiteness and reality results in a wider and clearer vision"—at any rate where the vision is trained to observation.

The lead problem of Brisbane is an intriguing example. In the early days of this Society plumbism was observed by one of our oldest members, Dr. Jefferis Turner, and it began to assume almost epidemic proportions. Twenty years later Dr. Hopkins suggested, and Dr. Lockhart Gibson, as a result of experiment, decided that white lead paint was the most easily accessible source of the poison.

Immediately prior to the detection of the earliest cases there was a wide increase in the reticulation and distribution of the potentially plumbi-solvent water of Enoggera and the newly-opened (1885) Gold Creek Reservoir. In 1916 the hard water of the River Stanley increasingly hardened the soft water of the other reservoirs and diminished their plumbi-solvency, and in 1921-22, following the appointment and special activities of a trained water-chemist, lead-poisoning almost disappeared. More and more of the diminishing cases became those demonstrating papillœdema—usually the result of massive dosage with lead.

In 1930, in response to a claim that 150 young persons per year were dying as a result of lead-poisoning, an investigation was instituted, and from that year to March, 1932, not one new case of frank plumbism with paralysis came to observation, though there was no apparent change in respect of the accessibility of desiccated lead paint, and 80 per cent. of Brisbane houses still showed 35 to 55 per cent. of white lead on their outside walls—the stories of sellers of "non-poisonous" paint to the contrary notwithstanding. It had been postulated and accepted that the lead was conveyed to the mouth by nail-biting and thumb-sucking, but investigation showed that at least 13 per cent. of school children (and of hospital out-patient children 20 per cent.) were nail-biters—without any sign of plumbism—and that there was no lodgment for lead under a nail bitten, as these were, to the quick.

It is not asserted that there were no cases where lead paint was the cause—quite the contrary, there were many histories where it could not have been anything else—but a further review rendered a picture much more complex.

There were two types of cases: one series where lead ingested over a long period in minute doses had produced a slow poisoning in cases where there was a familial kidney defect, familial syphilis, or where the violence of the toxin of scarlet fever, measles, or diphtheria had produced antecedent vascular damage. These cases appeared to diminish in rough approximation to the diminution of plumbi-solvent water. But there were cases of a second series which were related to a calcium deficiency in the diet (which, indeed, may have been a factor in the first also, but evidence was insufficient).

Pregnant women sometimes demand chalk, or plaster, or hair, or bite their nails to the quick, and hens eat their feathers because they lack calcium. In Brisbane a considerable series of investigations into the dietaries of out-patient children indicated a marked lack of calcium owing to the restricted use of milk and the non-availability of greens in cities like Brisbane and other industrialised towns. (Spinach, for example, is unobtainable, lettuce and other salad greens are poor and little used, cabbages and tomatoes, the only greens available with any degree of frequency have their own dangers because of the lead arsenate used to protect them from leaf-eating pests.)

In the experience of my wife and myself a correspondingly high degree of calcium deficiency is found among children here. It begins when they cease breast-feeding, and is definite from the age of 1½ to 3 years and onwards. This is certainly the age, as lead protagonists have pointed out, when the children are "kept on verandahs," and "cling to the painted railings." It is also the age when they pick with avidity at plaster and paint (both lead paint and "non-poisonous" paint) to supply their deficiency. Doubtless, like the "crib-biters" of the United States of America, one here and there gets frank plumbism in this way, if his enthusiasm is equal to it, and these, perhaps, include, as mentioned above, the "eye-cases" (papillœdema, &c.) so often described by Dr. Lockhart Gibson as following massive doses of lead. Several such are recorded by me from previous clinical notes.

In my interim report I wrote that in an environment where all, if any, must ingest minute doses of lead, there must be some selective factor of damage to account for those cases in the community which demonstrated frank symptoms of plumbism, and I proposed, as above, that this was damage resulting from hereditary familial tendency (30 per cent.), the exanthemata, congenital syphilis, or other depressive factor. I pointed out also that the vast majority of cases diagnosed here as "mild lead poisoning"—the only ones now available for investigation—might, from general appearances, be anything from malnutrition and vitamin deficiency or intestinal worms to chronic sepsis of the teeth, sinuses, or tonsils.

Many diagnoses of "mild lead-poisoning" are made in Brisbane on no better justification than pallor and nail-biting. These suspects are usually pale and listless, irritable and fretful. Their mothers complain that they always want to "lie about" instead of playing like other children, and wake languid and maybe complaining of a "stomache-ache." They have no appetite at meal times, and almost invariably refuse milk and vegetables particularly. The mother complains that they have no definite symptoms, but are "going back," are thin and pale, and are not gaining weight. Restlessness and night terrors are also recorded. Though these cases of so-called "mild lead-poisoning" have been the object of infinite guesswork and of stock treatment, it does not appear that they have ever been adequately investigated.

Our further investigations extend the proposed selective factor above to include calcium deficiency. In a community where all, if any, are subject to the ingestion of lead, the great majority undoubtedly deal satisfactorily with the toxic intake, eliminating the great proportion and storing the remainder in the bones in combination with calcium. Where there is a calcium deficiency in the diet our investigations tend to support the hypothesis that lead is not bound but circulates freely in the blood stream in the way which has been recognised to be the ideal way for its full toxic effect to be manifested upon the intima of the vessels and the organs, particularly the kidneys.

Amongst a large number of children whose diet is definitely deficient in calcium, then, it is not perhaps surprising to find on rare occasions *one whose lead-binding capacity is unequal to the strain* either of prolonged mild lead intoxication or of the sudden precipitation into the blood stream by an attack of one of the acute exanthemata of lead formerly stored in the bones. In the investigations to which I allude there is already apparent support for such a suggestion the bearing of which upon selectivity will be obvious.

The original source of the lead, whether in water or elsewhere, is still to seek, and the search is an interesting problem with many and complex angles, not the least of which is the fact that the pH of present-day water supplies is useless as a criterion of the utterly different water distributed forty, thirty, and twenty years ago, when plumbism with paralysis was an outstanding problem in Brisbane. On the face of it, it would appear that the source is simply desiccated white lead; the further one goes into the matter the more likely appears the involvement of a calcium factor related to food deficiencies.

Though frank plumbism seems to have disappeared except as an occasional result of the uncommon but well-recognised habit of pica, the calcium deficiency so often associated with the latter directs attention to the general problem of other dietetic deficiencies both widespread and serious.

Some months ago, during an investigation of the health of aboriginals in Queensland, attention was directed to the teeth for a similar reason. Perhaps the most outstanding characteristic of the aboriginal a generation ago was the perfection of his teeth—a constant source of admiration to those who frequent museums. Of the aboriginals I examined recently (more than 1,000 in number), a good set in an adult was a matter for comment! For the ages below 20—that is, the ages up to the cutting of all the teeth of the second dentition—the percentage was approximately 90 per cent. From 21 to 30 years of age, when women are subjected to the main strain of child-bearing and when inherent disabilities take their toll of both sexes, the percentage of "good" teeth drops to 39 per cent., the percentage of sets only "fair" rises to 22 per cent., definitely "poor" teeth form 28 per cent. of the total, and "bad" or "foul" conditions make a definite appearance. With each decade conditions became worse until, over the age of 50, no single good set was found, the teeth were only "fair" in one case in eight, were definitely "poor" in one out of eight also, and were foul, bad, broken down, or entirely lost in 75 per cent. The aboriginal has left his diet of native foodstuffs, both animal and vegetable, to live upon a diet of flour (dry damper), sugar, and tea. His teeth evidence it. But not his alone. There is equal evidence of equal lack of food balance among the white settlers throughout the whole of the Far North and the Far West. The circumstances incidental to isolation, difficulties and cost of transport and communication, the stereotyped list of supplies imported, and the absence of any local attempts at kitchen gardens, adequate milk supplies, &c., produce among white residents a definite series of food deficiencies detrimental to their survival.

At one railhead the standard of highest courtesy in meals was expressed by my warm-hearted host in terms of salt beef, one English potato (soft and blue-middled), a plate of tinned fruit, and water custard, with tea (drunk black by all but myself) with powdered milk. Everyone, I was interested to see, took lots of sugar—that ready but deceptive source of energy. The weekly train, which all were waiting for and assisted to unload, deposited a typical cargo, consisting of benzine in large quantities, two lots of English potatoes, two crates of Japanese onions, two cases of Edam cheeses, a series of cases of Melbourne bitter ale, two small kegs of rum, one half-case of tinned milk, many bags of flour, one case of soap, and some tobacco.

Goats are plentiful, but little use is made of the milk, and they go dry between times for lack of care and of fodder. Greens grow magnificently for four months of the year, but people forget to plant them, and get to do without them in any case. The younger generation grows up unacquainted with the essentials of diet, with the capabilities of the soil, or with the desire for the foods essential to the best development. In some areas it presents almost a laboratory series of food-deficiencies, with consequential breakdown and ineffectiveness.

So, in this age of every refinement of progress, when man surveys the world for further fields to conquer, we find him the unconscious victim here and there on our frontiers—and even in our cities—of the oldest and simplest of forces—insufficiency of vital food. The teaching of dietetics in schools—dietetics adapted to our own climate and conditions—would be a most valuable contribution to the conquest of climate if our teachers and our doctors would learn the subject and impart it.

But I must close. The half-century of our Society has seen a tremendous growth of science and has seen its application in many ways to Queensland's problems. It has seen in each decade some progressive achievement, as railways and roads have crept over the country, with population spreading along them, man's domain ever widening with his appliances, from artesian water to aeroplane transport and medicine.

We have lived a half-century that has seen the partition of the earth and the seas, triumphs in physics, in chemistry, in engineering, in medicine, and in art; that has seen the collapse of thrones and of economic theories; has seen the rise of the motor engine, the motor-car, the submarine, the long-range gun, poison gas, the aeroplane, the radio and wireless telegraphy, television, and the conquest of the stratosphere; and with the inevitable urge of every transition period, Fascism, Sovietism, nudism, companionate marriage, and all the old cults that have been revived and paraded by serious neo-primitives to express what they feel must be their individuality, and the world's newly-discovered destiny—as they did, indeed, at the Renaissance, or after the Great Plague, or in the decline of the Roman Empire, or in the days of Pericles, or of the social revolution in ancient Egypt that only-forgotten Ipuwer records, or in any great period of ancient or modern growth and change.

How hoary Time must chuckle! Perhaps, if he is ever guilty of a Gallicism, he occasionally murmurs,

"*Plus cela change, plus c'est la meme chose!*"

The Life Cycle and Seasonal History of Ceroplastes Rubens.

By B. Blumberg, M.Sc.

(Plate I. and six Text Figures.)

(*Read before the Royal Society of Queensland, 30th April,* 1934.)

I. INTRODUTION.

Ceroplastes rubens Maskell was originally described from Australia. According to Froggatt (1921), it was probably introduced into this country from Ceylon and from there spread to Japan and the Hawaiian Islands. It is stated by Veitch (1929) to be a common citrus pest throughout coastal Queensland, causing injury both directly by sucking the sap and indirectly by promoting the growth of the sooty mould which hinders photosynthesis. By some this scale is ranked as possibly the most serious scale insect in Queensland. Its hosts are extremely numerous and include mango, custard apple, and most ornamental shrubs as well as citrus.

No work on the life cycle and seasonal history of *C. rubens* in Australia has been published, although a good deal of work on its biology appears to have been done by Japanese investigators. In view of this and its economic importance the investigation which forms the subject of this paper was undertaken at the suggestion of Mr. F. A. Perkins, Lecturer in Economic Biology in the University of Queensland, in partial fulfilment of the Honours requirements of the Faculty of Science.

II. LIFE CYCLE OF THE FEMALE.

(A) The First Instar. (Fig. 1.)

The larvæ of *Ceroplastes rubens* hatch beneath the parent, and sooner or later wander over the foliage of the host plant, settling ultimately on leaves or stems, preferably over a vein, with head superior, and commence to secrete wax. Only scales on more or less horizontal leaves show frequent exceptions to this orientation.

The larva, or first instar nymph, is orange-coloured, and approximately ·4 mm. long by ·23 mm. broad, with well-developed legs, antennæ, a pair of ocelli, and pro- and mesothoracic spiracles. Each anal operculum bears apically a filamentous seta, referred to here as an anal filament. The pygidium bears a single small seta on each side of the anal cleft, and the stigmatic spines comprise two short mushroom-shaped outer spines internal to which is placed a conical medial spine about twice as high as the others. (Fig. 3, A_1 and A_2.)

Two longitudinal dorsal scaly wax ridges and two pairs of white marginal points of wax adjacent to the stigmatic clefts appear within twenty-four hours of settling. Growth and subsequent fusion of the dorsal ridges results, in another twenty-four hours, in a prominence referred to here as the dorsal crest. A pair of posterior lateral marginal wax processes now appear midway between the caudal extremity and the mesothoracic spiracles, while a slight excrescence of white wax is discernible at the anterior extremity of the body. At the end of a week sufficient secretion of wax from the general body surface has occurred to impart a purple colour and to obscure the divisions between the tergites. By this time the white excrescence at the anterior extremity is seen to have formed four digitate processes similar to which there are now also two pairs of processes bordering the anal opercula.

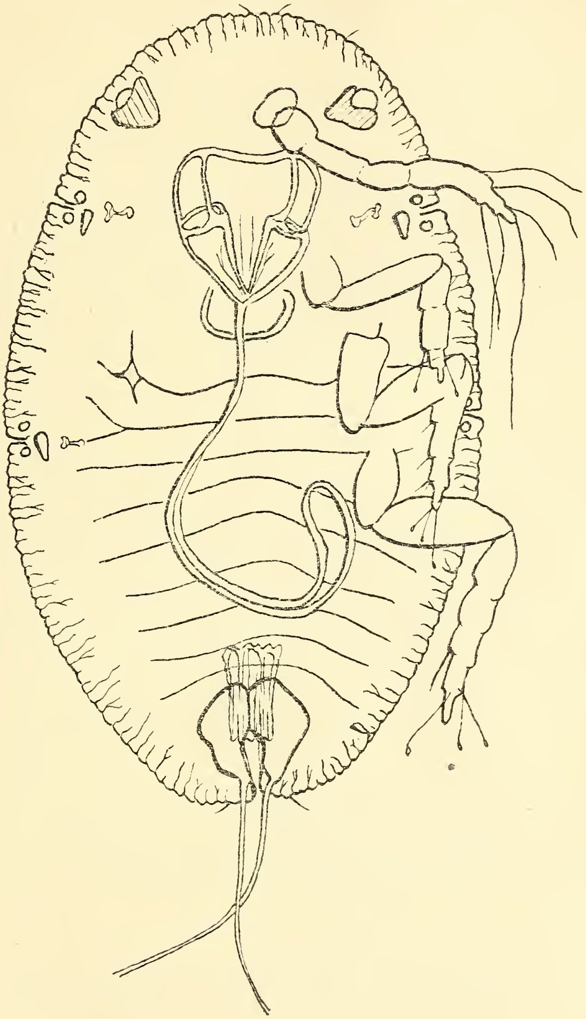

Fig. 1.—*Ceroplastes rubens.* First instar.

(B) The Second Instar Nymph. (Plate I. (*a*).)

Within a fortnight after settling the dorsum is markedly conical, purple, and ornamented with a pattern similar to wickerwork, and from it rises the dorsal crest, a truncated cone of white wax. Anterior, median, and posterior pairs of lateral marginal bluntly pointed white wax processes are evident. Except from the posterior pair there issues from these a small amount of powdery white wax. The anal filaments are present, but in about another week (approximately three weeks after settling) their loss marks the first ecdysis. A wisp of exuvium is extruded from the posterior end of the scale. Microscopic preparations of scales which have lost their anal filaments show that the number and pattern of the stigmatic spines are unaltered but that the opercula now bear two pairs of setæ in place of the anal filaments. (Fig. 3, B_1 and B_2.)

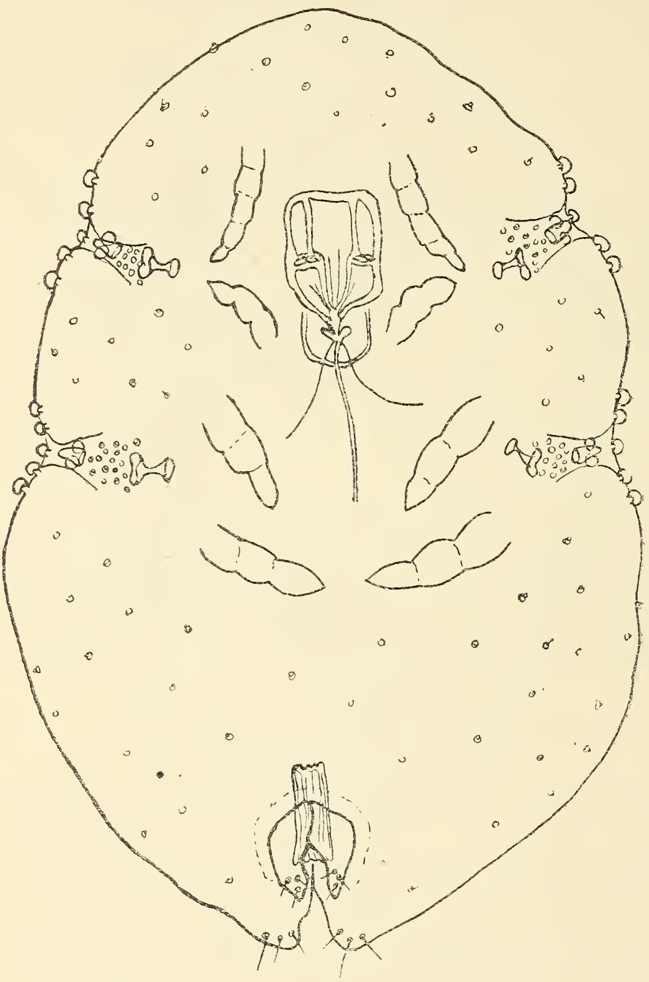

Fig. 2.—*Ceroplastes rubens.* Third instar.

(c) THE THIRD INSTAR NYMPH. (Fig. 2.)

Following the first ecdysis the accretion of wax on the dorsum results in the partial submergence of the anal opercula, dorsal crest, and anterior and median lateral marginal processes. The posterior processes, on the other hand, enlarge, and this condition, which becomes clearly evident within six weeks of settling, appears to coincide with the second ecdysis, marked by the extrusion of another exuvium.

Microscopic preparations of this stage show that the stigmatic spines have been increased in number by the development of either five or six mushroom-shaped additional spines on the outer margin of the stigmatic cleft. (Fig. 3, C_2.) Each operculum and each half of the pygidium bears three setæ. (Fig. 3, C_1.)

(D) The Fourth Instar. (Plate I. (*b*).)

The third ecdysis occurs ten or eleven weeks after settling. Externally there is no difference between young fourth instar and old third instar scales. The extent to which the anterior and median lateral marginal processes are submerged varies but is in both more or less complete. Even the posterior pair tend, in time, to become lost in the extending dorsum, although the extremities are nearly always discernible, even in the oldest scales. The digitate processes at either end also persist to a variable extent even in adult scales. The carapace, in the third and fourth instars, grows hat-shaped, forming a high, strongly convex central area of red wax (in the centre of which the vestigial dorsal crest is discernible) surrounded by a rim-like margin. Four convex protuberances on the margin each of which bears a prominent radially directed streak of powdery white wax extending downwards to the spiracles mark the site of the anterior and median lateral marginal processes. The posterior pair, although enlarged in the third instar are now almost submerged.

Microscopic preparations of the fourth instar show that the number and arrangement of the setæ on the anal opercula are unaltered, but each half of the pygidium bears five setæ instead of the previous three (Fig. 3, D_1), and the the stigmatic spines are increased in number. A common arrangement of these spines is to have seven or eight outer mushroom-shaped spines on either side of the cleft and one unpaired and two paired mushroom-shaped spines, together with a single larger conical spine in the cleft. (Fig. 3, D_2.) Totals of from eleven to nineteen per spiracle have been found. The numbers of pygidial spines on each side is also slightly variable, four, five, or six being found, while the number on each side of the cleft is not always alike. Five appears to be the usual number.

The size of the adult varies. Commonly it is from 3 to 4 mm. long, but occasionally stunted adults have been found between 2 and 3 mm. The third ecdysis, perhaps, occurs sooner than ten or eleven weeks after settling, but owing to a gap in the observations there is no earlier record.

(E) Reproduction.

The minute grape-like clusters of ovarioles found in the young adult undergo the usual development. Yolk makes its appearance, ultimately embryos appear and reach an advanced stage of development within the parent, both eyes and well-developed appendages being discernible. How long must elapse from the first appearance of yolk to the first sign of the embryo was not definitely ascertained, but from teasings made at intervals it would appear that in some cases a month is required. No doubt this period depends, at least in part, on such factors as temperature and humidity.

From Figures 4 and 5 it is seen that the period needed for the complete development of the embryo is considerably less for the spring-summer generation than for the winter-spring generation. In the

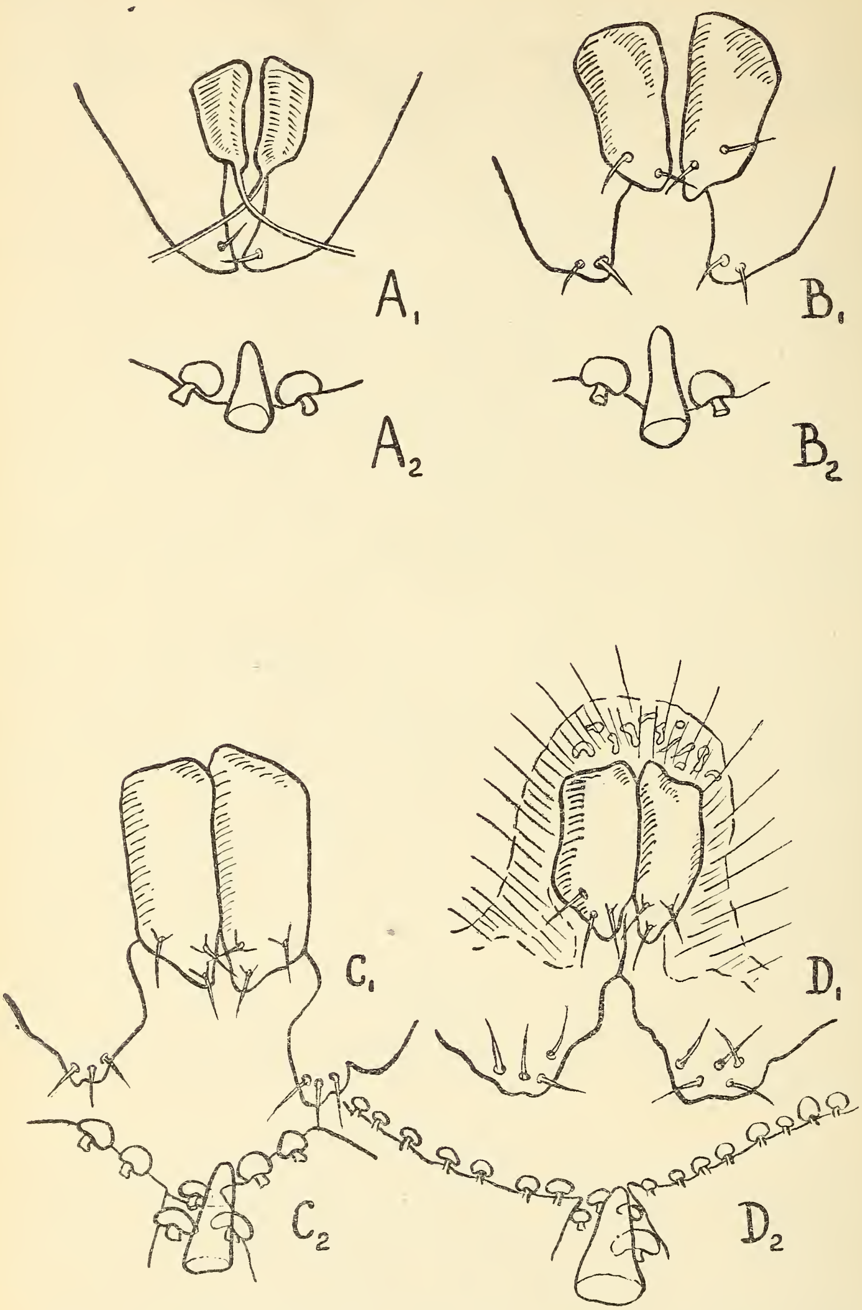

Fig. 3.—Pygidium and anal opercula in first instar (A_1), second instar (B_1), third instar (C_1), fourth instar (D_1). Stigmatic spines in first instar (A_2), second instar (B_2), third instar (C_2), fourth instar (D_2).

former case it is likely that this process occupies about a month, but data in support of this is incomplete. For the winter-spring generation, on the other hand, three months were found to elapse between the first record of yolk formation and the commencement of laying.

No specific investigation of the question of fertilization was carried out, but there is good reason to believe that in Queensland parthenogenesis is the rule. A few small, glassy scales which may have been males were found, but they were rare, and the contained insect was always dead. Fertilization is reported in Japan.

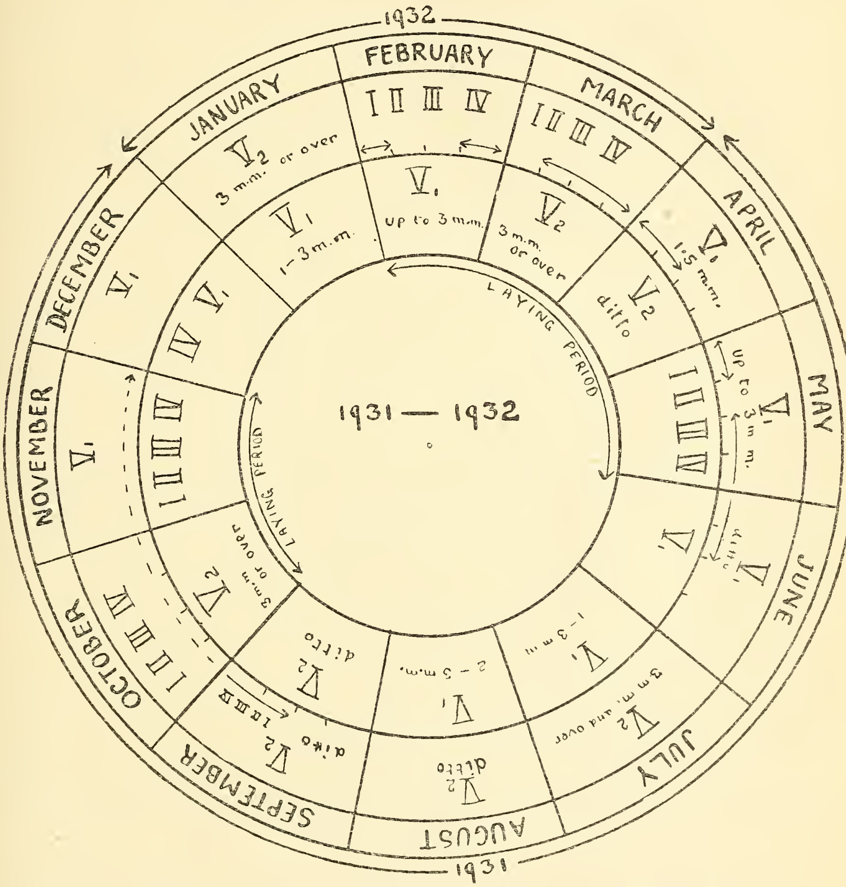

FIG. 4.—SEASONAL HISTORY DIAGRAM FOR 1931–32.

Roman numerals indicate stages represented during the month. Symbol ←→ indicates week or weeks during which larvæ were met with crawling freely on the host-plant.

Oviposition is an active process, as the movements made in expelling eggs from the vulva are plainly discernible in upturned scales. From 650 to 700 eggs were counted in gravid females by teasing on a squared slide. Whether this represents also the number of eggs actually laid was not ascertained. According to an unnamed Japanese author (Shizuoka Expt. Sta., 1918) 978 eggs were found to be laid in Japan.

The question of the number of eggs laid per day was never seriously taken up owing to the death of most of the insects under observation. Of three scales remaining, which had never previously laid, the figures for the first seven days of oviposition were as follows:—

Scale A.—3, 7, 9, 26, 30, 27, 50
Scale B.—6, 8, 15, 17, 35, 27, 45
Scale C.—9, 21, 28, 22, 33, 29, 50

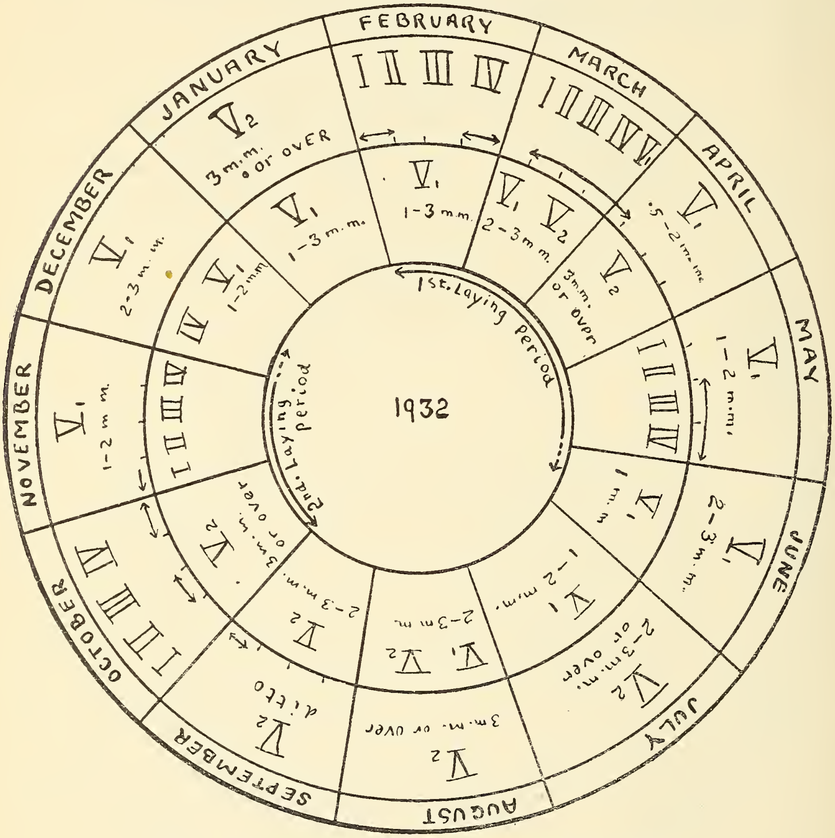

FIG. 5.—SEASONAL HISTORY DIAGRAM FOR 1932.
Symbols as in Fig. 4.

Seven scales of unknown age removed from the host plant laid, during the same twenty-four hours, 22, 27, 27, 15, 17, 30, 30 eggs, respectively. Obviously the only conclusion that can be drawn from such meagre data is that at least 50 eggs may be laid in twenty-four hours.

The period elapsing between laying and hatching is from two to three days. This, however, requires support from observations with a larger number of insects made at various times of the year. The newly-hatched larvæ do not emerge immediately from beneath the parent. The impression was gained that the crawlers emerge intermittently in bursts, depending, probably, on the external environmental conditions. The occurrence of laying scales packed with dead young, as well, perhaps, as eggs and living larvæ, was interpreted as due to unfavourable external conditions resulting in a fatally delayed emergence. As many as 250 such larvæ, most of which were dead, have been counted beneath a single scale.

Various suggestions have been made regarding the mechanism of emergence in other scales. It is probable, in this instance, that the larvæ make their way through openings between the carapace and the leaf.

(F) Duration of Life Cycle.

The duration of the life cycle varies with the season, the summer generation requiring from four to six months, whereas the winter generation need from six to eight. This conclusion is based on Figures 4 and 5, and is also supported by the following observations:—

1. Two seedlings (*Schinus terebinthifolius* and one unidentified) were received on 22nd October, 1931, bearing scales known, from previous observations, to be not less than seven and not more than thirty days old. On 7th February, 1932, young were found beneath these scales. The possible minimum life cycle would, therefore, be slightly over four months, while the possible maximum would be five months.

2. Larvæ were placed on a seedling of *S. terebinthifolius* on 3rd March, 1932; larvæ were found beneath the few scales which matured on 11th November, 1932. On this basis the life cycle had occupied thirty-one weeks, or about eight months.

(G) Technique.

At the commencement of the investigation an attempt was made to study the life history by marking about 100 newly-settled scales on a mango tree by means of scratches in the cuticle. This method proved unsatisfactory on account of its unwieldiness and because of the high mortality which rapidly caused the disappearance of almost all the scales under observation.

Transferences of crawlers to potted seedlings in the insectarium were more successful. *Schinus terebinthifolius*, *Ficus benjamina*, *Brassaia actinophylla*, and *Eugenia uniflora* were used, but scales established themselves only on the first three and completed development only on *Schinus*. As the larvæ used were obtained from *Schinus* plants this unsatisfactory establishment on the other seedlings, all of which are common hosts, may, perhaps, be ascribed to the difficulty of adaptation often encountered when a change of host is first attempted.[1]

The method of transference was to place a number of scales containing living young in small paper cones which were then pinned to the seedlings, the cone being removed in twenty-four hours. This ensured no scattering of eggs or adults, and made certain that only larvæ sound enough to crawl out would be used.

Regular observations were carried out on the scales *in situ*, either with a fourteen-diameter hand lens or with a microscope.

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[1] *Vide* case of *Eulecanium persicæ* transferred from peach to *Robinia*, quoted by Imms (1931b).

Scales were removed periodically from the seedlings and mounted for microscopic examination. Owing to the small number of scales remaining alive, not as many of these were made as could have been desired. The method of preparation followed MacGillivray (1921), while Werner's method (1931) of dealing with small stages on slides in petri dishes was found useful. For rapid examination of stigmatic spines or setæ immersion of small specimens directly in turps-phenol for half an hour was used with good results. Addition of a little benzol aided the solution of the wax.

III. SEASONAL HISTORY. (Figs. 4 and 5.)

The seasonal history as described below is based on evidence derived from—

(1) Regular weekly or fortnightly records of the composition of the scale population on an umbrella tree, a lemon tree, and a mango tree. The first two were mainly used.

(2) Regular fortnightly teasings and microscopic examination of the contents of the bodies of representatives of the various classes of scales on the tree. Occasionally the examinations were made at longer intervals.

(3) Observation of scales of similar ages marked with a scratch in the cuticle of the leaf.

(4) The rearing on seedlings in the insectarium of scales belonging to each of the two laying seasons.

It will be noticed that certain arbitrary reference numbers (I., II., III., IV., V.) have been applied to various stages in the development of *Ceroplastes rubens*. These numbers have no direct biological significance as there is no readily definable difference in the external appearance of successive instars and the external characters to which they relate may in some cases be found in the same instar, or a particular number may refer to scales with a certain external structure shared by more than one instar. This notation was adopted in order to facilitate reference in field notes to the various classes of scales on the tree at any time, as it would manifestly have been impossible to tell from external appearances, or even from a few microscopic preparations, in which instar the mass of any particular group of externally similar scales might have been. Furthermore, this notation enabled progress to be made with seasonal history observations at a stage in the investigation when the number and form of the various instars were not known. The stages to which these numbers refer are as follows:—

I.—The active larva found on the leaf before settling or secretion of wax (first instar).

II.—Two central dorsal white wax ridges and anterior and median lateral marginal white wax excrescences opposite the stigmata (first instar).

III.—Dorsal ridges fused into a single white dorsal crest; an additional pair of lateral marginal processes: *viz.*, a posterior pair; colour light reddish-brown like Stage II. (first instar).

IV.—The six marginal wax points are now distinct processes; dorsum conical; colour deep purple; digitate processes at cephalic and caudal extremities; size under 1 mm., and anal filaments present or absent (first and second instars).

V.—Accretion of wax on dorsum till only extremity of dorsal crest protrudes; submergence of anterior and median pairs of lateral marginal processes till only their four radiating lines of white wax remain; initial growth and ultimate submergence of posterior pair of lateral marginal processes. Colour is at first purple, later changes to pink, and finally takes on a bluish tinge when laying. Size varies with growth from under 1 mm. to as much as 4 mm. Anal filaments absent (third and fourth instars).

In the seasonal history diagrams scales in which the ovarioles are immature and those commencing to form eggs are distingiushed, respectively, as Stages V_1. and V_2.

In order to avoid confusion the account which follows considers only the begining and the end of each laying season. The larvæ which are the first to settle will be expected to produce the first laying adults in the following season, and similarly the last larvæ to settle should mature last. Obviously the larvæ settling in the intervening period will probably mature some time between the commencement and ending of the next laying season. It is not suggested that the scales will always mature in exactly the order in which they hatched or settled, because in all probability physiological factors and weather conditions cause some younger scales either to mature before or at the same time as older ones, or perhaps may even tend to synchronise the time of maturity of younger and older individuals in much the same way as happens with *Thrips imaginis* (Evans, 1932); but it is unlikely that this is of sufficient importance to invalidate the use here of the principle that over a laying period of a couple of months, the scales laying in, say, the first fortnight are in general older than those laying in the last.

The figures given in the diagrams, relating to the range in size of any group of scales, are not intended to be taken as accurate limits; they are given here merely as a broad indication of the difference in size of the majority of the members of one line from those of another.

In January, 1932, apart from young scales which were almost certainly dead, two classes could be separated, both in Stage V. One of these (V_2.) ranged from 2 to 3 mm. in length, and contained ovarian eggs which, to a greater or less extent had embryos. The other group (V_1.) averaged 1 to 2 mm., and contained only small ovarioles showing no tendency towards egg formation. Those in Stage V_2. had hatched in September or October, 1931; the others had settled, probably, in November, 1931. For clarity the subsequent history of these two classes of scales will be considered separately and are represented in Figures 4 and 5 in different concentric areas.

The older group were, in January, obviously approaching their laying season which began in the middle of February to a slight extent, but the larvæ disappeared at the end of the month, reappearing on about 10th March and ceasing once more early in April. Throughout this laying season the newly settled progeny were to be seen in stages I., II., III., IV., and V_1., and approximately two months after the cessation of laying all the scales of the new generation would be in Stage V_1. During February, March, and April all of the first four stages were met with. By May all these members of the recently settled generation were in Stages IV. and V., and in June all had entered Stage V. In July the ovarioles of those which had been among the earliest hatched became pear-shaped while germarium and vitellarium soon became evident. Throughout July, August, and September the older scales steadily developed eggs in which, in due course, embryos appeared. Laying commenced at the end of September, the earliest record of larvæ on the leaves being made on the umbrella tree on 29th September. Two bursts of emergence were recorded in October, one in the second week and another in the last There followed a gap in the observations for November. It appears, however, from seedlings in the insectarium that early in the month some larvæ were produced by members of the line which was laying in October. The progeny of the October and early November laying could be identified in December with Stage V_1., scales ranging from 2 to 3 mm. in length. It could be predicted that these scales would mature and commence laying in February and March, 1933.

So far the older group of scales met with in January, 1932, has been described. The younger group found in January probably settled in September or October, 1931, and were in Stage V_1., having only immature ovarioles. Except for growth in size these scales remained the same in February, but in March their ovarioles commenced to mature. In April they contained eggs with embryos, and in May laying commenced, occupying the latter half of the month. It will be noticed in Figure 5 that the bracket indicating the February-May laying season is extended by a dotted line in June. This is intended to represent the fact that a slight emergence of larvæ occurred in that month; but the extent of emergence varied considerably on different species of plants. In general the resultant progeny were few and the impression was gained that this emergence was of little importance. The larvæ which settled in May continued to develop, being found in Stage V_1. during June and July. So close was the intergradation of size and degree of development during August that it was difficult to decide where one group began and the other ended. It is probable that the line under discussion was represented by both stages V_1. and V_2., the latter appearing during the latter half of the month. During September eggs in varying degrees of development occurred with the production of embryos in October and larvæ during November. Owing to the termination of the investigation records for December and late January are absent, but from an examination of the umbrella tree at the time of writing (January, 1933) it appears that some laying has occurred in December, indicated by the dotted extension of the bracket.

As a standardised method of observation was not evolved till late in 1931, while the time available for studying *C. rubens* was strictly limited, records for the earlier part of 1931 are somewhat incomplete; but the notes which were made are completely in keeping with the observations made in 1932, as will be seen from Figure 4. The only notable difference was the commencement of hatching in September in 1931, about two weeks earlier than in 1932.

Generalising from these two years' results it may be said that, at least for the umbrella, lemon, and mango trees in or near Brisbane, there are two laying periods during the year. The first begins at the end of January and lasts for four or five months, ending in May or June; the second period commences late in September, and lasts from two to two and a-half months, ending in November or December (probably in November). Larvæ do not emerge continuously throughout these periods, but appear to do so in bursts or waves during which the moving larvæ are extremely numerous. Following this comes a lull. At such times, although living larvæ may be found plentifully beneath the parents, little or no attempt is made to leave the shelter of the maternal carapace.

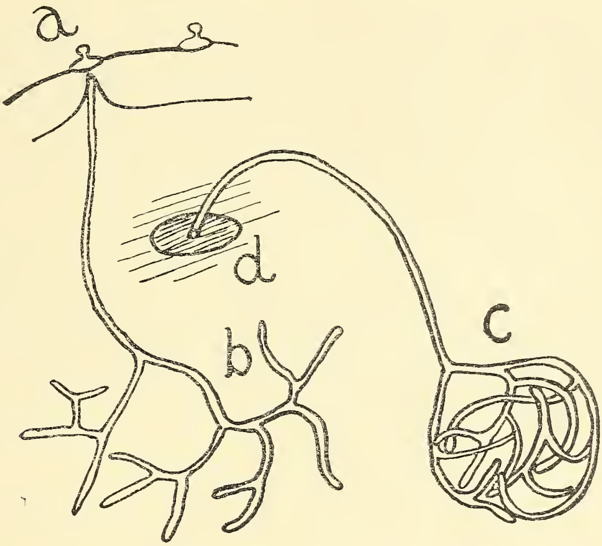


FIG. 6. The Wax Glands.

a. Stud-like wax-secreting pore.
b. Disentangled wax-secreting gland.
c. Common appearance of glands.
d. Usual view of the excavated cuticle beneath the wax-secreting pore.

IV. MISCELLANEOUS OBSERVATIONS.

(A) STARVATION.

The question how long scales may live without food is of practical importance because of the possibility of reinfestation of cleaned trees from fallen twigs or leaves. From the few experiments carried out it was found that newly hatched larvæ did not live longer than four or five days without food, while in one instance adult scales successfully produced young at the end of from forty to forty-six days' starvation. No attempt was made to determine what the maximum period might be.

(B) MORTALITY.

As mentioned in the section dealing with life history technique the observation of marked scales on the host plant is made difficult by the gradual disappearance of the scales under observation. The reason for this is obscure. If the scales die they would soon fall from the leaf, and perhaps this is the explanation, as even on sheltered insectarium seedlings, where mechanical influences such as wind and rain were excluded, the number disappearing was still high.

Two counts of about three hundred marked scales on an umbrella tree showed that the mortality in a state of nature on a favourite host plant was very high, 62 per cent. of the scales under a month old having disappeared or died in the course of less than three weeks. It was found that for some individual leaves the percentage of dead and missing scales was remarkably high, reaching, in one instance, 79 per cent.

It is quite possible that if only dead or unhealthy scales fall from the leaves, and if the mortality is highest in the earlier stages, that after rising to a maximum this loss would show a decrease as development proceeds. H. G. Hubbard, in "Insects Affecting the Orange," (Dept. Agric., Washington, D.C.) states that very few of *Ceroplastes floridensis* ever reach maturity owing to the influence of natural enemies and other causes, and claims that among the latter is the inability of females as they become old and gravid to maintain their hold upon the host plant. While there is also a heavy mortality among *C. rubens* the greatest disappearance seems to occur among the earlier stages, such as, I., II., III., IV., and early Stage V., and perhaps affects dead or diseased scales chiefly. Although as the body becomes packed with eggs the pressure on the leaf might be increased, the upward contraction of the ventral body wall noticeable at this time would be expected to mitigate any possible ill effects.

(D) Parasites and Predators.

Although no special attention was paid to this question a certain amount of information was inevitably obtained, brief reference to which may be made.

Adult *Cryptolæmus montrouzieri* were frequently met with, but larvæ were much less common. Though both larvæ and adults were placed in tubes with small scales and crawlers they would only eat the latter. Other Coccinellids found were *Orcus chalybeus, Halyzia galbula,* and *Coccinella transversalis.* Whether these insects were really predators of *Ceroplastes rubens* was not ascertained, but a specimen of *Leis conformis* which laid eleven eggs in the tube containing it was observed to devour crawling larvæ and eggs placed with it.

Larvæ of the Noctuid moth *Catoblemma dubia* Butl. were found only on the lemon tree, where they frequently destroyed very many *C. rubens* scales. They did not, however, appear to effect any appreciable control. A larva collected on 24th February, 1932, gave rise to the imago on 30th March of the same year. The larvæ seemed to affect, for preference, scales on twigs and branches rather than those on the upper surface of the leaves.

The commonest Chalcid found was *Parœnasomyiia liszti n.n.,* which is a secondary parasite, always being found in the host enclosed in a "puparium" formed from the larval skin of the primary parasite. On only one occasion was it found in association with another species. The latter was *Æniasoidea varia* Gir., which is doubtless a primary parasite.

Mites were found in association with the scales on the umbrella tree, but no time could be spared to study them. It is most probable that they are scavengers feeding only on dead larvæ and other debris.

A single minute fly larva collected beneath one of the scales on the lemon tree was probably a Cecidomyiid.

(E) The Wax Glands.

Dendritic structures which appear to be wax-secretory glands open into collar-stud-like secretory spines. A fine straight duct less than ·001 mm. in diameter opening, presumably, into the secretory spines, constitutes two-thirds of the total length, the remaining third taking the form of a racemose expansion of ramifying branchlets. The total length is usually about ·035 mm. These glands may readily be seen under the high power of the microscope in pieces of cuticle separated, by careful teasing, with the hypodermis attached. The best region to use is the margin of the body, as the ducts may then be followed right up to the secretory spines beneath which the cuticle is seen to be excavated in the form of an inverted cone.

Stained preparations were made successfully by staining pieces of cuticle bearing the glands in eosin and then mounting in glycerine jelly to which a drop of acetic acid had been added. The slide was warmed to hasten clearing. By reducing the illumination from the substage condenser the glands are visible under the high power of the microscope. As the straight ducts have been noticed in potash-cleared specimens it appears that this portion of the gland is cuticular. Only one form of wax gland was found, although the smaller variety of these racemose glands appeared to have more numerous branches than the larger.

REFERENCES.

1. Barnes, H. M. (1930) Gall Midges (Cecidomyidæ) as Enemies of the Tingidæ, Psyllidæ, Aleurodidæ, and Coccidæ. Bull. Ent. Res. vol. XXI., part 3.

2. Colonial Office M.S. *Ceroplastes rubens* Controlled Largely by the Fungus *Cephalosporium lecanii.* Abstract in Rev. App. Ento., vol. 7, p. 483.

3. Evans, J. W. (1932) The Bionomics and Economic Importance of *Thrips imaginis* Bagnall. C.S.I.R. Pamphlet No. 30.

4. Froggatt, W. W. (1921) A Descriptive Catalogue of the Scale Insects of Australia. Department Agric. N.S.W. Science Bulls. Nos. 14, 18, and 19.

5. Imms, A. D. (1931) .. Recent Advances in Entomology. (London) (*a*) p. 59, (*b*) p. 254.

6. Ishii, T. (1923) .. Observations on the Hymenopterous Parasites of *Ceroplastes rubens.* Dept. Agric. and Comm. Japan; Imp. Plant Quar. Stn. Bull. 3, Yokohama. Abstract in Rev. App. Ento. (A), vol. 12, p. 465.

7. Kuwana and Ishii (1927) An Account of Introducing *Scutellista cyanea* to Check *C. rubens* Mask. (In Japanese). Kontya ii., No. 1. Abstract in Rev. App. Ento. (A), vol. 15, p. 15.

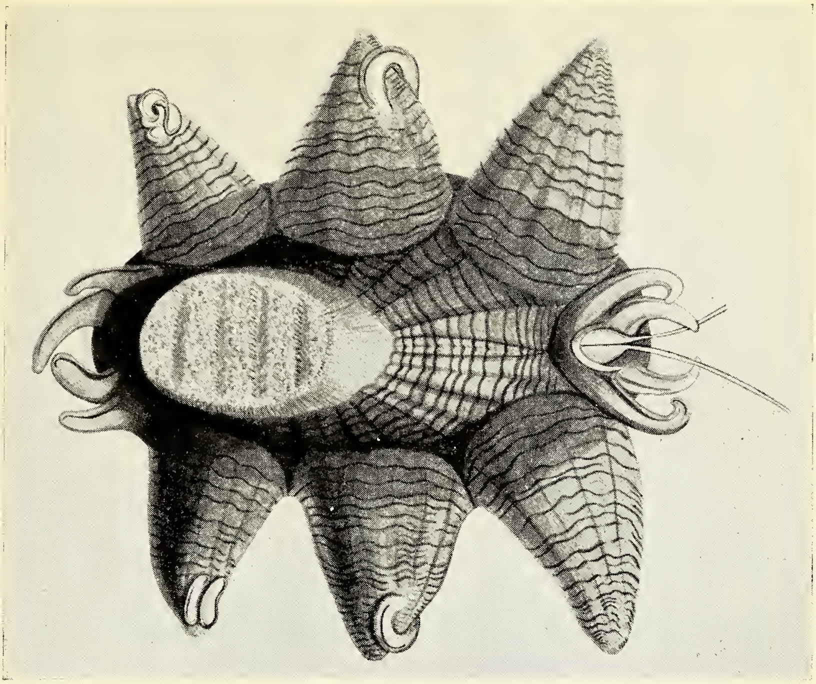
8. Kuwana, I. (1924) .. Descriptions and Biology of New or Little-known Coccids from Japan. Imp. Plant. Quar. Stn. Bull. Abstract in Rev. App. Ento. (A), vol. 12, p. 464.

9. MacGillivray, A. D. (1921) The Coccidæ (Scarab Co., Illinois).

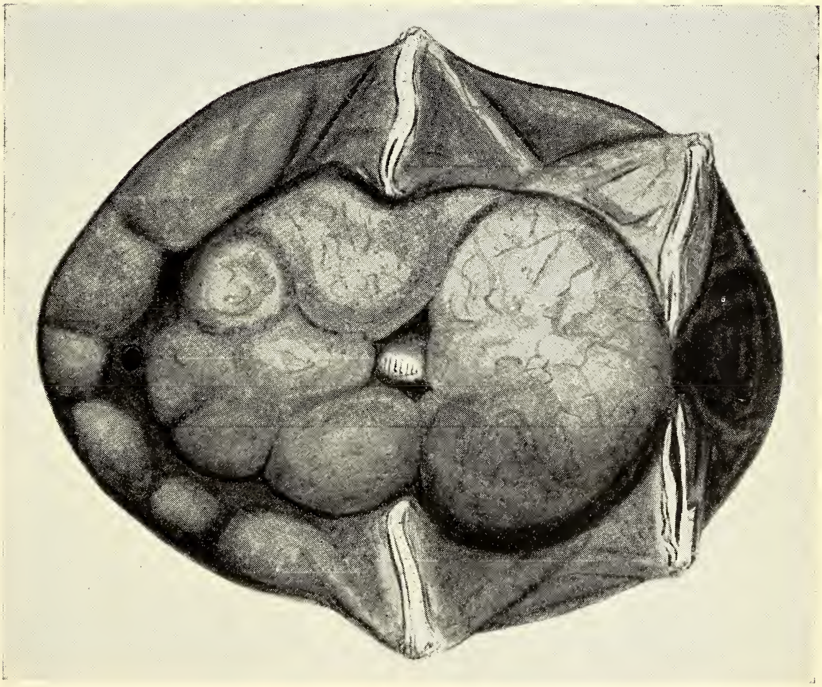
10. Misra, A. B. (1931) On the Internal Anatomy of the Female Lac Insect, *Laccifer lacca* Kerr. Proc. Zool. Soc. Lond., part 1.

11. Shizuoka Agric. Expt. Stn. (1918) Kankitsu gaichu Rubii-Romushi (Ruby-wax Scale, an Insect Injurious to Citrus). Abstract in Rev. App. Ento. (A), vol. 6, p. 401.

12. Werner,. W. A. R. (1931) Obsvns. on the Life Hist. and Control of the Fern Scale *Hemi-chionaspis aspidistræ* Sigh. Wash. Acad. Sci. & Letters, vol. XIII. Ann. Arbor., Univ. of Mich.



(*a*) *Ceroplastes rubens*—Second Instar Nymph.



(*b*) *Ceroplastes rubens*—Fourth Instar (Adult).

A Previously Undescribed Dendrobium from Papua

By C. T. White and B. D. Grimes.

(*Read before the Royal Society of Queensland, 30th April,* 1934.)

[Since this paper was read it has been withdrawn by the authors as they have found the species to be identical with *Dendrobium lævifolium* described by O. Stapf in Botanical Magazine Tab. 9011.—Ed.]

A Review of the Queensland Charophyta.

By JAMES GROVES, F.L.S.

Completed by G. O. ALLEN.

(Three Text Figures.)

(*Communicated by Dr. R. Hamlyn-Harris to the Royal Society of Queensland, 25th June,* 1934.)

(In accordance with the wishes of the late Mr. James Groves, I have completed this review on which he was engaged at the time of his death. He had finished the genus Chara and just started on Nitella (*N. Stuartii,* p. 53, onwards is entirely his), and had also written the first portion of the introduction and the greater part of the key; the rest has been compiled mainly by drawing on the store of notes he had accumulated during over fifty years study of the group. That Mr. Groves was not able to deal with the Nitellas is very much to be regretted, since they constitute, as frequently the case, the more difficult portion. I have added in the introduction some notes of a general character on these little-known plants.)

The Charophyta constitute a remarkably distinct group of Cryptogams, having no clear affinity with any other. There are no imperfect or primitive-seeming forms in the group, such as might afford a clue to their relationship. The 16th and 17th century herbalist writers placed the species then known under Equisetum, with the Horse-tails and the Mares-tail, on account of the superficial resemblance afforded by their whorled branchlets. Later authors up to comparatively recent times assigned them, under the name of Characeæ, the position of a family of Algæ, and some ingenious botanists have attempted, without success, to show an affinity between them and some of the lower Algæ. At the present time they are usually regarded as a separate primary group, co-ordinate with the Pteridophytes, Bryophytes, and Thallophytes. Owing to their aquatic existence, their vegetative system is comparatively simple—living completely submerged, there is no necessity for elaborate strengthening or assimilative tissues—but their reproductive organs are very highly developed and remarkably distinctive. Their geological history, dating back almost with certainty to Carboniferous times, shows them to be a very ancient type, which must have branched off from the ancestral tree at a very early stage in the evolution of the vegetable world.

At the present time Charophytes occur in still or evenly running water, fresh or brackish, practically all over the world, being found within the Arctic circle and extending to the Tropics, but most abundant in the warmer temperate zones, and from sea-level up to an altitude of more than 14,000 feet.

Australia possesses numerous endemic types, of which a fair share are found in Queensland; no doubt further investigation will lead to the discovery of others.

Like most aquatic plants, they have been less favoured by collectors than land plants. Until comparatively recently dried specimens only were collected, and these did not receive the careful treatment they require for satisfactory determination. Latterly, however, more adequate methods have been adopted in drying specimens, and what is still more important, portions have been preserved in formalin, so that their cell-structure can be readily examined. Dr. Hamlyn-Harris's extensive gatherings so preserved have assisted greatly in the preparation of this "review."

Our knowledge of the Queensland Charophytes is largely based on the writings and determinations of Alexander Braun, for many years, up to his death in 1877, the recognised authority on the whole group of Charophyta, and on the work of Otto Nordstedt, the eminent algologist, who edited Braun's most important (posthumous) book, besides doing much investigation himself in connexion with the Australasian Charophytes. F. Manson Bailey's "Comprehensive Catalogue of Queensland Plants," 1913, contains the most complete list of the species found in Queensland, with a few figures, but without descriptions, which latter are only to be gleaned from several scattered publications. The greatest number of illustrations are to be found in vol. vii. of Kuetzing's "Tabulæ Phycologicæ," 1857. In 1891 Nordstedt commenced a fine quarto work entitled "Australasian Characeæ," with excellent detailed descriptions and full-page illustrations, but unfortunately the first part only, containing nine species, could be published. In 1918 a 6-page octavo paper by Nordstedt, also entitled "Australasian Characeæ," was published by the Royal Society of Victoria. This consisted of a synopsis in key-form, furnishing a number of characters. (J. Groves.)

Charophytes grow entirely submersed and may be fairly easily recognised by their green colour (somewhat obscured at times by lime incrustation), the whorled arrangement of the branchlets and very often by the presence on the branchlets of the small dark roundish fruits enclosed in spiral cells. The male reproductive organs, small round objects brightly coloured in orange or red, are also sometimes conspicuous.

Of the only two genera as yet recorded from Queensland Chara is usually much the more robust whereas Nitella is decidely flexible, being quite limp when removed from its element and often with the slimy feel of a filamentous Alga. They may be distinguished at sight by the branchlets of a Chara not forking at all, whereas in a Nitella they are usually obviously furcate sometimes three or four times.

A microscope is essential for a close study of these plants. The number of described species is comparatively small, but their marked tendency to vary often makes their determination difficult. The word "usually" has frequently to be employed in descriptions.

Open still water and soft mud are what Charophytes prefer. They occur in large masses or mixed up with other aquatic vegetation. As many species have a short season whilst some are local and fugitive any likely spots repay thorough and frequent searching. Dr. Hamlyn-Harris tells me that in Queensland they flourish mainly in small isolated water-holes or in the beds of creeks, though in the latter habitat they are liable to be washed out by floods. They are not infrequently found growing in water-holes heavily charged with iron salts, with the result that the plants become literally enveloped in a thick iron sludge though they are none the worse for it.

Charophytes have practically no known economic uses. It was suggested at one time that their presence was inimical to mosquito larvæ, which gave rise to the hope that they might help to solve the malaria problem, but with closer study the idea has been virtually abandoned.

In collecting and preserving these plants the best results call for a certain amount of trouble. Where wading is feasible or they can be reached from the side of a ditch, gathering by hand is the most satisfactory method, as the plants can then be grasped by the "rooting" portion and the swellings known as bulbils can if present be secured; but if out of arm's reach a hoe or a drag comes in useful. This latter is often the only method possible as species have been collected in six feet of water, but they are likely to get tangled or damaged. Mud and any other undesirable material is easily removed at this stage; the cleaner the plant when it leaves the water, the easier it is to mount.

In the case of diœcious species both sexes should be gathered if possible and it is most important to secure some portion bearing ripe fruit, as this is often essential for the determination of Nitellas. They are carried most conveniently in a vasculum with a piece of wet cloth wrapped round each separate gathering.

For mounting on sheets the ideal apparatus is a flat zinc tray somewhat larger than the paper employed and with sloping sides about three inches high, and a sheet of perforated zinc to fit the tray easily. A small portion of a gathering should first be placed in a white vessel of water to enable a suitable portion to be separated out. About an inch of water is needed in the tray, the zinc sheet being placed under the paper to act as a support. The specimen is then arranged in as natural a position as possible and foreign particles removed. They should not be mounted so densely as largely to obscure the shape of the individual plant. The sexes of dioecious species are best mounted apart either on separate sheets or on the same. The specimen, still supported by the zinc sheet, is then lifted slowly out of the water and allowed to drain. It will not always be found necessary to float out in this way the stouter forms of Chara.

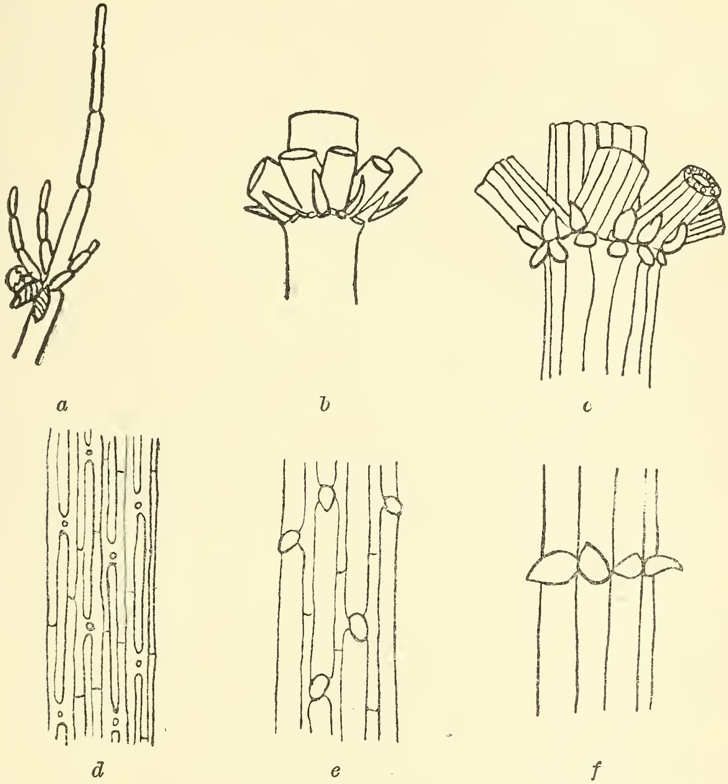
For drying-paper sheets of newspaper answer the purpose well. With a millboard as a base the sheet is then placed on a couple of layers or so of newspaper and over it is spread a piece of linen and more newspaper. Over another millboard at the top of the bundle is placed a considerable weight, such as heavy books, to follow the shrinkage and make the specimen adhere to the paper. The weight required is a matter of experience. With gelatinous species, a piece of waxed paper must be substituted for the linen.

The first drying-sheets should be changed after a couple of hours, the cloth being best removed by rolling it off slowly. At this half-dry stage it is often possible to improve a specimen by a little manipulation. If sufficient pressure has been used in drying, the plant generally adheres sufficiently to the paper not to need any gum.

Portions such as a whorl or the end of a stem should be mounted as slides, glycerine jelly or weak formalin with some glycerine being suitable media. Some form of cell is usually required. In the case of a Nitella a couple of ripe oospores should be crushed and the pieces of membrane mounted in canada balsam, preferably on the same slide as the larger portion. Lime incrustation is easily removed with weak nitric or hydrochloric acid. For reviving pieces of dry material dilute nitric acid will generally suffice for a Chara, and simple boiling or boiling in strong ammonia for a Nitella. Very young portions show the structure best; iodine solution is often useful for making it stand out more clearly.

The following notes on the structure of Charophytes are mainly intended to help in the determination of Queensland species by way of supplement to the Key. A full account is given in that magnificent work "British Charophyta," by Groves and Bullock-Webster (Ray Society, 2 vols.).

Three of the six genera have not been recorded from Australasia at all; two species of Tolypella (fig. 1) have been found.



Text Fig. 1.

Explanation:—

a—*Tolypella glomerata.* Fertile branchlet.

b—Stipulodes in a single circle. *Chara Braunii* (after H. Groves).

c—Stipulodes in a double circle. *C. contraria* (after H. Groves).

d—Triplostichous stem-cortex. *C. fragilis.*

e—Diplostichous stem-cortex. *C. contraria.*

f—Haplostichous stem-cortex. *C. submollusca* (after Nordstedt).

One of the most important characters separating the two Queensland genera—viz., the difference in the coronula—is easily made out under the microscope. The coronula is that little crown that caps the oogonium. There are always five spiral cells round an oogonium and where they meet at the top sits the coronula, ten cells in two tiers in Nitella and only one tier of five cells in Chara. In some species of Nitella the coronula is inclined to be deciduous. *N. furcata* has a very characteristic coronula, the upper tier of cells being very much elongated.

In Chara there is usually a sheath of cells, known as the cortex, round the stem though in three Queensland species (Nos. 1-3) the stems are ecorticate. Nitella has no such cortex, simply one long cell between the nodes where the branchlets arise. Similarly no Nitella has any cortex on the branchlets, whereas usually in Chara there is one, though the first six of the ten Queensland species are without it. As already mentioned the branchlets of a Nitella are always forked whilst those of a Chara are simple.

In most Nitellas the branchlets at each whorl are more or less alike, Groves substituting the name Homoeoclemæ for Braun's Homoeophyllæ as the branchlets obviously have not the functions of leaves. In four Queensland species (Nos. 19-22), however, they are definitely of two different kinds (Heteroclemæ), one much larger than the other, and arranged in two or three series. Groves has also introduced an important change here in Braun's classification by making this character of primary importance.

The next most important feature as a rule to note in a Nitella is the number of cells composing the dactyl (final ray). In some homœoclemous Nitellas including the very widely distributed tropical and subtropical *N. acuminata,* which is found as near as Java and Borneo, the dactyl consists of a single cell but none such have as yet been recorded from Queensland, *N. Stuartii,* the only species with a single-celled dactyl being heteroclemous. All the Queensland homœoclemous Nitellas fall, therefore, within the Arthrodactylæ—i.e., having jointed dactyls. The main division of the Arthrodactylæ is into those with two-celled dactyls (Bicellulatæ) and those with many-celled dactyls (Pluricellulatæ), the former being further subdivided into those with large dactyls (Macrodactylæ) and those with dactyls, or at any rate some of them, very short (Brachydactylæ). The shape of the apical cell—i.e., end-cell of the dactyl—is also important for purposes of classification.

The oogonium, the female reproductive organ, consists of an outer covering of five spiral cells, ascending always from right to left, and an inner body. After fertilization, which is effected by the free-swimming antherozoids of the antheridium (male reproductive organ) making their way through an opening at the top of the oogonium, the outer parts of these enveloping cells disappear, their lines of union remaining to form a series of spiral ridges and their inner walls being utilized it is believed to form the tough coloured outer membrane that closely surrounds the inner contents of the nut-like oospore. This membrane is of importance; it will usually require a one-sixth inch objective for its examination.

In most Nitellas this membrane is decorated and the type of marking has so far been found to be constant for a species. The most usual forms consist of either small granules or larger separate tubercles or a net-like pattern. In recent years Canon Bullock-Webster has devoted special attention to these membranes and made some beautiful drawings of them.

In the genus Chara the chief structural parts for the purposes of classification are the stipulodes and the cortex, *C. zeylanica* having a unique antheridium.

The stem of a Charophyte consists of nodes and internodes. At each node there arises a whorl of branchlets, and often a branch also, usually one in Chara and two in Nitella, these branches being similar to the stem and of unlimited growth. At the nodes there occur also in Chara (not in Nitella) either between or below the branchlets, one-celled organs known as stipulodes, arranged in either a single (fig. 2) or a double (fig. 3) circle, the Haplostephanæ and Diplostephanæ respectively. These stipulodes may be quite rudimentary as in *C. fragilis* or long as in *C. zeylanica,* but there is usually no difficulty in determining to which section a plant belongs.

It is important to understand the main features of the stem-cortex. This sheath of longitudinal rows of cells covers the internode of the stem. It arises in a curious way. At each stem-node two circles of cortex-cells start growing, one upwards and the other downwards, till they meet so that the cortex of each internode is the joint production of cells starting from the nodes above and below it.

These cortical cells are of two kinds, the primary series and the secondary. The primary rows themselves consist of alternating nodes and internodes, the internodes increasing in length only while the nodes divide laterally to form on either side elongated portions which range themselves alongside the primary series to form the secondary series. The nodes also divide to form outward-growing spines; the primary series in fact can generally be readily recognised by these spines. All the Queensland species with corticate stems (Nos. 4-10) have spines (mere papillæ in *C. fragilis*).

The secondary cells vary in length. Where they are about the same length as the internodes of the primary series they occupy the whole of the rows on either side of the primary row and consequently between any two spine-bearing (primary) rows there will be two plain rows (secondary). This type is called triplostichous (Nos. 8-10), fig. 4. If the cells of the secondary series are only about half the length of the internodes of the primary series they accommodate themselves in one row between the two primary rows. *C. contraria* and *C. Preissii* illustrate this diplostichous type of stem-cortex (fig. 5). In one species, *C. submollusca,* there is no secondary cortex, this condition being known as haplostichous (fig. 6). The cortex is generally clearest in the young parts of the stem.

Usually a species that has a stem-cortex has also a cortex to the branchlet but this is not the case with three Queensland species (Nos. 4-6). The branchlet-cortex is simpler than that of the stem, there being no division into primary and secondary series. It may be two-ranked as in *C. fragilis* or three-ranked as usually in *C. zeylanica.* It is of special importance for purposes of classification in the case of *C zeylanica,* where the lowest branchlet segment is without a cortex. The segments towards the free end of the branchlet in *C. contraria* are often ecorticate.

The antheridium, "a very highly developed organ, probably the most complex and beautiful structure of the kind throughout the vegetable kingdom" ordinarily consists of eight convex shields whose adjoining edges fit into one another. In the centre of the inner surface of each shield and directed inwards is a handle-shaped cell (manubrium) to which are attached at the free ends a large number of filaments containing antherozoids. Though so remarkable an organ its lack of variation was responsible until quite recently for the extraordinary fact being overlooked that *C. zeylanica* has only four lozenge-shaped shields instead of the usual eight triangular ones. Groves has remarked (J. of Bot. April, 1931, p. 97) that it is particularly interesting that this reduction of parts should occur in *C. zeylanica* considering that that species presents the most highly developed vegetative system in the whole group and in consequence is placed by Braun as the last in his list.

TABLE OF SECTIONS AND GENERA.

Stem ecorticate. Fertile branchlets forked. Coronula composed of 10 cells, ranged in 2 tiers	NITELLEÆ.
Antheridia terminal, in the forks of the branchlets. Oogonia lateral. Oospores longitudinally flattened	NITELLA.
Antheridia and oogonia lateral. Oospores terete. Branchlets of sterile whorls often simple, of fertile whorls forked, but with continuous axis	(TOLYPELLA).
(NOTE.—No representative of Tolypella is yet recorded from Queensland, but one species is found in Victoria and Tasmania and another in Kerguelen.)	
Stem corticate or ecorticate. Branchlets simple. Oogonia and antheridia lateral. Coronula composed of 5 cells, ranged in one tier. Oospore terete	CHAREÆ.
Stem corticate or ecorticate, with either one or two rings of usually ± elongated cells (stipulodes) below the branchlets. Oogonia partially surrounded by a whorl of elongated cells (bract-cells). Antheridia normally situated below the oogonia, taking the place of a bract-cell	CHARA.
Bract-cells and stipulodes as in Chara, but antheridia and oogonia produced side by side	(LYCHNOTHAMNUS).
Bract-cells and stipulodes as in Chara, but antheridia situated above the oogonia	(LAMPROTHAMNIUM).
Branchlet-segments very few. Bract-cells 1 or 2 at a node, very long. Stipulodes wanting	(NITELLOPSIS).
(NOTE.—None of the three preceding apparently monotypic genera has yet been recorded from Australasia.)	

KEY TO THE SPECIES.

NITELLA.

Branchlets of each whorl in a single series ± uniform in length and extent of forking	HOMŒOCLEMÆ.
Dactyls (ultimate rays) each consisting of a single cell (none as yet recorded from Queensland)	ANARTHRODACTYLÆ.
Dactyls each consisting of two or more cells	ARTHRODACTYLÆ.
Dactyls all or mostly 2-celled	*BICELLULATÆ.*
Diœcious.	
Apical cells of dactyls conical. Branchlets twice forked	1. *N. Sonderi.*
Apical cells of dactyls bi-tri-lobed. Branchlets 4-times forked	2. *N. partita.*
Monœcious	
Dactyls not much abbreviated. Ultimate forks usually fertile	*Macrodactylæ.*
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.*

Nitella—*continued.*

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 μ 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. oligospora.*

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

Oospore membrane tuberculate. Dactyls 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.*

Diœcious.

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 ± cylindrical, obtuse .. .. 15. *N. gelatinosa.*

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

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

Monœcious .. .. 18. *N. Hookeri.*

Branchlets in each whorl in 2-3 series, those of one (the "primary" series) much larger and more compound than the secondary .. .. HETEROCLEMÆ.

Diœcious.

Branchlets in two series, the secondary simple or once or twice forked. Oospore c. 300 μ long. A small slender plant .. .. 19. *N. Lhotzkyi.*

Branchlets in 3 series, the secondary 1-3 times forked. Oospore c. 400-500 μ long. A large robust plant .. 20. *N. congesta.*

Monœcious.

Branchlets usually in 3 series. Oospore 250-400 μ long. Dactyls 2-celled .. .. 21. *N. hyalina.*

Branchlets in 2 series. Oospore 200-250 μ long. Dactyls 1-celled .. .. 22. *N. Stuartii.*

CHARA.

Stipulodes in a single circle	HAPLOSTEPHANÆ.
Stem and branchlets entirely ecorticate.	
Diœcious. Stipulodes alternating with the branchlets. Oogonia and antheridia usually produced at the base as well at the free nodes of the branchlets ..	1. *C. australis.*
Monœcious. Stipulodes opposite to the bases of the branchlets. Oogonia usually produced at the base of the whorl in the axils, and occasionally at the free nodes of the branchlets	2. *C. macropogon.*
Monœcious. Stipulodes alternating with the branchlets. Oogonia and antheridia produced only at the free nodes of the branchlets	3. *C. Braunii.*
Stem corticate. Branchlets ecorticate.	
Diœcious.	
Series of cortical-cells equalling the number of branchlets	HAPLOSTICHÆ. 4. *C. submolusca.*
Series of cortical-cells twice as numerous as the branchlets	DIPLOSTICHÆ. 5. *C. Preissii.*
Monœcious.	6. *C. gymnopitys.*
Stipulodes in a double circle	DIPLOSTEPHANÆ.
Series of cortical-cells twice as numerous as the branchlets	DIPLOSTICHÆ. 7. *C. contraria.*
Series of cortical-cells thrice as numerous as the branchlets	TRIPLOSTICHÆ.
Branchlet-segments mostly, the lowest always, corticate	*Phlœopodes.*
Stipulodes of both series elongated. Oospore yellowish	8. *C. leptosperma.*
Stipulodes of both series extremely short or quite undeveloped. Oospore black	9. *C. fragilis.*
Lowest branchlet-segment always ecorticate ..	*Gymnopodes.*
Antherida quadriscutate (in all other species octoscutate)	10. *C. zeylanica.*

NITELLA Agardh.

HOMOEOCLEMÆ.

ARTHRODACTYLÆ.

Bicellulatœ.

1. *N. Sonderi* Braun, in Linnæa XXV., p. 704 (1852); Braun & Nordstedt, Fragmente, p. 47 (1882); Nordstedt, in Hedwigia, p. 182 (1888); De Alg. et Char. IV., pp. 8 and 24 (1889).

Figures.—Kuetzing, Tab. Phyc. VII., pl. 42, fig. 1 (1857); Br. & Nordst. I. c., pl. V., figs. 111-113; Nordst., Hedwigia, pl. VI., fig. 1 (oosporte membrane).

Diœcious. Stem slender. Whorls rather lax, of 6-7 branchlets twice furcate; primary rays half or more than half the length of the branchlet; secondary rays 4-6, shorter (except those not again forked) than the tertiary; tertiary rays (dactyls) 3-6 of about equal length, uniformly 2-celled, the lower cell tapering somewhat at the apex, upper narrowly conical. Oogonia solitary or geminate produced at both nodes. Coronula c. 45 μ high, c. 30 μ broad. Oospore dark brown, 180-200 μ long, 140-160 μ broad; membrane with very small scattered spines (fide Nordstedt).

Locality.—Recorded by Nordstedt (1888) from the Gulf of Carpentaria. An Australian endemic species discovered near Melbourne by F. v. Mueller.

2. *N. partita* Nordst., Australasian Characeæ Part 1 (1891).

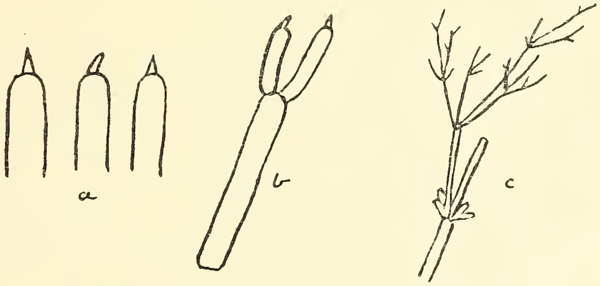
Figure.—Nordst. 1, c.; F. M. Bailey, Comp. Cat. Queensland, pl. fig. 687 (1913).

Diœcious. Stem 600μ in diameter. A small plant, probably c. 10 cm. high. About 6 branchlets to a whorl, apparently rather unequal in length, 3-4 times forked; primary rays rather more than half the length of the branchlet, secondary rays 4-6, tertiary 3-5, quaternary 3-4. Dactyls 2-celled; ultimate cell bi-tri-partite with cuspidate diverging points. Oogonia solitary or rarely two together; coronula short.

This remarkable plant was described by Nordstedt from "one small specimen with unripe fruit" collected by Alfred Henry at Georgina River. It appears from the map that this is a remote place not easy of access. It is most desirable that further specimens should if possible be collected to see whether the extraordinary lobed ultimate cells are normal. "Such a forked terminal cell does not occur in any other known species of Nitella" (Nordst.).

Macrodactylæ.

3. *N. phauloteles* Groves, in Proc. Roy. Soc. Queensland XXXVIII., xvi., p. 262 (1927) (fig. 7 a-c.).



Text Fig. 2.—*Nitella phauloteles*, Groves.

Explanation:—

a—Apices of dactyls, × c. 40.
b—Final forking, × c. 30.
c—Part of stem whorl, showing one branchlet (sterile), × c. 3.

Monœcious. Stem c. 450 μ in diameter. Branchlets normally 6 in a whorl, unequal in length, the fertile 2-3, sometimes 4-times forked; primary rays one-third to half the length of the entire branchlet; secondary rays usually 4 or 5, tertiary 2-4, quaternary and quinary usually 2, the rays at each forking conspicuously unequal. Final rays (dactyls) of fertile branchlets uniformly 2-celled, the lower cell often elongated, rounded at its distal end, the ultimate cell small, bluntly conical, sometimes but little longer than the breadth at the base. Gametangia produced at all nodes, but oogonia and antheridia rarely at the same node. Oogonia solitary, c. 400-450μ long, 375 μ broad; coronula c. 30μ high,μ 60μ broad; oospore golden-brown, c. 275-300 long, 240-265 μ broad, 175-200 μ thick, showing 5-7 thin firm ridges; membrane with extremely fine regular shallow granulation.

Localities.—Murphy's Creek, April, 1910, T. L. Bancroft; Ithaca, April, 1912, C. T. White; Doomben, near Brisbane, May, 1925, E. W. Buhot; Doomben, September, 1926, R. Hamlyn-Harris; Cameron Creek, near Ipswich, January, 1927, R. H.-H.; Kedron Brook, Enoggera, April, 1927, R. H.-H.; Enoggera Creek, November, 1928, R. H.-H.; Pine River, September, 1928. R. H.-H.

A small slender plant of rather lax habit, the whorls not exceeding 20 mm. in diameter. The principal features would seem to be the irregularity in length of the branchlets and rays, the rounded distal end of the lower cell and the small short conical ultimate cell of the dactyls, from which the specific name is taken. The decoration of the oospore membrane is so fine and shallow that without the closest examination the membrane appears plain. First discriminated from the specimens collected by Mr. Buhot in 1925.

4. *N. pseudo-flabellata* Braun, 1862, MS.; Braund & Nordstedt, Fragmente, pp. 12 and 54 (1882); Nordstedt, De Alg. et Char., p. 10 and p. 24 (forma *australiana*) (1889).

Monœcious. Branchlets usually 6-8, twice and often three times forked. Primary rays $\frac{1}{2}$ to $\frac{2}{3}$ the length of the entire branchlet. Rays at first forking 6-7, at second and third usually about 5. Dactyls of about equal length, uniformly 2-celled, the lower one tapering somewhat at the distal end, upper cell a narrowly conical and very acute mucro. Gametangia at each forking. Oogonia solitary. Oospore dark brown, c. 300-320 μ long, 250 μ broad, showing about 6-7 ridges; membrane ''somewhat spongy'' (Nordst.).

Localities.—Nordstedt 1 c. refers with some doubt a plant from Endeavour River (Persieh, 535) to a forma *australiana* of *N. pseudo-flabellata* from its likeness to one of the Java plants determined by Braun (Fragm., p. 54). H. Groves referred to this species a plant collected near Murphy's Creek by Bancroft.

The outer membrane of forma *australiana* is described by Nordstedt (1 c. p. 24) as being a little spongy, but covered also with small pointed warts standing a little more closely than in *N. Sonderi* and a little smaller too. The membrane appears to be granulate.

A very variable and indefinite species that has never been properly diagnosed, the original being based on rather different plants from various localties. Dr. T. F. Allen laid stress on the elongated primary ray as an important feature of this species, but Groves was of opinion that the larger number of rays, especially at the second and ultimate forkings together with the greater number and approximately equal length of the uniformly 2-celled dactyls were features of more importance.

Recorded from various parts of Asia; also from New Zealand and New Caledonia.

5. *N. mucosa* Groves, in Linn. Coc. J. Bot. XLVI., p. 100 (1922); *N. pseudo-flabellata* Braun forma *mucosa* Nordstedt, De Alg. et Char., part 2, Act. Univ. Lund., XVI., p. 16 (1880); De Alg et Char., part 4, p. 10 (1889).

Monœcious. Branchlets commonly 3-times forked, primary rays as long or longer than half the total length of the branchlet. Dactyls 4-5. Oospore dark brown, 300-360 μ long, 285-300 μ broad, showing 6-7 ridges; membrane bearing little closely set prickles (Nordst.). Antheridium 200-230 μ in diameter.

Localities.—Stannary Hills, 1909, T. L. Bancroft; Sandgate, November, 1911, C. T. White, No. 3; Ithaca Creek, May, 1912, C.T.W., Nos. 3 and 4.

Nordstedt (1880) separated two New Zealand examples as forma *mucosa* of *N. pseudo-flabellata* Braun, the distinguishing feature being that the young fertile heads were enveloped in mucus. Groves elevated forma mucosa to specific rank in a paper on Charophytes collected in Ceylon by T. B. Blow and remarked that it resembled *N. pseudo-flabellata* in the proportionate length of the primary ray and in the number of tertiary rays but differed from that species in having the fruiting whorls enveloped in thick mucus.

Only one of Nordstedt's two New Zealand type plants bore ripe fruit. A beautiful drawing by Bullock-Webster of the membrane of forma *mucosa* recorded in De Algis 1889, p. 25, from Waikato, New Zealand, depicts it as tuberculate with a tendency for the tubercules to form lines. Of the Queensland specimens only those from Ithaca bear ripe oospores but the membrane of these is thickly felted so that it is not possible to ascertain the nature of the decoration.

The presence of mucus in fruiting whorls is easily detected when the plants are fresh or preserved in fluid but it is often not discernable in dried specimens.

Recorded in addition to New Zealand and Ceylon from Malay Peninsula and probably Japan and Tonking.

(In Bailey's list *muscosa* is in error written for *mucosa.*)

6. *N. leptosoma* Nordstedt, De Alg. et Char., part 2, p. 17 (1880); De Alg. et Char., part 4, p. 11, part 6, p. 25 (1889); Australasian Characeæ, part 1 (1891).

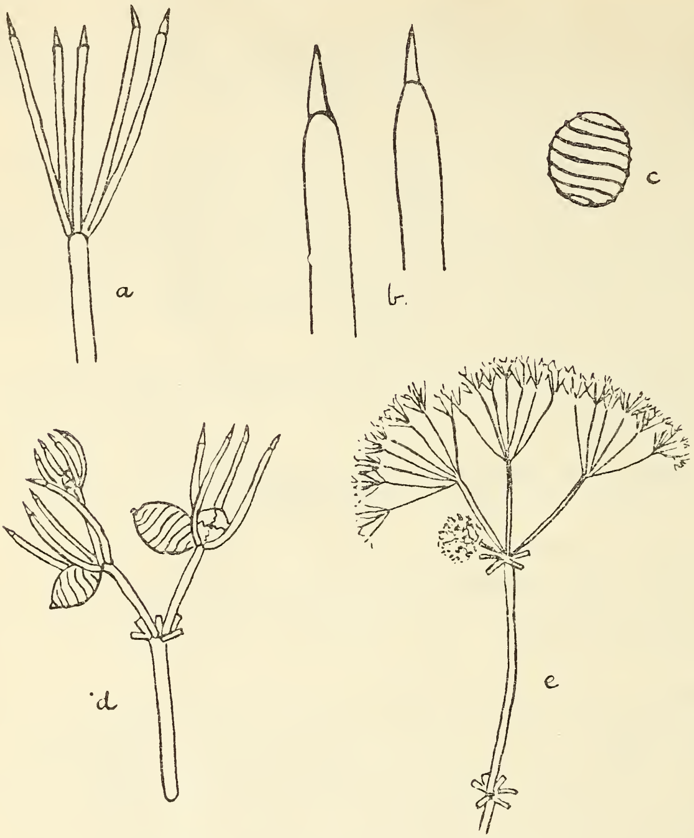
Figure.—Austral. Char. 1. c.

Monœcious. A small slender plant about six inches high. Whorls of 6-8 branchlets, one (or more usually in the upper whorls twice) forked, the sterile whorls being comparatively long while the fertile are in the form of interrupted spikes enveloped in mucus; 3-5 rays at each furcation, the primary rays tending to exceed half the length of the branchlet; dactyls 2-celled, the lower cell being of almost equal thickness throughout till it narrows at the top, the apical cell forming an acute mucro. Oogonia solitary, at both furcations; oospore dark brown, 310-350μ long, c. 310μ broad, with 7-8 slightly prominent ridges. Membrane "thickly dotted with small acute elongated spines" (Nordst.). Canon Bullock-Webster's drawing of a membrane from Taupo, New Zealand (ex herb. Nordst.), shows a tuberculate type with which Nordstedt's fig. 6 agrees.

Localities.—This species is included with some doubt. In the first supplement (Brisbane, 1886) of F. M. Bailey's "Synopsis of the Queensland Flora" localities are given as Mount Perry and near Brisbane, but in his "Comprehensive Catalogue" the species is entered with a query. In De Alg. et Char., 1889, 1 c., Nordstedt mentions a doubtful variety of this species from Queensland ("still water near Brisbane, leg. C. F. Bailey," quoted in Austr. Char. as T. Bailey). Nordstedt remarks that it could not be determined with certainty as the oospores were not ripe and it also differed somewhat from the type and would on further observation probably prove a distinct species.

Elsewhere known only from New Zealand.

7. *N. Comptonii* Groves, in Linn. Soc. J. Bot. XLVI., p. 69 (1922). Figure.— 1 c., pl. 5. (Fig. 8 a-e.)



Text Fig. 3.—*Nitella Complonii,* Groves.

Explanation:—

a—Sterile branchlet, final forking, ×c. 25.
b—Apices of dactyls, × c. 80.
c—Oospore, × c. 45.
d—Part of fertile branchlet, × c. 20.
e—Part of stem whorl, showing 3 sterile and 1 fertile branchlet, × c. 3.

Monœcious. Stem c. 400μ thick. Whorls distant. Usually 8 branchlets to a whorl, 3-4 (usually 3) times forked; primary ray equal to half the length of the entire branchlet; secondary rays 6-8, tertiary 5-7, quaternary 5-6, with one or two often again forked. Dactyls 4-6, 2-celled, elongated, slender, slightly curved at the base; lower cell more or less narrowed at the apex, apical cell long-conical, $\rightarrow$85μ long, c. 25 μ broad at the base.

Fertile whorls in mucus, often forming small round heads. Gametangia at second and third forkings; oogonia solitary; coronula persistent. Oospore c. 300 μ long, 250 μ broad, very dark brown, showing about 8 prominent ridges. Membrane finely granulate. Antheridium c. 250μ in diameter.

Locality.—Enoggera Reservoir, May, 1912, C. T. White.

The collector's note is "growing on mud at edge of water; could find none at deeper depth."

N. Comptonii was described from a plant found in New Caledonia in 1914 by Mr. R. H. Compton. The Queensland specimen is in fluid only. Mr. Groves remarks that it is "apparently glœocephalous judging from its capacity for accumulating foreign matter."

It appears from some old notes of his that he was quite possibly contemplating describing this as a new species but it seems to me closely to resemble *N. Comptonii.* The present plant does not show more than three furcations and the oospore measures c. 280μ long. The oospore membranes of the two are much alike.

Distinguishable from *N. leptosoma* by being usually three times forked, by the larger number of rays and by the sterile first furcation; from *N. mucosa* by the heteromorphous branchlets.

Brachydactylæ.

8. *N. oligospira* Braun, in Monats. Akad. Berl., p. 357 (1858); *f. australiana* Nordst., De Alg. et Char., p. 26 (1889).

Monœcious. A rather small and slender plant of lax habit; sterile and fertile whorls more or less similar; branchlets twice or partly thrice forked. Dactyls 2-celled and varying much in length, some being very short, apical cell acute. Oogonia solitary, coronula short; oospore subglobose, yellowish-brown, 260-280μ long, with 6 prominent ridges; membrane rather irregularly reticulate.

Nordstedt remarked that the place of this Australian form could not be fixed exactly owing to the absence of any ripe oospores but that it came nearest to f. indica. It has 4-5 branchlets, 3-4 secondaries, and 2-3 dactyls.

Locality.—Head of Ithaca Creek, Taylor's Range, Brisbane, April, 1885, H. Tryon.

"A variable and rather indeterminate species which seems to occupy an intermediate position between the sections Macrodactylæ and Brachydactylæ" (Groves). The present species was the first instance of a representative of this group being found in Australia. The oogonia being solitary distinguishes it from the other three Queensland species.

A characteristically tropical species occurring in India, Ceylon, Java, N. and S. America, and the West Indies.

9. *N. Microcarpa* Braun, in Monats. Akad Berl., p. 357 (1858); Br. & Nordst., Fragmente, p. 71 (1882).

Figure.—Br. & Nordst., 1 c., pl. II., figs. 56-57, pl. III., fig. 78.

Monœcious. Stem slender. Whorls of six branchlets, 3-4 times forked. Dactyls 2-celled, the end-cell consisting of a very short sharp mucro. Fruit either germinate or three together. Oospore golden brown, very small, only 180-250μ long, showing 6 spirals; membrane reticulate.

Localities.—Brisbane, Darra, July, 1928, R. Hamlyn-Harris; Murarrie, near Bacon Factory, July, 1928, R. H.-H.; Brisbane, Wynnum road, Ti-tree Swamps, August, 1928, R. H.-H.; Brisbane, Tingalpa, August, 1928, R. H.-H.

Mr. Groves put all four gatherings under this species, which is included in Nordstedt's Australasian list (1918) on account of the oogonia being frequently germinate. The dactyls are not all very short, this brachydactylous character being more pronounced in the Tingalpa specimens. Those other gatherings were referred by him to *N. microcarpa* sens. lat., viz., Mt. Buderim, April, 1912, Nos. 1 and 2, C. T. White; still pool near Burleigh Heads, September, 1912, C.T.W.

The membrane being reticulate distinguishes it from *N. orientalis* which has granulate markings.

Widely distributed in the tropics, being found in India, Ceylon, Malay Peninsula, China, Japan, Java, S. Africa, N. and S. America, and West Indies.

10. *N. Orientalis* Allen, Bull. Torr. Bot. Club, vol. 21, No. 12, p. 524 (1894).

Figure.—Allen 1 c.

Monœcious. Very variable in size. 6-8 branchlets to a whorl, 3-5 times forked. Dactyls sometimes long and often very short. Oogonia usually clustered, sometimes solitary, never at the first node. Coronula short, small, and connivent, with the upper layer much longer than the lower, which are small and disk-shaped. Oospore c. 350 μ long, 300 μ broad, showing 7-9 ridges; membrane surface "minutely roughened with granules, which are quite coarse and more prominent at one or two points on the shell, usually near the apex."

Locality.—Stannary Hills, T. L. Bancroft.

Groves remarks that his late brother (Henry Groves) referred the plant to this species with some doubt. The species seems to be rather an ill-defined one and was founded on three gatherings which "though variable may belong to the same species" (Allen).

Elsewhere known only from Japan.

11. *N. Furcata* Agardh, Systema Algarum, p. 124 (1824); (*N. Roxburghii* Br. 1849, *N. polyglochin* Br. sens. strict.); Br. & Nordst., Fragmente, p. 73 (1882); Nordst., De Alg. et Char., p. 27 (1889).

Figure.—Br. & Nordst., l.c., figs. 140-144.

Monœcious. Six branchlets to a whorl; sterile c. 25 cm. long, fertile half as long, 3-times furcate. About 4 secondaries, 3 tertiaries, and quaternaries. Dactyls all very short and divergent. Oogonia clustered. Oospore 250 μ long, 225 μ broad (Nordst.); showing 6-7 ridges. Membrane reitculate. Coronula very tall owing to the cells of the upper tier being prolonged into sharpish points.

Locality.—Endeavour River, 1887, M. Persieh.

"In the typical state of this when all the upper cells of the coronula are elongated the character is very marked" (Groves) and renders it easily distinguishable from any other Nitella.

This species occurs in many parts of Asia, including India, Burma, Malay Peninsula, Java, Japan, &c., recorded also from Madagascar and N. and S. America.

Pluricellulatæ.

12. *N. Myriotricha* Braun, 1855, M.S.; Br. & Nordst., Fragmente, p. 80 (1882); Kuetzing, Tab. Phyc., VII., p. 15 (1857).

Figures.—Kuetz., 1 c., pl. 39; Br. & Nordst., 1 c., figs. 158-163.

Diœcious. Branchlets 5-7 in a whorl, 3-4 times furcate, fertile branchlets smaller and contracted. Dactyls usually 3-celled, apical cell pointed. Oogonia solitary, at all forkings, enveloped in mucus. Oospore c. 250-260μ long, showing 7-8 prominent ridges; membrane rather coarsely reticulate.

Localities.—Moreton Bay, near Brisbane (comm. F. v. Mueller, 1867); Gulf of Carpentaria (Mueller); Sunnybank, near Brisbane, 1926, C. T. White; St. Lucia, September, 1927, ♀♂, R. Hamlyn-Harris; Greenslopes, August, 1928, ♂, R. H.-H.; Tingalpa, old well near swamp, August, 1928, ♀, R. H.-H.

"This very distinct plant—one of the most beautiful Australian species—is characterised by very fine many-times-forked branchlets, extremely thin (c. 20μ in diameter), long cylindrical pointed end-cells on the sterile branchlets, and the fruiting heads enveloped in a dense cloud of mucus" (J.G.).

The oospore ridges, about 6, in the Sunnybank plant, are very inconspicuous, in this respect differing from Mueller's, and the oospore is only c. 200μ long.

Not recorded outside Australia.

13. *N. Diffusa* Braun (1860); Br. & Nordst., Fragmente, pp. 14 and 80 (1882); Nordst., De Alg. et Char., p. 28 (1889).

Figure.—Br. & Nordst., 1 c., figs. 154b-157.

Diœcious. Six branchlets to the whorl, 2- or sometimes 3-times forked, fertile whorls tending to form heads. Dactyls 2-3 celled, usually 3-celled (when apparently 4-celled it is due to suppressed forking) the cells becoming shorter and narrower with the end-cell very short and acute. Oogonia either solitary or germinate, rather small, occurring at first and second forks; coronula short. Oospore chestnut-brown, c. 350μ long, c. 310μ broad, showing 8 ridges with a prominent crest; membrane very finely reticulate. Antheridia c. 550μ in diameter.

Localities.—Brisbane ♀♂; Main Range, Fassifern Creeks, ♂ F. M. Bailey (comm. 1884); Tambourine Mountain, November, 1909, J. H. Simmonds (comm. F.M.B.); Rosewood, September, 1911, C. T. White; Goodna, October, 1911, C.T.W.; Doomben, August, 1926, C.T.W.; Enoggera Creek, January, 1927 ♂, September, 1933 ♀♂, R. Hamlyn-Harris; St. Lucia, April, 1927, R. H.-H.; Brisbane, April-May, 1927, R. H.-H.; large swamps off Wynnum road, July, 1928 ♂, R. H.-H.; small claypits at Greenslopes, ♂, swamps on Wynnum road, August, 1928, ♀, R. H.-H.; Tingalpa, August, 1928, ♀, R. H.-H.; Downfall Creek, Geebung, September, 1933, ♂ R. H.-H.

According to the key in Nordstedt's Synopsis (1918) this plant should be distinguishable from *N. cristata* by the fertile whorls not forming the small dense heads characteristic of the latter and also by the sterile branchlets of the lower whorls not being forked.

Elsewhere this plant is only known from Tasmania.

14. *N. Cristata* Braun, in Linnæa XXV., p. 706 (1852); Br. & Nordst., Fragm., p. 82 (1882).

Figures.—Kuetzing, Tab. Phyc., VII., pl. 41 (1857) ; Br. & Nordst., 1 c., fig. 165.

Diœcious. Six branchlets to a whorl, fertile whorls forming small dense heads; branchlets once or more usually twice furcate, each time giving rise to 3 rays; dactyls 2-4- (usually 3-) celled, tapering and divergent; end-cell acute. Oogonia solitary or aggregate, at both forks, oospore 300-380μ long (Nordst.) showing 6 extremely developed ridges with a large crest membrane decorated with tubercles.

Localities.—Main Range, 1883, F. M. Bailey; near Brisbane River, 1886; F.M.B.; Ithaca Creek, May, 1912, C. T. White; Yeronga, November, 1927, R. Hamlyn-Harris; Murarrie, Wynnum road, July, 1928, ♀♂, R. H.-H.; Victoria Park, Brisbane, July, 1928, ♀♂, R. H.-H.; Horse Paddock, Yeronga, July, 1928, ♂, R. H.-H.; Buruda, July, 1928, ♀♂, R.H.-H.; Wynnum road, August, 1928, ♀♂, R. H.-H.; pool by Pine River, September, 1928, R.H.H.; Enoggera Creek, October-November, 1928, R.H.H.

The chief feature distinguishing this species from *N. diffusa* is the small dense fertile heads. Groves remarks in litt. that he hopes he has sorted the plants out correctly between this species and the foregoing, but they seem to run close together. It has less forking than *N. myriotricha* and the oogonia are not enveloped in mucus.

Not known outside Australasia; recorded from various parts of S.E. Australia and from Tasmania.

15. *N. gelatinosa* Braun, in Hooker's J. Bot., p. 198 (1849) ; *Chara gelatinosa*, Braun, in Linnæa XVII., p. 115 (1843) ; Nordst., Hedwigia, p. 185 (1888) ; De Alg. et Char., p. 13 (1889) ; Bailey, c.c., p. 678 (1913).

Figures.—Kuetz., Tab. Phyc. VII., figs. 28-30 (1857) ; Nordst., Hedwigia, pl. VI., fig. 2 (oospore membrane).

Diœcious. Sterile branchlets either simple or once furcate; fertile once or twice forked, primary ray very short and dactyl long. Dactyls 2-4-celled, end-cell typically obtuse but variable. Oogonia in dense heads enveloped in mucus. Oospore c. 200-270μ long, showing 7-8 ridges; membrane coarsely reticulate, with c. 4 meshes to the fossa.

Localities.—Johnstone R., T. L. Bancroft (Nordst., De Algis.) ; Stannary Hills, 1909, ♀, T.L.B.; Wynnum road, August, 1928, ♀, R. Hamlyn-Harris; Tingalpa, August, 1928, ♀♂, R. H.-H.

Groves remarks in litt. that this species and *N. tasmanica* seem very closely related. Nordstedt who studied the Australian Charophytes more closely than any other man has remarked that the difference between *N. tasmanica* and some forms of *N. gelatinosa* appeared to him to be very slight. There is a suggestion in the Fragmente that perhaps *N. gelatinosa* ought to be divided into three species based on the different characters of the sterile branchlets.

16. *N. tasmanica* (F. Muell.) Braun, in Linnæa XXV., p. 707 (1852) ; Br. & Nordst., Fragmente, p. 83 (1882) ; Nordst., De Alg. et Char., p. 29 (1889).

Figure.—Kuetzing, Tab. Phyc. VII., fig. 40 (1857).

Diœcious. 7-8 branchlets to the fertile whorl, twice forked, usually 5 secondary rays and 4-5 tertiary. Primary and secondary rays short, dactyls long, 3-4 (sometimes even 5-) celled. Fertile whorls very gelatinous. Oospore dark brown to opaque, 220-240μ long, 190-210μ broad; membrane reticulate, meshes in 3-4 rows and rather irregularly arranged.

Localities.—Trinity Bay, 1886, ♂, Sayer; Johnstone R., 1886, T. L. Bancroft; Cochin Creek, 1910, ♀♂, T.L.B.

Somewhat weaker but otherwise like *N. cristata* in appearance.

Known elsewhere only from Tasmania and New South Wales.

17. *N. polycephala* Braun, 1868, MS.; *N. gelatinosa* var. *polycephala* Braun, 1852, in Linnæa XXV., p. 706 (1852); Br. & Nordst., Fragmente, p. 85 (1882).

Figure.—Br. & Nordst., 1 c., figs. 169-171.

Diœcious. Very small and delicate, about 50 mm. tall. Sterile branchlets 6 to a whorl, once forked; 4-5 ± equals 4-celled dactyls the end-cell being mucro-shaped. Fertile branchlets twice forked, primary and secondary rays short, dactyls longer; dactyls 3-celled, lowest cell swollen. Oogania solitary, very small at both forkings, coronula short. Oospore 160-180μ long, showing 5 ridges.

Locality.—Brisbane River, ♀ A. Dietrich (comm. 1868: Fragmente).

Distinguishable from *N. gelatinosa* by the smaller oospore showing 5 ridges only and by the fertile heads being only slightly mucous.

Elsewhere known only from Melbourne, the specimen being ♂.

18. *N. hookeri* Braun, in Hooker's J. Bot. I., p. 199 (1849); Br. & Nordst., Fragmente, pp. 15, 86-88 (1882); Hooker, Handbook New Zealand Fl., p. 550 (1864).

Figure.—Br. & Nordst., 1 c., figs. 172-176.

Monœcious. Whorls of 6-8 branchlets, the lower lax and distant, the upper somewhat capitate. Branchlets 1-2-, occasionally partly 3-, times forked. Dactyls 3-4-celled, the lowest one or two cells elongated, the next usually abbreviated and conspicuously narrower and along with the short still narrower conical end-cell forming a small mucro. Oogonia often 2-3 at a node. Oospore very dark brown, c. 425μ long, 350-375μ broad, showing about 7-9 strong ridges; membrane thick, usually of two layers, the outer finely and densely granulate. Antheridia 300-360μ in diameter.

Locality.—Included from Queensland without locality in Bailey's Catalogue.

It is usually readily distinguishable by the shape of the dactyl and its being monœcious and without mucus.

An endemic Australasian species, occurring in S. Australia, Victoria, N.S. Wales, Tasmania, New Zealand, and Kerguelen Island.

HETEROCLEMÆ.

19. *N. lhotzkyi* Braun, in Hooker's J. Bot. I., p. 197 (1849); *Chara Lhotzkyi,* Br., in Linnæa XVII., p. 114 (1843); *N. conglobata* var. *Lhotzkyi,* Br. & Nordst., Frangmente, p 75 (1882).

Figure.—Kuetzing, Tab. Phyc. VII., pl. 39, fig. 1 (1857).

Diœcious. 7-8 larger twice furcate branchlets to the whorl, 1-6 (-12) smaller once furcate branchlets. 3-5 dactyls, 2-celled; end-cell a very narrow mucro. Oospore c. 300μ long; membrane shows shallow reticulation.

Localities.—Copperfield, 1871, ♀, v. Boweran; Sources of Thompson River, 1871, ♂, Birch; Murweh, Warrego R., March, 1912, ♂, A. Cameron.

An altogether smaller plant than *N. congesta.* An endemic Australian species, recorded from various parts of the Continent.

20. *N. congesta* (R. Brown) Braun, in Hooker's J. Bot. I., p. 198 (1849); *Chara congesta,* R. Brown, 1810, prodr. I., p. 346 (1810); Braun, in Linnæa XVII., p. 114 (1846-7)); Br. & Nordst., Fragmente, pp. 14, 77 (1882).

Nordst., De Alg. et Char., p. 12 (1889), Australasian Characeæ (1891.)

Figure.—Br. & Nordst., 1 c., fig. 153; Nordst., Austr. Char., pl. 6 (1891).

Diœcious. Young whorls with a mucous covering. Whorls very dense, sperical, 5-10 (-30) mm. in diameter; branchlets in three series, larger 7-8 to a whorl, 3- and sometimes partly 4-times forked, smaller series about 40, 1-3-times forked. Dactyls gradually attenuate, 2-celled; end-cell tapering to a sharp point. Oogonia clustered, often 3 together, at first and second forkings only. Oospore dark brown 400-450μ long, 350-400μ broad, showing about nine very broad ridges; membrane "slightly spongy" (Nordst.), "minutely granulate, some granules larger and more prominent than others" (Bullock-Webster).

Locality.—This may or may not be a Queensland species; it is recorded "ad Novæ Hollandiæ oram septenrionalem et australem" by Braun.

A very luxuriant plant, readily distinguishable from the foregoing by its rigid and robust character and by the dense globular whorls which include numerous secondary branchlets.

Occurs in N., S., and W. Australia and Tasmania.

21. *N. hyalina* Agardh, Systema Algarum, p. 126, ex parte (1824); Br. and Nordst., Fragmente, p. 78 (1882).

Figures.—Kuetzing, Tab. Phyc. VII., pl. 35, fig. 2 (1857); Bailey, l.c., fig. 686; Groves & Bullock-Webster, British Charophyta, vol. I., pl. XVI. (1920).

Monœcious. Branchlets in 3 series, usually 8 larger ones and about 16 smaller and simpler secondary branches in 2 series, one above and the other below the primary branchlets. Primary branchlets 2-3 furcate, upper secondary 1-2 furcate, lower once furcate or simple. Dactyls uniformly 2-celled, the lower cell gradually narrowing; end-cell narrowly conical acute. Gametangia enveloped in mucus, occurring usually at the second and third forkings, rarely at the first, of the primary brachlets, sometimes occurring also on the secondary. Oogonia solitary; oospore brown, c. 250-400μ long, c. 200-300μ broad, showing 8-9 ridges. Membrane granulate.

Localities.—Rockhampton, W. Watson (comm. F. v. Mueller, 1876); Roper River (var. *brachyactis*); Flinders R., 1883, E. Palmer; Burketown and Gregory R., Gulf of Carpentaria, 1886, T. L. Bancroft; Gladfield, near Warwick, C. J. Gwyther; Murphy's Creek, April, 1910, T.L.B.; Upper Brookfield, Brisbane, June, 1926, C. T. White; Pine R., September, 1928, and February, 1929, R. Hamlyn-Harris; Enoggera Creek, November, 1928, September, 1933, R. H.-H.; Hatchery, Brisbane, 1929, R. H.-H.)

Readily distinguishable from *N. Stuartii* by the 2-celled dactyls and from the other two heteroclemous species by its monœcious character.

This species, first found in the Lake of Geneva, Switzerland, was later recorded from various other parts of Europe and subsequently from all over the world.

22. *N. stuartii* Braun, in Linnæa XXV., p. 704 (1852); Braund & Nordstedt, Fragmente, p. 704 (1882); Nordstedt, De Alg. et Char., pp. 7, 23 (1889); *N. subglomerata,* Braun, var. *japonica,* T. F. Allen, 1896, Torrey Bull. Bot. Club, XXII., p. 251.

Figure.—Kuetzing, Tab. Phyc. VII., pl. 42, fig. 2 (1857).

Monœcious. Stem moderately stout. Upper whorls of branchlets in two circles, those of the upper circle longer than the lower, varying considerably in number, all twice forked; the secondary rays of the lower circle short, usually 5-6; dactyls 4-8, nearly equal in length, fairly long, uniformly 1-celled, with acuminate points. Gametangia produced at both forks. Oogonia in clusters of →6 together; coronula rather conspicuous, hardly broader than high; oospore rich golden-brown, 200-250μ long, 175-200μ broad, 90-100μ thick, showing about 6 well-marked but not prominent ridges, membrane finely reticulate, walls of the meshes rather thick. Antheridia about 200-225μ in diameter.

Locality.—Shallow part of main stream, Cash's Crossing, Pine River, September, 1928, R. Hamlyn-Harris. Apparently the only record for this species from the mainland of Australia.

A very distinct plant which cannot be confused with any other species, being distinguished by the double circle of branchlets, and twice-forked branchlets, coupled with 1-celled dactyls. This and *N. polygyra* (not recorded from Queensland) seem to be the only Australian species having single-celled dacytls.

N. stuartii was first described from Tasmania, and has since been found in North Island, New Zealand, and in Japan.

CHARA Linn.

HAPLOSTEPHANÆ. Stipulodes in a single circle.

ECORTICATÆ. Stem and brachlets without cortex.

1. *C. australis* R. Brown, Prodr., p. 346 (1810).

Figure.—Kuetzing, Tab. Phyc. VII., pl. 27 (1857).

Diœcious. Stem varying in thickness, often very stout, entirely ecorticate. Branchlets 5-7 in a whorl, of usually 4 segments, the ultimate segment very short conical acute often curved; bract-cells often only partially developed, and as well as the bracteoles and bractlet very short narrow acute. Stipulodes very short conical acute, singly or in pairs, alternating with the branchlets. Oogonia produced at the base of the branchlets and singly or in clusters of 2-3 at the free nodes. Coronula-cells connivent, straight or spreading. Oospore black, broadly-ellipsoid or sub-cylindrical, c. 550-800 μ long, showing 7-8 firm low ridges. Antheridia c. 1,100 μ in diameter, at the base and at the free nodes of the branchlets.

Localities.—Main Range, near Brisbane, C. H. Hartman; Pine River, 1928, R. Hamlyn-Harris; Gulf Country, Northern Queensland, T. L. Bancroft, No. 30 (Herb. Brisbane); recorded also by Braun (1882) from Gulf of Carpentaria (coll. F. v. Mueller, 1856) but whether from East or West coast is not stated.

A characteristic Australasian species, occurring in many parts of Australia and in Tasmania, New Zealand, New Caledonia, and the Fiji Islands. Outstanding features are the few branchlet-segments, the small often minute sharply pointed stipulodes bract-cells and ultimate branchlet segments, the gametangia (♀♂) being produced at the base of the whorl and clustered at some of the free nodes. Typically it is a rather large stout bright green plant with rather short branchlets, the internodes swollen so that the nodes appear constricted, but more slender forms (vars. *lucida* and *Viellardi*) have been found.

2. *C. macropogon* Braun, in Linnæa XVII., p. 116 (1843); *Lychnothamnus macropogon*, Braun, Char. Afr., p. 798 (1868); *Macropogon australicum*, Migula, Die Characeen, p. 273 (1891).

Figures.—Kuetzing, Tab. Phyc. VII., pl. 46, fig. 1-2 (1857); Bailey, l.c., fig. 688.

Monœcious. Stem rather slender, entirely ecorticate, upper internodes often very short, the whorls forming dense heads. Branchlets 6-8 (-10) in a whorl, usually of 4-5 segments. Bract-cells at the lower nodes 4-5, long slender and divergent, often shorter and less numerous at the upper. Stipulodes normally very long and slender, declining, but sometimes short and even rudimentary, one produced opposite the base of each branchlet, sometimes with small adventitious ones between them and occasionally some produced above the branchlets on the inner side of the whorl. Oogania most produced in the axils of the branchlets and equalling them in number, rarely one or two on the outer side of the whorl, also occasionally on some of the free nodes of the branchlets, rarely in company with the antheridia; coronula short erect, the cells ellipsoid or nearly spherical. Oosport very dark brown, c. 500-600 μ long, 250-300 μ broad, showing about 10-12 low ridges. Antheridia at the free nodes of the branchlets, and occasionally at some at the base, c. 500 μ in diameter.

Localities.—Rockingham Bay, Salt-water Creek, March, 1868, J. Dallachy; Westbrook, near Toowoomba, November, 1911, H. Tryon.

A characteristic Australasian species, occuring in N. and S. Australia, Victoria, Tasmania, and New Zealand; also found in a few localities in China and South Africa. A moderate-sized plant; in the typical form the long graceful declining stipulodes are a very marked feature, and this conspicuous "beard" gave rise to its specific name. The segregated ♀ and ♂ organs and the densely crowded upper whorls, forming "foxtails" are not met with in any other Queensland species. Large spherical, nearly white root-bulbils have been found and are probably frequent, but few collectors obtain the rooting parts of these plants.

3. *C. braunii* Gmelin, Fl. Bad., Alsat. IV. (suppl.), p. 646 (1826); *C. coronata* (and *C. braunii*), Bischoff (1828).

Figures.—Kuetzing, Tab. Phyc. VII., pl. 43, fig. 1 (1857); Nordstedt, Austral. Char., pl. 7 (1891).

Monœcious. Stem of moderate diameter, entirely ecorticate, internodes fairly long. Branchlets about 8-10 in a whorl, of 4-5 segments, the ultimate segment often very short. Bract-cells varying greatly in development, sometimes all elongated, sometimes the posterior quite rudimentary, produced at all the nodes, those at the final node often as long as the ultimate segment of the branchlet. Stipulodes alternating with the branchlets, varying greatly in length. Gametangia produced at the free nodes of the branchlets. Oogonia often germinate. Coronula-cells spreading, upright or connivent. Oospore black, very variable in size, 400-600 μ long, showing 5-10 ridges. Antheridia c. 250-300 μ in diameter.

Localities.—Isolated pool, Cash's Crossing, Pine River, September, 1928, R. Hamlyn-Harris; also recorded from Richmond River (1887) by Nordstedt.

A medium-sized plant, often tufted in growth, but not producing dense heads. From its clear green ecorticate stems and branchlets, and rather lax habit, it has often been mistaken for a Nitella. It is almost world-wide in its distribution, and as might be expected is extremely variable. It is readily distinguishable from the other two ecorticate species by the gametangia not being produced at the base of the whorl; from *C. australis* also by being monœcious, from *C. macropogon* by the stipulodes alternating with the branchlets. The ultimate segment of the branchlet being about the same length as the subtending bract-cells gives the effect of a little crown at the extremity of the branchlet.

CORTICATÆ. Stem corticate, branchlets ecorticate.

4. *C. submollusca* Nordstedt, in Hedwigia, p. 189 (1888).

Figures.—Nordst., l.c., pl. 6, figs. 7-11; Bailey, l.c., fig. 689.

Diœcious. Stem 200-400 μ in diameter, cortex 1-ranked. Spine-cells nearly spherical with acute points. Branchlets ecorticate 6-11 in a whorl of 3-4 segments. Bracteal appendages (developed) in ♀ 5-6, acuminate or acuminate-mucronate, posterior very short or rudimentary; in ♂ 2-4 developed. Stipulodes twice as many as the branchlets, very small, acuminate. Oogonium c. 700 μ long (excl. cor.), 450 μ broad; coronula-cells very short, connivent. Oospore very dark brown or black, 360-570 μ long, 260-350 μ broad, showing about 7 ridges. Antheridium $\rightarrow$600 μ in diameter.

Localities.—Rockingham Bay, Salt-water Creek, March, 1868, J. Dallachy; between the Norman and Gilbert Rivers, 1874, T. Gulliver; Cairns, 1892, G. Podenzana; "Tropical Australia" (Queensland ?), Mueller.

C. submollusca is slender and sometimes exceeds a foot in height. The outstanding character is the single series of cortical-cells, corresponding in number with that of the branchlets. The rows of cells are sometimes non-contiguous. A very interesting feature is the occasional presence of reserves of starch in some internodes of the stem and in the lower parts of the branchlets which latter are white and swollen, giving them quite a different appearance from the normal branchlets. This curious condition is figured by Nordstedt in fig. 11.

5. *C. preissii* Braun, in Linnæa XVII., p. 118 (1843).

Figures.—Kuetzing, Tab. Phyc. VII., pl. 45, fig. 1, pl. 50, fig. 2 (1857).

Diœcious. Stem moderately stout; cortex diplostichous, the cells of both series of about equal diameter; spine-cells acute varying in length, sometimes as long as the diameter of the stem, sometimes quite short. Stipulodes usually well-developed (in the type) twice as numerous as the branchlets. Branchlets ecorticate 10-14, of 5-6 segments. Bracteal appendages 3-5, usually well-developed, acuminate. Coronula short, the cells connivent. Oospore described as black. Antheridium $\rightarrow 800\mu$ in diameter.

Locality.—Herbert Creek, E. Bonman, 1870 (fide Nordstedt).

In Braun's later works *C. preissii* was combined with *C. Hookeri* to form a composite species, *C. dichopitys*. It has been recorded from Western Australia, New South Wales, Victoria, and Tasmania, as well as from Queensland.

B. *Bancroftii* Groves MS., Var. nov. Unum stipulodium ad quemque ramulum.

Localities.—Dalby, May, 1893, ♂, T. L. Bancroft; Sandgate, November, 1911, ♂, C. T. White; Enoggera Reservoir, May, 1912, ♀♂, C.T.W.

The above plants seem to be uniformly unistipulate (i.e., stiplodes equalling the branchlets in number), but in this section of Chara the character does not appear to be a stable one. Further investigation of this and the type may elicit other points of difference between them and make it desirable to separate the variety as a distinct species. The antheridia measured were c. 600μ in diameter. The oospore of the Enoggera plant is very dark brown, c. 400μ long, 275μ broad, and shows c. 8-9 strong ridges.

(*C. leptopitys* Braun, also diœcious, but differing from the foregoing species in producing gametangia at the base of the whorl, as well as at the free branchlet-nodes, occurs in Western Australia, South Australia, Victoria, and Tasmania.)

6. *C. gymnopitys* Braun, in Linnæa XXV., p. 708 (1852).

Figures.—Kuetzing, Tab. Phyc. VII., pl. 50, fig. 1 (1857); Bailey, l.c., fig. 690.

Monœcious. Stem moderately stout, usually rather rigid, cortex 2-ranked, the primary cells sometimes larger than, some the same size as the secondary. Branchlets escorticate 9-14 in a whorl, usually of 4-6 segments. Bract-cells produced at all the nodes, varying greatly in number, $\rightarrow 10$, long and slender, acuminate; bracteoles similar. Stipulodes numerous ($\rightarrow$twice the number of the branchlets) usually long occasionally rudimentary. Coronula very variable, the cells sometimes short and connivent, sometimes long and divergent. Oospore dark brown to nearly black, varying greatly in size. Antheridia 300-450μ in diameter.

Recorded by Braun from "Moreton Bay, F. Muller, 1858"; by Nordstedt from "Lagoon-road to Cawaral, Q. Thozet," and from "Bloomfield River, Miss Bauer, 1885." These I (J.G.) have not seen; all the specimens from Queensland which I have examined come under the following:—

B. *Benthamii, Chara Benthami* Braun. Stipulodes equalling, or but slightly exceeding the branchlets in number, usually shorter and stouter than in the type.

Localities.—Brisbane, 1883, F. M. Bailey; Brisbane River, F.M.B.; head of Ithaca Creek, 1885, H. Tryon; Gregory R., Gulf of Carpentaria, 1886, T. L. Bancroft; Mount Perry, 1891, J. Keys; Burpengary, T.L.B.; Burketown, T.L.B.; Cochin Creek, 1910, T.L.B.; Corinda, 1911-2, C. T. White; Brisbane Botanic Gardens, 1912, C.T.W.; Enoggera Creek, 1912, C.T.W., and 1927, and September, 1933, R. Hamlyn-Harris; St. Lucia, 1927, R. H.-H.; Murarrie, 1928, R. H.-H.; Tingalpa, 1928, R. H.-H.; Pine River, 1928, R.H.-H.; Hatchery, Brisbane, 1929, R.H.-H.

The stipulodes of the variety appear normally to equal the number of the branchlets, but sometimes exceed it, owing to the presence of a few adventitious ones, but never in the specimens I have examined approach to double the number. Braun placed *C. Benthami* in the section Unistipulatæ, but recognised that the character was not a stable one among the Haplostephanæ. He placed *C. gymnopitys* among the Bistipulatæ. From the examination of a large number of specimens of these plants from different parts of the world, I incline to the view that the type forms represent the two extremes of a widely-distributed tropical and subtropical species. In *C. gymnopitys* type, the stipulodes and bracteal appendages tend to be longer and more slender than in var., and the bract-cells more numerous. The Cochin Creek plant is an unusually slender form, with small fruits, the oospore measuring c. 325 μ in length, 250 μ in breadth.

DIPLOSTEPHANÆ. Sipulodes in a double circle.

DIPLOSTACHÆ. *Corticla-cells of stem 2-ranked.*

7. *C. contraria* Kuetzing, Phyc. Germ., p. 158 (1845).

Figure.—Kuetz., Tab. Phyc. VII., pl. 61 (1857).

Monœcious. Stem varying greatly in diameter, from quite slender to rather stout; cortex regularly 2-ranked, the primary series more prominent than the secondary; spine-cells solitary obtuse. Branchlets 6-10 in a whorl, consisting of 5-7 segments, the several lower corticate, the cortex 2-ranked, the upper ecorticate; bract-cells about 5, the posterior often rudimentary. Stipulodes in a double row, two pairs to each branchlet, usually rather short, and somewhat irregular in development. Coronula-cells straight or spreading; ripe oospores very dark, almost black, c. 500-700μ long, 350-425μ broad, showing 10-14 ridges. Antheridia 300-450μ in diameter.

Locality.—Currumbin, November, 1911, C. T. White.

A very widely distributed species, occurring in all the continents; in Australasia recorded from W. Australia, S. Australia, New South Wales, Victoria, Tasmania, and New Zealand. Not included in Bailey's list of Queensland Charophytes, and at present only known from one locality. The Currumbin specimens belong to a rather stout vigorous form; the oospores are about 600μ long, 350μ broad, and show about 10 ridges. The greater prominence of the primary series of cortical-cells so that the spine-cells are seated on ridges, the much darker ripe oospores, and the somewhat irregular stipulodes, serve to distinguish *C. contraria* from *C. vulgaris,* which latter species it closely resembles, but which has the secondary cortical-cells more prominent than the primary so that the spine-cells are seated in furrows. *C. vulgaris* has not so far been found in Australia but is recorded from New Zealand and is one of the commonest species in many parts of the world. Both *C. contraria* and *C. vulgaris* are usually incrusted with carbonate of lime.

TRIPLOSTICHÆ. *Cortical-cells of stems 3-ranked.*

Phlœopodes. Lowest branchlet-segment corticate.

8. *C. leptosperma* Braun; Braun & Nordstedt, Fragmente, p. 184 (1882).

Figure.—Br. & Nordst., 1 c., figs. 93-96.

This species was founded on a plant collected by Liebmann in Mexico in 1853. The principal characters relied upon to separate it from the closely allied *C. fragilis* were that the oospore is yellow (not black as in *C. fragilis*) and more slender than in that species, and that the stipulodes of both series are well-developed.

A plant collected by Edward Palmer in 1882 in Mitchell River, Carpentaria, was referred by Nordstedt (1889, p. 39) with a considerable element of doubt, to a variety of this species though it differed a good deal from the Mexican plant. It is much to be hoped that the Mitchell R. plant may be again collected so that it can be satisfactorily determined, as the specimen seen was a very bad one.

9. *C. fragilis* Desv., in Loisel. Not. aj. Fl. Fr., p. 137 (1810).

Figure.—Kuetzing, Tab. Phyc. VII., pl. 54 (1857).

Monœcious. Stem slender, firm and brittle; cortex regularly 3-ranked; primary and secondary series of equal diameter; spine-cells rudimentary. Branchlets 7-8 in a worl, consisting of 8-10 segments, mostly corticate, the cortex 2-ranked; bract-cells acuminate-mucronate, about 7, the anterior 2-4 elongate, usually not exceeding $\frac{1}{2}$ the length of the fruit, the rest $\pm$ rudimentary. Stipulodes rudimentary or very slightly developed. Coronula-cells connivent, straight, or slightly divergent; ripe oospores near black, 550-700μ long, 350-450μ broad, showing 12-15 ridges. Antheridia about 500μ in diameter.

Localities.—Gladfield, near Warwick, C. J. Gwyther; Flinders River, F. von Mueller; Hatchery, Brisbane, November, 1928, R. Hamlyn-Harris; Gatton, August, 1929, R.H.-H.

Probably the most widely distributed of all the Charophyta. The 3-ranked stem-cortex, the 2-ranked branchlet-cortex, the nearly black oospore and the corticate lowest branchlet-segment, mark this off from all the other Queensland species.

GYMNOPODES. Lowest branchlet-segment ecorticate.

10. *C. zeylanica* Willdenow in Mem. Acad. Berl for 1803, p. 86 (1805); *C. polyphylla*, Braun, olim.; *C. gymnopus*, Braun in Monats. Berl. Akad. for 1867, p. 942 (1868).

Figues.—Willdenow, l.c. pl. 2, fig. 1; Kuetzing. Tab. Phyc. VII., pl. 57, fig. 1 (1857),

Monœcious. Stem usually rigid and brittle, the cortex regularly 3-ranked; spine-cells solitary, acute, usually short. Branchlets usually numerous ($\rightarrow$14), of 7-14 segments, the lowest ecorticate, the several succeeding corticate, the cortex normally 3-ranked, the upper 1-4 seggents ecorticate. Coronula variable; oospore black ovoid or nearly cylindrical, very variable in size. Antheridium $\rightarrow 550\mu$ in diameter, the envelope consisting of four shields.

Locality.—Mitchell River, Carpentaria, 1882, Edward Palmer (fide Nordstedt, 1889, p. 40).

C. zeylanica is widely distributed in tropical and subtropical countries in both hemispheres. The ecorticate lowest branchlet-segment and the normally 3-ranked branchlet-cortex readily separate it from any other Australasian Chara, but the most remarkable character, which it does not appear to share with any other described Charophyte, is the quadriscutate antheridium.

BIBLIOGRAPHY.

BAILEY, F. M.—A Synopsis of the Queensland Flora. First Supplement, Brisbane, 1886. Second Supplement, 1888. Third Supplement, 1890.

Comprehensive Catalogue of Queensland Plants, pp. 678-682, 851, figs. 686-690. Brisbane, 1913.

BRAUN, ALEX.—Charæ Preissianæ (Linnæa, Vol. XVII., pp. 113-119). 1843.

Charæ australes et antarcticæ (Hooker, J. Bot., I., pp. 193-204). 1849.

Plantæ Müllerianæ (Linnæa, Vol. XXV., pp. 704-709). 1852.

Flora Tasmaniæ II., Hooker, J. D., pp. 159-160. 1860.

Handbook of the New Zealand Flora, Hooker, J. D., London, pp. 549-550. 1864.

BRAUN, ALEX., and NORDSTEDT, C. F. O.—Fragmente einer Monographie der Characeen. Berlin, 1882.

BROWN, ROBERT.—Prodomus Floræ Novæ Hollandiæ et insulæ, Van Diemen I., p. 346. 1810.

GROVES, J.—A New Species of Nitella (Characeæ) from Southern Queensland. Proceedings Royal Society Queensland, Vol. XXXVIII., No. 16, p. 262 [Description of *N. phauloteles* sp. nov.]. 1927.

GROVES, J., and BULLOCK-WEBSTER, G. R.—British Charophyta. London, 1920 and 1924.

KUETZING, F. T.—Tabulæ Phycologicæ, VII. Nordhausen, 1857.

Phycologia Germanica. Nordhausen, 1845.

MUELLER, FERD. VON.—Second General Report of the Government Botanist on the Vegetation of the Colony [Victoria], p. 17. 1854.

NORDSTEDT, C. F. OTTO (See also Braun and Nordstedt).—''De Algis et Characeis,'' Part 2 (Characeæ Novæ Zeelandiæ), Act, Univ. Lundens, XVI. 1880.

''Einege Characeen bestimmungen,'' Hedwigia, pp. 181-196, pl: VI. 1888.

''De Algis et Characeis,'' parts 4-6, pp. 2-40. Lunds Univ. Arssk. XXV. 1889.

''Australasian Characeæ,'' Part I. Lund, 1891.

Australasian Characeæ,'' Proc. Roy. Soc. Victoria, XXXI. (new series), Part I. 1918.

An Interpretation of the Silverwood-Lucky Valley Upper Palæozoic Succession.

By A. H. VOISEY, B.Sc.

(One Text Figure.)

(*Communicated by Dr. W. H. Bryan to the Royal Society of Queensland, 27th August,* 1934.)

INTRODUCTION.

The whole Silverwood area was first thought to be Permo-Carboniferous on the evidence of fossils found in various places. Professor H. C. Richards and Dr. W. H. Bryan[1] in 1924 explained the area as a number of isolated fault blocks of Permo-Carboniferous material within an older series of Middle Devonian Age. They attempted to place the individual blocks of Permo-Carboniferous material into their proper relative stratigraphical positions as follows:—

Volcanic Series
Condamine Beds
Wallaby Beds
Eurydesma Beds.

An endeavour was then made to correlate the suite thus assembled with the Kamilaroi sequence in N.S.W. The Eurydesma Beds were considered Lower Marine, the fresh water Wallaby Beds Greta, and the rest Upper Marine.

In 1930 J. H. Reid (p. 48) disagreed with Richards and Bryan's interpretation on two points:—(1) the correlation of the Permo-Carboniferous, and in particular the position of the Condamine Beds which he regarded as certainly on the lowest stratigraphical horizon of those described from Silverwood and to be of the transition series which he advocated for the beds of Gympie, Silverspur, Drake, and Kempsey; (2) the evidence of an important folding movement later than the Silverwood Series (Devonian) and earlier than the Fault Block Series (Permo-Carboniferous).

During February last I paid a visit to the Silverwood district with a view to comparing the sequence of Upper Palæozoic rocks there with that found in the Macleay and Hunter River districts of New South Wales.

Being in agreement with Reid as to the position of *Monilopora* low in the sequence, after finding it at Kempsey, I looked for it in the Eurydesma Block below the Eurydesma horizon and the search was successful. This discovery made it imperative that the Condamine Beds be placed below the Eurydesma beds as proposed by Reid from evidence elsewhere. As to Reid's suggestion that the Condamine Beds belong to a transitional marine series in place of the fresh-water Kuttung Beds of New South Wales, I disagree on the grounds that the Kempsey Monilopora beds, which may be correlated with those at Silverwood, overlie fresh-water Kuttung rocks including tillite, varves, and *Aneimites*. Detailed correlation of the Carboniferous and Permian rocks of New South Wales and Queensland will be attempted later.

The other alterations in the Fault Block sequence seem desirable on account of the evidence presented below. The position of the volcanic series is more in accord with Reid's suggestion (p. 50) that it can be correlated with the Stanwell Lower Bowen Volcanics even to the *Glossopteris* horizon.

My thanks are due to Dr. W. H. Bryan for his valuable advice and directions with regard to the field work. The hospitality of Mr. and Mrs. H. W. Scott, of Stanthorpe, and Mr. and Mrs. R. Hamilton, of Warwick, enabled me to carry out my observations. Without the help of Mr. Hamilton, who was my guide in the field, it would have been impossible for me to have become acquainted with the whole sequence.

THE RELATIONSHIP BETWEEN THE CONDAMINE BEDS AND THE EURYDESMA BEDS.

As Reid pointed out, the correlation of the Condamine Beds with the Upper Marine Series of the Hunter Valley (N.S.W.) because of the abundance of *Trachypora wilkinsoni* has been invalidated since 1924. Richards and Bryan described the upper strata of the Condamine Beds as rhyolitic tuffs and very tuffaceous grits, lighter in colour and coarser in grain than the underlying beds (R. and B., p. 66). The highest bed is a "tuffaceous grit containing marine fossils" (*Martiniopsis* cf *subradiata, Monilopora,* and a zaphrentoid coral were collected by me from the top of the series).

Now the lowest beds of the Eurydesma Block are "conglomerates and grits containing numbers of marine fossils, the most typical genera of which are *Fenestella, Dielasma,* and small Palæopectens" (R. and B., p. 60). These are distinctly tuffaceous in places and some might be better described as dark green tuffs. In fact, they resemble strongly the uppermost beds of the Condamine Block. This resemblance is such that it indicates little, if any, break in the sequence between the two sets of strata.

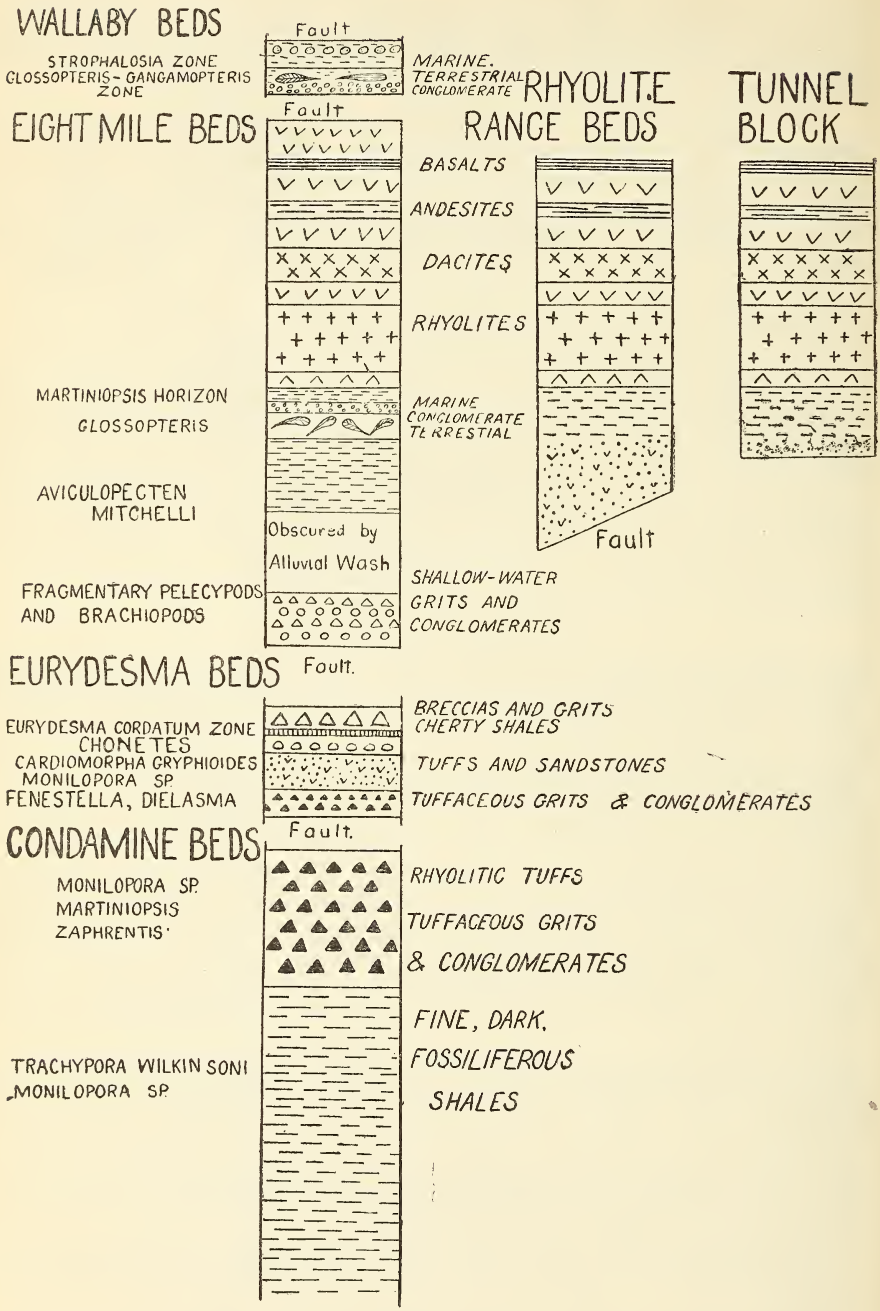
Just above the grits and tuffs of the Eurydesma Block are "brown and grey sandstones some 270 feet in thickness, for the most part, poorly fossiliferous, but containing in the upper part *Cardiomorpha gryphioides*" (R. and B., p. 69). It was in the lower section of this unit, just above the grits, that a number of specimens of *Monilopora* were found. Small Palæopectens are associated with the coral.

In view of the presence of the *Monilopora* and tuffaceous grits at the top of the Condamine beds and also at the base of the Eurydesma Beds it seems that the Condamine beds immediately underlie the Eurydesma Beds. Moreover, this is based solely upon the field evidence. Apart from this Richards and Bryan[1] and Reid[3] agree that it is unlikely that the typically Carboniferous corals, *Monilopora* and *Cladochonus,* would be present high up in the Permian.

The lowest beds of the Condamine Block are covered by Mesozoic sediments.

THE RELATIONSHIP BETWEEN THE EURYDESMA BEDS AND THE WALLABY BEDS.

Richards and Bryan[1] wrote of the Eurydesma and Wallaby Beds:— "The marked divergence in strike may represent a time gap of some importance, but on the other hand it may represent a dislocation brought


WALLABY BEDS
STROPHALOSIA ZONE
GLOSSOPTERIS - GANGAMOPTERIS ZONE
Fault
MARINE.
TERRESTRIAL
CONGLOMERATE
EIGHT MILE BEDS
Fault
RHYOLITE RANGE BEDS
TUNNEL BLOCK
BASALTS
ANDESITES
DACITES
RHYOLITES
MARTINIOPSIS HORIZON
GLOSSOPTERIS
MARINE
CONGLOMERATE
TERRESTIAL
AVICULOPECTEN MITCHELLI
Obscured by Alluvial Wash
Fault
FRAGMENTARY PELECYPODS AND BRACHIOPODS
SHALLOW-WATER GRITS AND CONGLOMERATES
EURYDESMA BEDS
Fault.
EURYDESMA CORDATUM ZONE
CHONETES
CARDIOMORPHA GRYPHIOIDES
MONILOPORA SP.
FENESTELLA, DIELASMA
BRECCIAS AND GRITS
CHERTY SHALES
TUFFS AND SANDSTONES
TUFFACEOUS GRITS & CONGLOMERATES
CONDAMINE BEDS
Fault.
MONILOPORA SP.
MARTINIOPSIS
ZAPHRENTIS
RHYOLITIC TUFFS
TUFFACEOUS GRITS
& CONGLOMERATES
FINE, DARK, FOSSILIFEROUS SHALES
TRACHYPORA WILKINSONI
MONILOPORA SP.

about by the heavy faulting which dropped the whole Stanthorpe Road Block into the Silverwood Series. The fact that the two sets of beds are adjacent units in the same infaulted block suggests that they are approximately of the same age.''

The junction between the Wallaby Beds and the Eurydesma Beds is definitely a fault. This just crosses the ridge before the ascent to the Wallaby Rocks is made. Small creeks follow the fault plane on either side of the ridge. It may seem likely the beds, being adjacent are not far separated in age but there does not appear to be anything else to favour a close relationship. A glance at the fossil lists taken from that given by Richards and Bryan[1] shows that many new forms came in with the Marine Wallaby beds while only two, *Fenestella fossula* and *Stutchburia costata,* are common to them and the Eurydesma Beds.

The amount of strata lost by faulting is unknown and the difference in strike can be accounted for by the fracture of some folded structure or perhaps rotation by the fault.

In view of the lack of field evidence to indicate a close stratigraphical relationship between the two sets of beds one is forced to use the palæontological evidence which demands a considerable break.

	Eurydesma.	Volcanics.	Wallaby.
Fenestella internata			X
Orbiculoidea sp.			X
Strophalosia jukesii			X
Strophalosia cf. clarkei			X
Strophalosia cf. gerardi			X
Spirifer stokesii			X
Spirifer cf. vespertilio			X
Solenopsis sp.			X
Mytilus cf. bigsbyi			X
Aviculoptecten sprenti			X
Astartila sp.			X
Martiniopsis oviformis		X?	X
Protoretepora ampla		X	X
Productus brachythaerus		X	X
Polypora		X	X
Spirifer tasmaniensis		X	X
Spirifer duodecimacostata ..		X	X
Deltopecten farleyensis		X	X
Deltopecten subquinquelineatus ..		X	X
Fenestella fossula	X	X	X
Stutchburia costata	X	X?	X
Chonetes sp.	X	X	
Dielasma	X	X	
Martiniopsis subradiata	X?	X	
Edmondia sp.	X	X	
Chænomya sp.	X	X	
Mœonia sp.	X	X	
Aviculopecten mitchelli	X?	X	
Cleobis	X	X?	
Platyschisma oculum		X	
Aviculoptecten squamuliferus ..		X	
Cardiomorpha cf. gryphiodies ..	X		
Eurydesma cordatum	X		

THE POSITION OF THE VOLCANIC SERIES.

The fauna of the volcanic series has an almost equal number of forms common to the Eurydesma Beds and the Wallaby Beds. It thus seems to bridge the gap between the two. Further collecting would no doubt alter this balance but the fossils so far obtained are all in favour of placing the Volcanic Series between the Eurydesma Beds and the Wallaby Beds.

At any rate, the Volcanic Series cannot be considered Upper Marine on faunal evidence. *Aviculoptecten mitchelli,* for instance, has not been recorded so far from Upper Marine Strata.

Apart from the palæontological aspect the volcanic rocks are an important consideration. Reid[3] thinks it improbable that there should be a thick series of volcanic flows on such a high Bowen horizon in Queensland as that allotted to the Silverwood occurrence by Richards and Bryan.

A correlation of the series with the Kiama volcanic rocks is not likely. Richards and Bryan[1] when suggesting that this might be so stated "while there is much evidence for considering the two series contemporaneous they are chemically and petrologically quite distinct, the Kiama Series being essentially potash-rich while the local volcanics are relatively poor in this base.

It is more probable that a close correlation could be made with the Lower Bowen volcanic rocks elsewhere in Queensland. Rhyolites, dacites, and andesites are common in this position.

It will be remembered that the tuffs in the Condamine beds are rhyolitic in composition, and I have noted some acid tuffs in the Eurydesma Beds below the *Cardiomorpha* horizon. Richards and Bryan[1] pointed out that there was a progressive change from acidic to basic lavas and tuffs in the volcanic section. If this generalization is true for the whole sequence the rhyolitic tuffs of the Condamine and Eurydesma Blocks must be below the volcanic series. As to the continuity, then, we note that the beds above the *Eurydesma* horizon are mudstones followed by "breccias and grits containing fragments of large and thick-shelled pelecypods." The lowest beds of the Eight-mile Block which are met in the field are described as "shallow-water grits and conglomerates, the former containing fragmentary remains of pelecypods and brachiopods" (R. and B., p. 63). There is here a very marked lithological relationship which makes it easy to imagine a continuity from the Eurydesma Beds into the Eight-mile Block Marines. Moreover, there is, less than a mile between the topmast beds of the Eurydesma Block and the lowest of the Eight-mile Block.

The possibility of the Volcanic Series underlying the Condamine Beds was considered and rejected owing to the great amount of evidence pointing to the position suggested above. Also the fauna cited is probably later than the corals, *Monilopora* and *Cladochonus*, and I feel that *Glossopteris,* at any rate, would be out of place a few thousand feet below these.

A REVIEW OF THE SEQUENCE.

I am inclined to the view that the only stratigraphical break of any magnitude in the Fault Block Series is that between the Volcanic Series and the Wallaby Beds. However, this does not seem very important because the only beds lost are probably lavas and tuffs. The conglomerate below the *Glossopteris-Gangamopteris* Beds looks like the base of the series. It appears that, after the extrusion of the lavas, there was a development of a fresh-water lake without an intervening marine stage.

If the conclusions arrived at are accepted, the whole sequence may be considered without referring to the field occurrence. On the evidence of the nature of the sediments and the fossils contained therein the Fault Block Series may be divided into five stages:—

(5) Shallow Water Marine.

(4) Fresh Water.

(3) Volcanic.

(2) Shallow Water Marine (with oscillations to fresh-water conditions in the upper part).

(1) Deep Water Marine.

It may be of some significance that, with the exception of the Wallaby Block, the rocks get younger to the west—the general dip being in this direction also.

With regard to the age of the beds the Wallaby Fresh Water horizon is taken to be of Greta or Lower Coal Measure age as Richards and Bryan[1] suggest. The Marine Wallaby Beds might then be equivalent to the Upper Marine of the Hunter Valley, New South Wales, while the Volcanic, Eurydesma and Condamine stages are Lower Marine.

GEOLOGICAL HISTORY.

The deep water calcareous shales of the Condamine Block were deposited well away from the shore line. Here the corals *Monilopora* and *Trachypora* flourished. Coincident with the outbreak of volcanic activity causing the formation of beds of rhyolitic tuff there was a gradual shoaling of the sea. Coarse conglomerates, grits and tuffs buried shallow water pelecypods and brachiopods. The thick-shelled *Eurydesmas* were very abundant at one period and form now a well-marked horizon in the coarse sediments.

Oscillations of the strand-line took place and fresh water *Glossopteris* shales became interbedded with marine sandstones. Great outbursts of volcanic activity ensued and after marine tuffs were laid down lavas poured over the land.

At the conclusion of the eruptions a freshwater lake developed and above a basal conglomerate *Glossopteris-Gangamopteris* shales were formed. A sea transgression gave rise to the deposition of sandstones containing abundant *Strophalosias* and Bryozoans. The new fauna was very unlike that of the marine period preceding the volcanic stage.

BIBLIOGRAPHY.

1. Richards, H. C., and Bryan, W. H.
The Geology of the Silverwood-Lucky Valley Area. Proceedings of Royal Society of Queensland, Vol. 36. 1924.

2. Richards, H. C., and Bryan, W. H.
Permo-Carboniferous Volcanic Activity in Southern Queensland. Proceedings of Royal Society of Queensland, Vol. 35. 1923.

3. Reid, J. H.
The Queensland Upper Palæozoic Succession. Queensland Geological Survey Pub. No. 278. 1930.

Report on Samples of Surface Tertiary Rocks and a Bore Sample containing Ostracoda from Queensland.

By FREDERICK CHAPMAN, A.L.S., F.G.S.

(Plate II.)

(*Communicated by Dr. F. W. Whitehouse to the Royal Society of Queensland, 27th August,* 1934.)

INTRODUCTORY NOTE.

Some years ago I was favoured with a small parcel of samples of fossiliferous rocks from Queensland by Dr. W. H. Bryan of the University of Queensland, who requested me to identify the ostracoda contained therein.

These sedimentary rocks with ostracoda are of special interest on account of their previously known contents comprising other fossils, as mollusca, insects, fish remains, and leaves of dicotyledonous plants.

The examination of this collection has revealed the important fact that some of the samples are distinctly hydrocarbonaceous, a character apparently due to the remains of bivalved crustaceans (Ostracoda); moreover this group as regards its occurrence in estuarine and fresh-water deposits in Australia, has been little studied.

DETAILED DESCRIPTIONS OF SAMPLES.

Specimen A.—"Locality, Redbank Plains, 10 miles S.W. of Brisbane. Associated with a rich fish fauna, not yet described, dicotyledonous plants in process of description (including *Banksia* sp.), and two insects described by Dr. R. J. Tillyard, *Euporismites balli* (Qld. Geol. Surv. Pub. No. 253) and *Scolypopites bryani* (Proc. Roy. Soc. Qld., 1923, pp. 16-20, figs. 1-2, pl. 1)." W. H. Bryan, 28-4-25.

In the year 1926 Mr. O. A. Jones published a paper on "The Tertiary Deposits of the Moreton District, South-eastern Queensland" (Proc. Roy. Soc. Qld., vol. 38, No. 2, pp. 23-46), which specifically relates to rock samples contained in the present collection. On page 26 he gives topographical and structural details of the Redbank Series, and on pages 35 and 38 deals with the fossil remains, other than ostracoda.

Specimen A represents a hydrocarbonaceous shale of very close texture, but with distinct bedded structure. It is of a dark chocolate-brown colour and when cut with a knife has a glistening appearance; the same is shown when the surface is rubbed. A test with chloroform gives a fairly strong reaction in regard to oil contents. When fractured in the bedding plane the surface seems to be crowded with the valves of several genera of ostracoda, which are here referred to the fresh-water forms *Cypridopsis compressa* sp. nov. and *Herpetocypris æqualis* sp. nov., whilst there is also present in large numbers the well-known estuarine and marine species *Cythere crispata* G. S. Brady.

Specimen B.—"Locality at 160 feet. Bore No. 2 Australian Oil Corporations Bore, Dunn's Farm, Beaudesert, 30 miles S. of Brisbane. At 95 feet in same bore gasteropods are found, identified by Mr. C.

Hedley as *Melania* sp. At 116 feet coal seam encountered.'' W. H. Bryan.

The rock is of a dark-grey colour with a greenish tinge. It resembles an estuarine mudstone, and the irregular fracture of the bedded surface indicates an incipient shrinkage structure. This specimen gives a strong reaction with chloroform as to hydrocarbonaceous contents.

The species of ostracoda found in this rock are apparently all of shallow marine or estuarine habitat. They are referable to *Cythere queenslandiæ* sp. nov. and *Krithe reniformis* (G. S. Brady), whilst a species of *Cytheridea* may also be present.

Specimen C.—''Locality, Cooper's Plains, 5 miles S. of Brisbane, associated with fish fauna and dicotyledonous leaves.'' W. H. Bryan.

A dark chocolate brown, closely bedded mudstone. Throughout this rock are scattered innumerable minute spherical or subspherical concretions which are probably magnesic in character. On washing down a specimen of this rock it is seen to contain a small proportion of subangular and water-worn quartz grains. On testing the mudstone with chloroform, evidence was found of a fairly high hydrocarbonaceous content.

Although O. A. Jones (1926, op. cit., p. 39) mentions ostracods as occurring at Cooper's Plains in association with fish remains and leaves, no ostracoda were found in the samples forwarded to me.

Specimen D.—''Same locality as C, and immediately beneath Tertiary basalts.'' W. H. Bryan.

Pale grey magnesic mudstone with yellow stain on fractured surfaces. This rock contains numerous minute spheroidal concretions, similar to those in specimen C, but of a whitish tint. No organisms present.

Sample per Mr. L. C. Ball of the Queensland Geol. Survey. Locality, Lowmead Bore, between Gladstone and Rockhampton, at 202 feet.

This sample is a dark chocolate-brown closely bedded mudstone, containing innumerable carapaces of ostracoda. These ostracod valves are crushed and, therefore, too imperfect to describe in detail. They are apparently referable to the genera *Pontocypris, Cythere,* and *Paradoxostoma.* The chloroform test shows that this rock is strongly hydrocarbonaceous.

References to other organic contents in the Lowmead strata are given by O. A. Jones, 1926, op. cit., p. 41.

DESCRIPTION OF SPECIES.

Super Order OSTRACODA.

Fam. CYPRIDIDÆ.

Genus *Erpetocypris* G. S. Brady and A. M. Norman, 1889 (*Herpetocypris* G. O. Sars, 1890).

Erpetocypris æqualis sp. nov.

Plate II., figs. 1*a, b*.

Description.—Valve seen from the side, long-ovate, back gently arched, ventral margin slightly concave; anterior border strongly convex; meeting the ventral to form a moderately sharp angle, posterior margin well rounded. Seen in profile anterior extremity somewhat compressed, posterior roundly inflated. Surface smooth, shell opaque.

Dimensions.—Length of carapace, 1·12 mm.; height, 0·58 mm.; thickness of carapace, 0·53 mm.

Affinities.—This species is more regularly ovate than *Erpetocypris reptans* (Baird) of the British and European fresh-water lakes and streams. It nearly resembles *E. glacialis* G. O. Sars, of the European marshes, in its convex dorsum and evenly rounded extremities.

Occurrence.—Tertiary. Redbank Plains, 10 miles S.W. of Brisbane, Queensland. Very rare.

Genus *Cypridopsis* G. S. Brady, 1868.

Cypridopsis compressa sp. nov.

Plate II., figs. 2*a*, *b*.

Description.—Valve seen from the side, arcuately ovate; back strongly arched, ventral border concave in the median region; anterior margin well rounded and truncately so at the dorsal angle; posterior border evenly rounded. Seen in profile, ovate and strongly compressed in the anterior third, convex at the posterior. Surface smooth, shell white and opaque.

Dimensions.—Length of carapace, 0·9 mm., height, 0·56 mm.; thickness of carapace, 0·33 mm.

Affinities.—The present species bears a fairly close resemblance to *Cypridopsis picta* (Straus), a fresh-water form found in Norway, France, and Belgium. It differs from the latter in the broader anterior border and less inflated posterior.

Occurrence.—Tertiary. Redbank Plains, 10 miles S.W. of Brisbane, Queensland. Very rare.

Genus *Pontocypris* G. O. Sars, 1865.

? *Pontocypris* sp.

Plate II., fig. 3.

Several examples of a form closely resembling that of the genus *Pontocypris* occurred in the cypridiferous shale of Lowmead Bore, Queensland. The valves are so much crushed, however, as to prevent more than a tentative reference being made.

Fam. CYTHERIDÆ.

Genus *Cythere* O. F. Müller.

Cythere crispata, G. S. Brady.

Plate II., figs. 4 *a*, *b*, 5.

Cythere crispata Brady, 1868. Ann. & Mag. Nat. Hist., ser. 4, vol. II., p. 221, pl. xiv., figs. 14, 15. Idem, 1880, Rep. Sci. Results "Challenger," Zool., vol. 1, pt. III. Rep. on the Ostracoda, p. 72, pl. xiv., figs. 8 *a-d*. Chapman. 1914. Descriptions of New and Rare Fossils obtained by Deep Borings in the Mallee, Pt. III. Ostracoda to Fishes. Proc. Roy. Soc. Vict., vol. XXVII (N.S.), Pt. 1, p. 33, pl. vi., fig. 9.

Observations.—This variable and in many respects strikingly characteristic species has a long geological range as well as a wide geographical distribution. It made its appearance in the Lower Miocene of Victoria and was found in Pleistocene deposits of Norway and Scotland. As a southern living species it is well known from Port Jackson and Booby Island, and it is also recorded from Hong Kong Harbour and from the shores of Britain and Europe generally. It appears to be more at home in shallow water dredgings but has also been found off S. Australia in 100 fathoms ("Endeavour"). The present Tertiary specimens are of typical size, having a length of 0·6 mm. as compared with recent examples quoted by Brady, with a length of 0·5 mm.

Occurrence.—Specimen A, Redbank Plains, 10 miles S.W. of Brisbane, Queensland. Common.

(?) *Cythere queenslandiæ* sp. nov.

Plate II., figs. 6 *a, b*, 7.

Description.—Carapace minute, valves narrowly triangular, dorsal margin gently convex, ventral more strongly so, anterior border subtruncate with a marginal fold. Sharply angled on the ventral side and rounded off on the dorsal, posterior extremity subacuminate. Edge view oval, compressed anteriorly and more inflated at the posterior. Shell thin, surface smooth, almost iridescent, with occasional oblique or transverse sulci or folds on the median area.

Dimensions.—Length of Holotype, 0·44 mm., height, ·02; thickness of carapace, 0·19 mm. Length of paratype, 0·5 mm.

Affinities.—This minute pyriform type of the genus cannot be exactly matched with anything previously described but bears some resemblance, both in form and surface relief with Jones' *Cytherideis unisulcata*, from the Oligocene of the Isle of Wight (T. R. Jones, 1857, Monograph of the Tertiary Entomostraca of England, Pal. Soc. Vol. IX., p. 48, Pl. V., fig. 10). The furrow of that species, however, is described as transverse, whereas in the present form it is oblique, curved and sometimes double. Jones in his later revisional memoir, with Sherborn (Pal. Soc., 1889, p. 46) suggests for the genus either a young *Cypridea* or possibly a *Metacypris*. Further investigation may prove the relationship of this present small form with *Cypridea* rather than *Cythere*.

Occurrence.—Specimen B, 160 feet, Bore No. 2, Australian Oil Corporation, Dunn's Farm, Beaudesert, 30 miles S. of Brisbane. Very common.

cf. *Cythere* sp.

Plate II., fig. 8.

Occurrence.—A crushed carapace of a quadrate form was seen in the sample from the Lowmead Bore probably referable to *Cythere*. It suggests affinity to some estuarine species.

Genus *Krithe* Brady, Crosskey and Robertson, 1874.

Krithe cf. *reniformis* (G. S. Brady).

Plate II., fig. 9.

? *Paradoxostoma reniforme* Brady, 1868. Contrib. to Study of Entomostraca. Ann. & Mag. Nat. Hist., Ser. IV., Vol. II., p. 224, pl. XV., figs. 1, 2. *Krithe reniformis* (Brady), Brady and Norman, 1889.

Mon. Marine & Freshwater Ostracoda of the North Atlantic and of North-western Europe. Sect. 1. Podocopa. Sci. Trans. R. Dublin Soc., Vol. IV. (Ser. II.), p. 182, pl. XXI., figs. 23, 24.

Observations.—In general form some carapaces occurring in the ostracod shale of Dunn's Farm Bore, Beaudesert, agree with Brady's species. In point of size the fossil specimens are almost twice the length. The living specimens were found in shallow water down to 200 fathoms.

Genus *Paradoxostoma* Fischer, 1855.

cf. *Paradoxostoma sp.*

Plate II., fig. 10.

A slender, almost siliquose carapace noticed in the ostracod shale of the Lowmead Bore may be tentatively referred to the above genus. *Paradoxostoma* is a marine genus usually found between tide-marks.

SUMMARY AND REMARKS ON AGE OF SAMPLES.

1. Three of the samples submitted are rich in ostracodal remains.

2. The Redbank Plains ostracod shale contains species of freshwater and estuarine characters, thus indicating a lacustrine area that was open intermittently to a shallow sea.

3. The ostracods of the Beaudesert marl are of shallow marine or estuarine origin.

4. The chocolate brown mudstone of Cooper's Plains contained no ostracods.

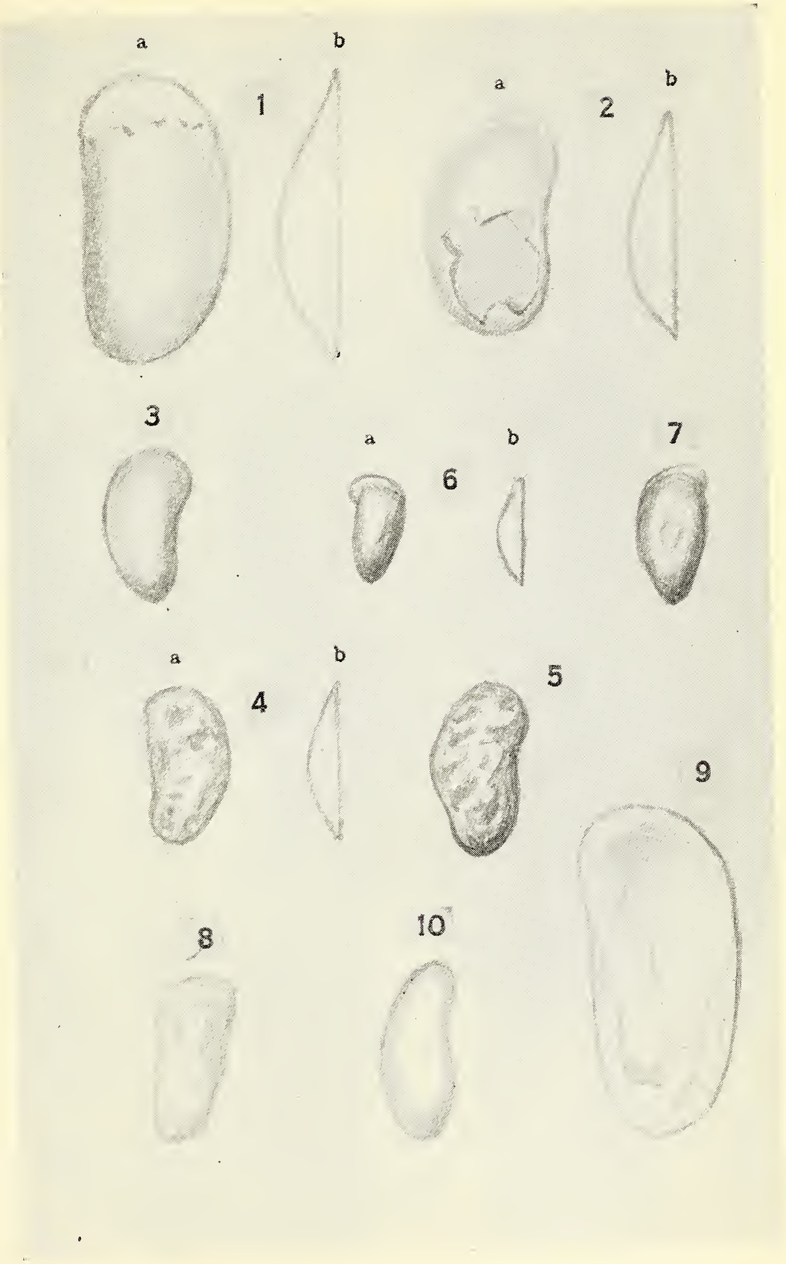
5. The sample (C) underlying basalt at Cooper's Plains is entirely inorganic.

6. The ostracoda in the mudstone of Lowmead Bore are uniformly crushed, but what evidence there is points to a shallow marine deposit.

7. The four samples referred to in paragraphs 2, 3, 4, and 6 are strongly hydrocarbanaceous.

8. The ostracoda here described give no very decisive data as to the age of the various beds other than Tertiary. The rocks may range, however, from Lower Miocene, or even older, to Pliocene. As regards the Redbank Plains Series, Dr. E. S. Hills, in a study of fish remains from that horizon (now in the press), concludes that it is probably of Oligocene age. The occurrence of the freshwater genera, *Herpetocypris* and *Cypidopsis* in the Redbank Plains Series, if of Oligocene age, would extend their known backward range very considerably. On the other hand the marine and estuarine species *Cythere crispata,* occurring in the same series, was found by the present author in the Lower Miocene of the borings in the Victorian Mallee.

9. The described rock specimens and species of ostracoda are deposited in the Museum of Department of Geology, University of Queensland.



Ostracoda from Tertiary Shales, near Brisbane.

EXPLANATION OF PLATES.

Plate II.

Fig. 1 *a, b.*—*Herpetocypris æqualis*, sp. nov. *a*, left valve; *b*, profile of same valve. Holotype. Tertiary. Redbank Plains, 10 miles S.W. of Brisbane, Queensland. x 34.

Fig. 2*a, b.*—*Cypridopsis compressa*, sp. nov. *a*, right valve; *b*, profile of same valve. Holotype. Tertiary. Redbank Plains, 10 miles S.W. of Brisbane, Queensland. x 30.

Fig. 3.—*? Pontocypris* sp. Right valve, restored. Tertiary, Lowmead Bore at 20 feet, between Gladstone and Rockhampton, Queensland. x 17.

Fig. 4 *a, b.*—*Cythere crispata* G. S. Brady. *a*, left valve; *b*, profie of same. Plesiotype. Tertiary. Redbank Plains, 10 miles S.W. of Brisbane, Queensland. x 34.

Fig. 5.—*C. crispata* G S. Brady Right valve of another specimen Plesiotype, Tertiary. Redbank Plains, 10 miles S.W. of Brisbane, Queensland. x 34.

Fig. 6 *a, b.*—*Cythere queenslandica*, sp. nov. *a*, left valve; *b*, profiile of same. Holotype. Tertiary. No. 2 Bore, 160 feet, Dunn's Farm, Beaudesert, 30 miles S. of Brisbane, Queensland. x 36.

Fig. 7.—*C. queenslandica*, sp. nov. Right valve of another specimen. Paratype. Tertiary. No. 2 Bore, 160 feet, Dunn's Farm, Beaudesert, 30 miles S. of Brisbane, Queensland. x 34.

Fig. 8.—cf. *Cythere* sp. Right valve. Tertiary. Lowmead Bore, between Gladstone and Rockhampton, Queensland. x 24.

Fig. 9.—*Krithe* cf. *reniformis* (G. S. Brady). Left valve. Plesiotype. Tertiary. Dunn's Farm Bore, 160 feet, Beaudesert, 30 miles S. of Brisbane, Queensland. x 34.

Fig. 10.—cf. *Paradoxostoma* sp. Right valve. Tertiary. Lowmead Bore, 202 feet, between Gladstone and Rockhampton, Queensland. x 24.

The Relative Penetrability of Various Tissues of the Orange and the Banana to Ethlene.

By D. A. HERBERT, D.Sc., and L. J. LYNCH, B.Sc., Agr., University of Queensland.

(Read before the Royal Society of Queensland, 27th August, 1934.)

(Plate III.)

INTRODUCTION.

The artificial ripening of bananas and of citrus fruits by means of ethylene and other gases, e.g., acetylene and coal gas—in which latter ethylene is an important constituent—is now an established commercial practice in Australia. The effect of the treatment is, however, very different for these two types of fruit. In both cases the yellow tint characteristic of ripe fruit is readily developed as a result of the destruction of the chlorophyll by the gas treatment. In addition the ripening of the central pulp of the banana is accelerated, but this does not occur in the case of the orange and lemon. In consequence the latter fruits are often marketed in an immature condition, though they look ripe. The normal ripening processes in citrus fruits are as yet very imperfectly understood, but are obviously quite different from those of the banana. The scope of this paper does not include a discussion of the effects of ethylene on the chemical reactions involved, our aim being rather to determine whether the extent to which ethylene penetrates the tissues of the fruits under consideration has any connection with the differential results obtained in the banana and the orange in commercial gas treatment.

The possibility of obstruction to diffusion of gases is suggested by the results of an examination of the gas in the coconut (4). Gas appears in this fruit after the endosperm is well developed, and in old nuts, where the gas averaged 23 c.c., it was found that a typical analysis was—

Nitrogen	99·8 per cent.
Oxygen	·2 per cent.
Carbon dioxide	trace

The gas found in young nuts containing 2 or 3 cc. had the composition—

Nitrogen	81·3 per cent.
Oxygen	18·7 per cent.
Carbon dioxide	trace

These figures suggest an obstruction to diffusion, and in the experiments to be described, the relative penetrability of peel and pulp of bananas and oranges is tested as a factor in the differences in ripening in the presence of ethylene.

ALLIED INVESTIGATIONS.

Minute traces of ethylene are sufficient to accelerate the ripening process in fruits for commercial purposes. Young, Bagster, Hicks, and Huelin (1932) found that with the banana, 1 part of coal gas in 1,000 of air is effective in summer, and 3 parts in 1,000 in winter. Since ethylene occurs in coal gas to the extent of but 3 per cent. approximately, the actual amount of this constituent present in the ripening chamber is very small. In the experiments to be described, therefore, we have not used the method of chemical analysis, but have made use of various plants whose response to small quantities of ethylene or of other unsaturated gases such as acetylene or carbon monoxide is both marked and rapid. It has been found by various investigators, particularly those working in the Boyce Thompson Institute, that this method may be made very delicate, and that traces of unsaturated gases may be detected by such test plants as the tomato (*Solanum lycopersicum*) and etiolated sweetpeas (*Lathyrus odoratus*) in dilutions impossible of chemical analysis.

The reaction of such test plants opens up another aspect of the effect of ethylene. Knight and Crocker of the University of Chicago investigated the poisonous effects of coal gas on carnations (*Dianthus caryophyllus*) which "go to sleep" under its influence, and found that ethylene was the active constituent, the minimum effective dose being 1 in 2,500,000 of air. Zimmerman, Hitchcock, and Crocker (1931) have shown that 1 part of ethylene in 100,000 of air induces earlier opening of rosebuds, and premature abscission of the petals. Such tests are not adapted for the detection of ethylene contamination in air, partly owing to the time factor.

The tests adopted depend upon the fact that ethylene induces epinasty in leaves of certain plants, a phenomenon characterised by the more rapid growth of the upper region with a consequent bending of the distal area in a downward direction.

At the commencement of the present century it was already well established that laboratory air caused such a response, and Neljubow (1901) traced it, in the case of the epicotyls of the pea and other legumes, to the effect of ethylene, the movement being at times obtained in a concentration of 1 in 3,000,000 parts of air. Subsequent work in Europe and America has confirmed this, and a general account of allied investigations is included in a recent paper by Crocker, Zimmerman and Hitchcock (1932). Harvey (1913) as a result of his investigations into the response of the castor oil plant (*Ricinus communis*) recommended it as a test plant for small quantities of ethylene in air. Crocker, Zimmerman and Hitchcock (1932), extending the investigation, have drawn up a list of 72 plants showing marked epinasty of leaves under this treatment, 17 which show light epinasty, and 113 which exhibit none whatever. The tomato (*Solanum lycopersicum*) is recommended by these authors in another paper, on account of the fact that its leaves respond to 1 part in 5,000,000 of air. In this research they established the fact that ethylene diffuses rapidly through plant tissues, even through killed sections of stem; various concentrations ranging from 1 to 50 per cent. ethylene were used, and all the effects were approximately the same.

TEST PLANTS INVESTIGATED, AND THE NATURE OF THEIR RESPONSE.

On the basis of these reported investigations, we set up a series of preliminary experiments for the determination of plants suited to our purpose. A small-leaved variety of *Coleus Blumei, Ageratum conyzoides, Stellaria media, Galinsoga parviflora, Bidens pilosa,* and *Euphorbia heterophylla* were found to exhibit a ready response, and young plants were available in unlimited quantities. *Coleus Blumei* had been tested by Crocker, Zimmerman, and Hitchcock (1932), who reported it as giving a slight epinastic response to ethylene; we, however, found that our material responded definitely and readily. This difference in response of varieties of the same species is shown elsewhere. Crocker, Zimmermant and Hitchcock noting marked epinasty in 13 only of the 31 varieties of *Capsicum annuum* tested by them. As a result of our preliminary experiments, *Stellaria media* was indicated as a suitable test plant.

The response is an epinastic bending of the leaves, more particularly of the second, third, and fourth pairs below the apex. The petiole curves downwards and the blade also curves, particularly in its lower part; in the extreme type of response, opposite leaves become so placed that their apices pass one another and the leaves cross. In the preliminary experiments it was found that though plants of the different species mentioned might be left in the laboratory exposed to the air and show no response whatever, similar material covered with a bell-jar frequently exhibited unmistakable response within twelve hours. In consequence of this behaviour, a series of experiments was initiated in which air from different sources was collected in bell-jars and tested with *Stellaria media* and *Galinsoga parviflora.* These sources consisted in (*a*) a kitchen containing a gas cooker, (*b*) a suburban garden where there was little chance of gas contamination, (*c*) a study in which the air was contaminated by tobacco smoke, (*d*) a small laboratory in which was situated a number of gas burners, and where there was considerable tobacco smoke contamination, (*e*) an open space in the vicinity of a chemical laboratory, (*f*) and an infrequently used room originally intended for a refrigeration plant. In all cases other than the suburban garden and the room last mentioned, the results either definitely indicated contamination of the atmosphere to a degree sufficient to induce epinasty of the test plants or else were erratic in character. It was the erratic behaviour of test plants that led us to suspect that isolated wisps of gas from the source of contamination might float about in relatively pure air, and that in the open they would, in the ordinary course of events, pass on unless confined in a bell-jar over a responsive plant, when they would exercise the characteristic effect. The fact, therefore, that plants of *Stellaria media* existing in a garden bed were normal in appearance, did not necessarily indicate absence of contamination in the surrounding atmosphere. As a result of a test extending over several days it was found that the air in the refrigerator chamber was free of contamination for purposes of the work in view, and was in consequence utilised for the final experiments on which this report is based.

That portion of the apparatus designed to contain the ethylene was charged at some distance from the building, and the vessels in which the test plants were to be placed were filled with the atmosphere of the operating room by the simple expedient of taking them to the site of the experiment filled with water, and emptying them.

OTHER PRELIMINARY EXPERIMENTATION.

The matter of substances impermeable to ethylene was investigated at some length in order to ensure that all jars and containers used in the experiment are adequately and efficiently sealed. For this purpose the substance to be examined was placed as a partition between a jar containing ethylene and another of normal air, a test plant being located in the latter; the substances investigated by us in this way were water, hard paraffin, soft paraffin, and mercury, and were found to be equally efficient in preventing the diffusion of the gas. The utilisation of hard paraffin, however, necessitated its application in a hot molten condition, and the vapour escaping therefrom into the compartment containing the test plant proved capable of inducing epinasty in two and a-half to three hours. In addition, the heat applied under these circumstances caused incipient wilting, and thus hard paraffin as a sealing agent was finally rejected.

The use of soft paraffin as a sealing agent was found satisfactory, other than in one particular—viz., the liberal application of this substance to the leaf of *Stellaria media* is sufficient of itself to cause marked epinasty. This material was used throughout the experimental work for the purpose of sealing the ethylene chamber, due care being taken to prevent it from coming into contact with the leaves of the test plants.

Mercury and water were found to be equally efficient for sealing purposes, and were used alternately in the experiments to seal the outer jar from the atmosphere of the room.

SOURCES OF ERROR.

It is necessary to differentiate between normal wilting and true epinastic response. In well marked cases of epinasty the leaf curves downwards and passes beyond the vertical, and ultimately either passes or alternatively becomes closely appressed to the stem, whereas in wilting loss of turgor results in the vertical placement of the leaf. Response and wilting may be further distinguished by inversion of the plant, when in the former case the leaves remain rigidly appressed to the central axis, while in the latter, the organs concerned respond to the influence of gravity.

Another source of error may be that due to exhalation of unsaturated hydrocarbons of the ethylene type from the fruits themselves. Should such be the case, the test plants would be undoubtedly affected, independent of any gaseous diffusion which may occur. That exhalations of this type do take place during the ripening process in some fruits has been confirmed by recent investigations in England. According to the Report of the Food Investigation Board, London, for the year 1932, the germination of peas (*Pisum sativum*) is retarded by exposure to apple atmospheres, and it is suggested that the active agent is either ethylene or a body of similar nature. Unpublished work within the University of Queensland shows a statistically significant retardation of germination of peas, both as a result of exposure to air from ripening Granny Smith apples and to ethylene gas.

A further source of error may be due to setting up the apparatus in contaminated atmospheres. Precautions observed in this instance have been previously described in the section dealing with test plants.

METHOD OF PROCEDURE.

The method observed consisted in brief in the utilisation of the fruit as a diffusion membrane separating a container charged with ethylene gas on the one hand, and another containing air alone. In the latter compartment a number of test plants were arranged and the diffusion of ethylene was detected by the epinasty induced in the subject plants (see Plate III.).

The fruit was sealed into the mouth of the gas chamber by means of soft paraffin, a substance which had been shown (*vide supra*) to be impervious to the passage of the gas. Two small glass tubes containing water were affixed above the fruit, and the test plants placed therein. The apparatus thus arranged was covered by means of a large glass jar and sealed to the external atmosphere either by water or by mercury.

The experiment was arranged in three series—viz., banana, orange, and controls. Since the ripening process in bananas is accelerated by ethylene treatment, it was assumed that penetration of the pulp by the gas takes place, and the object of this series was to determine the individual relative efficiencies of skin and pulp as media of diffusion, and in addition, a combination of the two as a path for conduction. In the case of the skin, the whole banana was paraffined at both ends and sealed into the chamber. To test diffusion through the pulp, glass tubes were inserted from either end, and the whole surface of the fruit then smeared with soft paraffin. In the final experiment a ring of skin was removed and replaced by paraffin and sealed into the container as previously described.

In contrast with the banana, the ethylene treatment of citrus, while producing the external appearance of the ripe fruit, does not accelerate the maturation of the pulp. This may be due to non-penetration of the tissues by the gas, and the experiments in this series were designed to confirm or deny this possibility. To test the permeability of the outer epicarp, the whole orange was sealed to the gas chamber. The inner mesocarp was tested by removing portion of the epicarp from opposite sides of the fruit and covering the remainder of the surface with soft paraffin. In the final experiment—that of the permeability of the pulp to ethylene—glass tubes were inserted at either side of the fruit covered with an impervious coating and then sealed to the container.

The third series was designed to act as a control, and also to indicate whether a substance generated by the fruit itself might be exhaled and so produce an epinastic response in the test plants. Banana and orange controls were arranged in a manner similar to those under test, but differed in that the containers were not charged with gas. The final control was again similar but contained no fruit. To test the efficiency of the seals on the one hand, and the purity of the atmosphere of the experimental chamber on the other, several uncovered controls were placed at various points in the room.

The apparatus was set up in a thermally insulated room under conditions of constant temperature and uniform illumination. Observations were made at intervals. The concentrations of ethylene gas in air varied from 25 per cent. to 50 per cent. for the first three experiments, and as a result of the deductions made therefrom, were subsequently reduced to that normally used in the commercial ripening of fruit.

RESULTS.

In all, the experimental work was replicated three times, and essential features were maintained constant throughout. Slight variations in temperature occurred, not from design but by reason of the lack of convenient thermostatic control. These rather minor discrepancies were permitted only where they could exert no significant effect upon the result.

Experiment 1.

The temperature during this period was maintained constant at 76 deg. F. Definite response was observed throughout, other than in the checks—

Orange.	Response.	Banana.	Response.
Intact fruit	+ +	Intact fruit..	+ +
Pulp	+ +	Pulp	+ +
Mesocarp	+	Skin-pulp	+
Check	—	Check	—

Control plant in open air —.

In the case of the mesocarp of the orange, the response while definite, was less intense than in the remaining experiments with this fruit. The skin-pulp of the banana differed in a similar manner from intact fruit and pulp. The negative response of the open control demonstrated lack of contamination of the atmosphere of the experimental room, and thus proved the efficiency of the sealing method. Soft paraffin was the sealing agent used.

Experiment 2.

The temperature was maintained at 82 deg. F. Soft paraffin was again employed for sealing purposes. The results were in entire accord with those of Experiments 1 and 3.

Experiment 3.

For this and the subsequent experiment water seals were used with success. The temperature varied from 76 deg. F. at the commencement to 78 deg. F. at the termination of the experiment. The results coincided with those of Experiments 1 and 2, other than in the fact that all responses exhibited approximately the same degree of intensity.

Experiment 4.

This was carried out at a temperature of 72 deg. F. and the results obtained exactly paralleled those of Experiments 1 and 2.

DISCUSSION.

The results of the experiments indicate that orange and banana fruits exposed to ethylene are readily penetrated by that gas, and that in both types it passes with facility through the outer part of the peel. In the orange the passage through the intact fruit, or through pulp only, took place much more readily than through fruits where the mesocarp (the white inner portion of the peel) had to be traversed. This indicates that this last region provides a partial barrier, though it is penetrable as is evidenced by the response of the test plant. When the intact fruit is used to separate the ethylene from the test plant, it is evident that the bulk of the gas passes around the fruit via the epicarp. The intact banana, too, afforded a ready passage to ethylene, as did also the pulp only. Where, by girdling a banana, the path of diffusion lay through the peel into the pulp and finally through the skin again, it was found that the process was considerably impeded, indicating that here again the inner part of the peel was a partial barrier. That it is, however, no more effective as a barrier than the inner peel of the orange, is indicated by the degree of response of the test plant. Yet in the banana ripening takes place in spite of the obstruction to diffusion into the pulp. Obviously the differences in the artificial ripening of the orange and the banana cannot be ascribed to differences in penetrability of the outer layers.

The control experiment wherein no gas was employed established the fact that neither ethylene nor other substance capable of causing a response was produced by the banana or the orange, at least in quantities sufficient to affect the test plant.

ACKNOWLEDGEMENTS.

Our thanks are due to Mr. E. W. Hicks, B.A., B.Sc., for kindly providing the ethylene, and to Mr. R. S. Mitchell, B.Sc. Agr., for constant help during the course of the experiments. Mr. Mitchell's aid in the setting up of the experiments and in the observation of results was of very material assistance in their conclusion.

SUMMARY.

The diffusion of ethylene through the epicarp, mesocarp, and endocarp of orange and banana fruits was tested, making use of *Stellaria media* as a test plant. Stellaria was chosen from a number of species tested. Ethylene was placed in a series of vessels plugged with oranges and bananas, so treated that any diffusion out into the surrounding vessel containing the test plant had to take place through (*a*) whole fruit, (*b*) endocarp and mesocarp, (*c*) endocarp only. Traces of ethylene passing into the surrounding vessel produced a pronounced and characteristic epinastic response in the *Stellaria* leaves. This response also takes place in laboratory air, and due precautions were taken to have the experiments carried out in uncontaminated air. It was found that diffusion took place readily through epicarp and endocarp, but that the mesocarp offered some resistance, though it was permeable. Control experiments indicated that ethylene was not produced by the fruits themselves in sufficient amounts to affect the test plant. It is concluded that the differences in the ripening of oranges and bananas in an atmosphere containing ethylene are not due to a barrier against diffusion into the orange pulp, as the mesocarp of the banana offers approximately the same resistance as that of the orange, according to the evidence of the test plant.

EXPLANATION OF PLATES.

Figure 1.—Apparatus used in the experiments. The inverted vessel is sealed into a glass dish with paraffin. The fruit is sealed in the mouth of a cylinder containing ethylene, the test plant, *Stellaria media,* being placed in a tube containing water, held in position by rubber bands. This figure shows the response when laboratory air is used in the outer vessels.

(A) Response of test plant to ethylene which has passed through an intact banana;

(B) Response of test plant to ethylene which has passed through an intact orange;

(C) Response of test plant to laboratory air (compare Fig. 2 A. E. I; and Fig. 3 A and D. in which uncontaminated air was used). The more pronounced epinastic curvature in A and B is obvious.

Figure 2.—Series of experiments with the outer vessel removed immediately before the taking of the photograph.

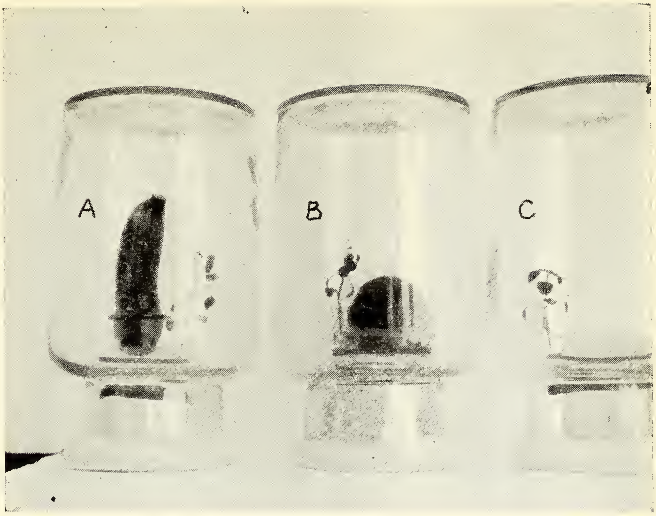


Figure 1.

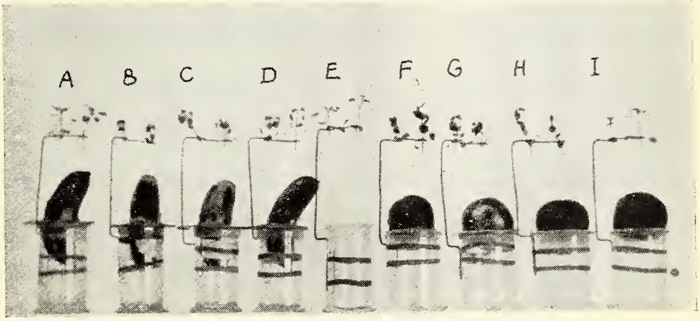


Figure 2.

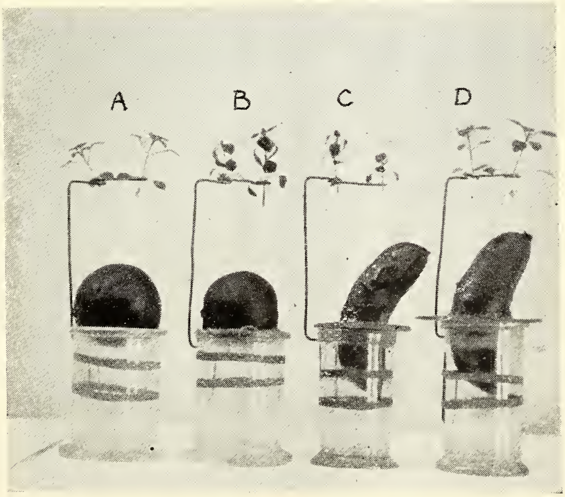


Figure 3.

(A) No ethylene in the vessel, no response in presence of banana fruit;

(B) Ethylene in vessel, passing to test plant through endocarp (note glass tubes); test plant showing epinasty;

(C) Ethylene in vessel, passing to test plant through the intact fruit; test plant showing epinasty;

(D) Ethylene in vessel passing through epicarp and mesocarp to endocarp, and back through the epicarp and mesocarp to test plant, the peel being girdled where the banana is sealed into the vessel; test plant showing epinasty;

(E) Control with no fruit and no ethylene; no epinasty;

(F) Ethylene in vessel passing to test plant through intact fruit; test plant showing epinasty;

(G) Ethylene in vessel, passing to test plant through the endocarp (note glass tubes); test plant showing epinasty;

(H) Ethylene in vessel, passing to test plant through orange with the epicarp removed; test plant showing epinasty;

(I) No ethylene in vessel, no epinasty in presence of banana fruit.

Figure 3.—Photograph showing method of setting up experiments; A and D, controls, showing no epinasty in presence of fruits; B and C, response with ethylene in the cylinders into which the fruits have been sealed. The test plants are held in tubes containing water; the tubes are rather indistinct in the photograph.

REFERENCES.

Crocker, W., Zimmermann, P. W., and Hitchcock, A. E. 1932. Ethylene-induced epinasty of leaves and the relation of gravity to it. Contribution Boyce Thompson Institute 4, 177-218.

Food Investigation Report for 1932. London.

Harvey, E. M. 1913. The Castor Bean plant and laboratory air.

Herbert, D. A. 1923. The gas in the coconut. Philippine Agriculturist 11 (6) 177-179.

Neljubow, D. 1901. Ueber die horizontale Nutation der Stengel von *Pisum sativum* und einiger anderen Pflanzen. Bot. Centralbl. Beihefte 10, 128-138.

Young, W. J., Bagster, L. S., Hicks, E. W., and Huelin, F. E. 1932. The ripening and transport of bananas in Australia. Bull. No. 64, C.S.I.R. Melbourne.

Zimmermann, P. W., Hitchcock, A. E., and Crocker, W. 1931. The effect of ethylene and illuminating gas on roses. Contribution Boyce Thompson Institute 3, 459-481.

Zimmermann, P. W., Hitchcock, A. E., and Crocker, W. 1931. The movement of gases through plants. Contribution Boyce Thompson Institute 3, 313-320. 1931.

A Few Notes on the Genus Ptychosperma in Queensland.

By C. T. WHITE, Government Botanist, Brisbane.

(*Read before the Royal Society of Queensland, 27th August, 1934.*)

In the course of his studies on the genus *Archontophœnix,* Professor L. H. Bailey, of Ithaca, wrote me some time ago asking about *A. Jardinei* F. M. Bail. This was changed to the genus *Ptychosperma,* where it obviously belongs, some years ago by F. M. Bailey on the advice of Professor O. Beccari. The palm is evidently common in cultivation in tropical gardens, and has always been known in them as *Hydriastele Wendlandiana,* being probably distributed from Buitenzorg under that name.

Doctor Burret in 1927 transferred this commonly cultivated palm to *Ptychosperma* under the name of *P. Wendlandiana,* concluding from the published description that *P. Jardinei* F. M. Bail. was distinct.

Burret, in his Comprehensive Account of Ptychosperma in Fedde's Repertorium, vol. 24, pp. 263-271, relegates *P. Capitis Yorkii* Wendl. and Drude and *P. Jardinei* F. M. Bail. to "species dubiæ," but I am convinced that these two species and *P. Wendlandiana* Burret, all from Cape York, represent one and the same palm, and that the name *P. Capitis Yorkii* Wendl. and Drude has priority. It is true that *P. Capitis Yorkii* Wendl. and Drude was named from leaves and inflorescence branches, and lacked flowers and fruit. From the narrowness of the leaf segments, however, i.e., scarcely 4 cm. broad, I have little doubt of its identity with the later described species of F. M. Bailey and M. Burret.

The type material of *P. Jardinei* F. M. Bail. consists of a single whole leaf and two inflorescences complete as regards the branching but from which all the flowers and fruits have become detached, one much stouter than the other (evidently the fruit-bearing one), a large number of detached flowers and a number of detached, rather unripe fruits. I have compared these flowers with those of *P. elegans* (R. Br.) Bl. as cultivated in Brisbane, and can find absolutely no difference except, perhaps, that the petals of those of *P. elegans* are a shade stouter and broader.

I have not seen the Cumberland Islands fruits quoted by Burret, but the description he gives of them differs in no way whatever from the one he gives of *P. elegans.* R. Brown's type of the species was collected on the east coast of Australia somewhere between Sandy Cape and the Cumberland Islands. *P. Capitis Yorkii* is probably only at most a variety of the more widely distributed *P. elegans,* the only tangible difference I can see is that the leaf segments of *P. Capitis Yorkii* are narrower than those of *P. elegans,* the width of the former being 2-4 cm., those of the latter 5-8 cm.

It is very difficult to key out the species of *Ptychosperma* in cultivation, though the palms in the field may look distinct. In his Queensland Flora, vol. 5, pp. 1676 and 1677, F. M. Bailey describes the Cape York plant on one page as *Archontophœnix Jardinei* and on the other as

Ptychosperma elegans. In 1909 Dr. O. Beccari wrote to F. M. Bailey, then Government Botanist at Brisbane: "I think that you may change the name of your *Archontophœnix Jardinei* to that of *Ptychosperma Jardinei.* The same plant is cultivated at Buitenzorg under the erroneous name of *Hydriastele Wendlandiana,* and probably from there distributed under that name." This change was immediately made by Bailey and published in the "Queensland Agricultural Journal" for July, 1909. Apparently the true *Hydriastele Wendlandiana* Wendl. and Drude is unknown in cultivation. It is a native of the Northern Territory of Australia, but little is known of its distribution in that country, and I think it is only known from the original gathering by B. Gulliver on the Liverpool River in the far north of that territory.

My friend Captain H. A. Johnstone, a keen student of palms, wrote me some time back, 22nd February, 1931, that at the Botanic Gardens, Darwin, on his way back to England from Australia he had seen a slender stemmed palm with narrow segments that might be this species; but unfortunately at the time of his visit it bore neither flowers nor fruit. It is very much to be hoped that this little known palm will be rediscovered and introduced into cultivation.

As a contribution to the distribution and synonymy of these palms, the following notes are offered:—

PTYCHOSPERMA ELEGANS (R. Br.) Bl. Rumphia 11, 117. 1843.

Seaforthia elegans R. Br. Prodr. Fl., Nov., Holl., 267. 1810.

Ptychosperma elegans Wendl & Drude, in Linnæa XXXIX., 215. 1875 (in parte).

Queensland.—East Coast between Sandy Cape and Cumberland Islands (R. Brown); Cape Sidmouth (Curdie); near Cooktown (O. Warburg, No. 19506); Mackay (D. Buchanan); near Rockhampton (Nernst); Fitzroy River (Nernst & Thozet), growing among rocks; Byfield (C. T. White, 8191), medium sized palm of rather handsome appearance, very hard wood; common on hillsides in rather light rain-forest.

Wendl. & Drude 1 c. quote a specimen from Strangeway River, Northern Territory (Stuart). This is far away from other localities for the species and rather different country. It is much to be desired that better material be seen and the locality again visited by a botanist.

I think the palm illustrated and described by Hooker in Bot. Mag. t. 7345 represents the true *P. elegans;* the pinnæ are described as 3 in. wide, and the stem illustrated for the size of the palm is a comparatively stout one.

PTYCHOSPERMA CAPITIS YORKII Wendl. & Drude, in Linnæa XXXIX., 217. 1875.

Ptychosperma elegans Wendl. & Drude, 1 c., 215. 1875 (nec. R. Br., Bl.)

Kentia Wendlandiana Benth. Fl. Austr. VII., 138 (1878) (in parte nec. F. v. Muell.).

Ptychosperma elegans F. M. Bailey, in "Queensland Agricultural Journal," 1, 232. 1897. (nec. (R. Br.) Bl.)

Archontophœnix Jardinei F. M. Bailey, in "Queensland Agricultural Journal," 11, 129. 1898.

Ptychosperma Jardinei F. M. Bailey, in "Queensland Agricultural Journal," XXIII., 35. 1909.

Ptychosperma Wendlandiana Burret. Notizb. Bot. Gard. Mus., Berlin, X., 205. 1927.

Ptychosperma Wendlandiana Burret var. *sphœrocarpa* Burret, 1 c., 206.

Hydriastele Wendlandiana Hort. (nec. Wendl. & Drude.)

Queensland.—Cape York (Dæmel), Somerset, Cape York (Veitch's collector) (F. L. Jardine).

Notes on the Geological Structure at Nathan Gorge, in the Upper Dawson Valley, Queensland.

By E. M. Shepherd, M.E.

Two Text Figures.

(*Read before the Royal Society of Queensland, 29th October, 1934.*)

Nathan Gorge, in which it has been proposed to construct a dam across the Upper Dawson River for the irrigation of lands in the valley below, is situated some 30 miles E.N.E. of Taroom. Here the river crosses a belt of elevated country through a gorge in which the present bed-level (about 500 feet above sea-level) is some 300 feet below the general level of the adjacent area.

An unconformable junction between palæozoic and mesozoic strata occurs in the lower section of the gorge. The older rocks are hard dense sandstones and conglomerates dipping westwards, believed to belong to the Upper Bowen Freshwater series. Above them are mesozoic sandstones very nearly horizontal and undisturbed.

GENERAL TOPOGRAPHY.

Above the gorge the river flows through a relatively flat valley, and the construction of a dam would provide a remarkable reservoir, the capacity of which, when considered in connection with the size of the dam, would rival any similar "valley storage" in the world.

The sides of the valley gradually draw together and become more precipitous as the country rock changes progressively from shales and mudstones to fine sandstones and shales, and coarse current bedded sandstones. Away from the watercourses the land is often level and undulating, but near the river and tributary creeks it is very rough and steep. The gorge section may be regarded as commencing near Price Creek. About 4 miles from here the river which hitherto has had a general trend to the east turns sharply to the north, and in this region occur the narrowest sections. The sides of the gorge then become steeper and higher but wider apart, and the adjacent country is more broken, with a general height of about 350 feet above the river bed. The gorge gradually merges into a valley with a relatively flat bottom, the sides drawing back from the river to form flanking ranges.

The length of the gorge section of the valley is about 10 miles, but rough country extends from the junction of Spring Creek to below Cattle Creek, a distance of some 20 miles.

The river itself consists of a chain of long deep waterholes, with densely timbered strips of regularly-flooded black soil below the sandstone cliffs of the gorge sides. Numerous springs in the gorge section flow into the river, and due to their influence the stream, at least in this region, is perennial. Borings have shown that once the river channel was many feet below its present level, and its bed has been extensively silted up by aggradation, so that now a thick blanket of silt, exceeding 50 feet in depth, covers the old bed of quartz gravel.

There are several puzzling features in the physiography of the Dawson Valley.

Evidence is available to show that in the gorge itself, silting is still in progress, due to the very low velocity of the river which during high flood apparently does not exceed 2 or 3 miles per hour. The main cause of this is the flatness of the bed, for from Taroom to the gorge the fall is 92 feet in a river distance of 46 miles, or 2 feet per mile, and from the gorge to Theodore it is 84 feet, or an average of 1·7 feet per mile.

In the upper basin, out of a catchment area of about 9,000 square miles, some 2,000 square miles appear to lie below the level of the tops of the cliffs at the gorge, some 300 feet above the present river bed.

From investigations in the region of Theodore, it appears that there is a considerably greater depth of silt covering the original bed rock than at the gorge.

Below Theodore the profile of the valley becomes steeper without the reason for the change being clear, but no data as to depth of bed rock is available.

The author has been led to wonder what is the relationship between these conditions, and the causes which produced them.

Perhaps a differential earth movement could be the cause. If they are the result of a changed equilibrium between erosion and deposition following altered climatic conditions, it seemed reasonable to expect the hydraulic behaviour of the river to be less abnormal than investigations have proved it to be.

(A) Geological Structure.

The geological structure of the gorge area is relatively simple. The rocks are all sedimentary and appear to comprise two unconformable series, the older being visible only in the lower parts of some of the deeper gorges, and in the river below the gorge section. No outcrops of this have been found higher up the river than the junction of Cabbage Tree Creek.

The junction of the two series dips to the south-west and was found about R.L. — 5·00 feet at the original dam site, and about R.L.* — 80·00 at the upper site from diamond drilled bores. (See text figure 1.) This indicates that the apparent dip of the junction is approximately 85 feet per mile in a direction bearing 219 degrees between these two dam sites, and 47 feet per mile in a direction bearing 230 degrees between the junction of Cabbage Tree Creek and the first site. The junction is unlikely to be a plane, being an old land surface, and data are insufficient to give the general true dip of the unconformity with much exactitude.

Visible portions of the older series consist of freshwater sandstone and conglomerates with occasional bands of shale. Current bedding is frequent and there are many conglomerate beds. The texture of the sandstones varies from very coarse to very fine, the average being

* Throughout this paper the level datum of the Department of Irrigation and Water Supply has been adopted for convenience of reference. Hence R.L. 0 is approximately 400 feet above sea-level.

medium grained and fairly even. Some bands of shale and a hardened and compacted ironstone shale also are found. These rocks are believed

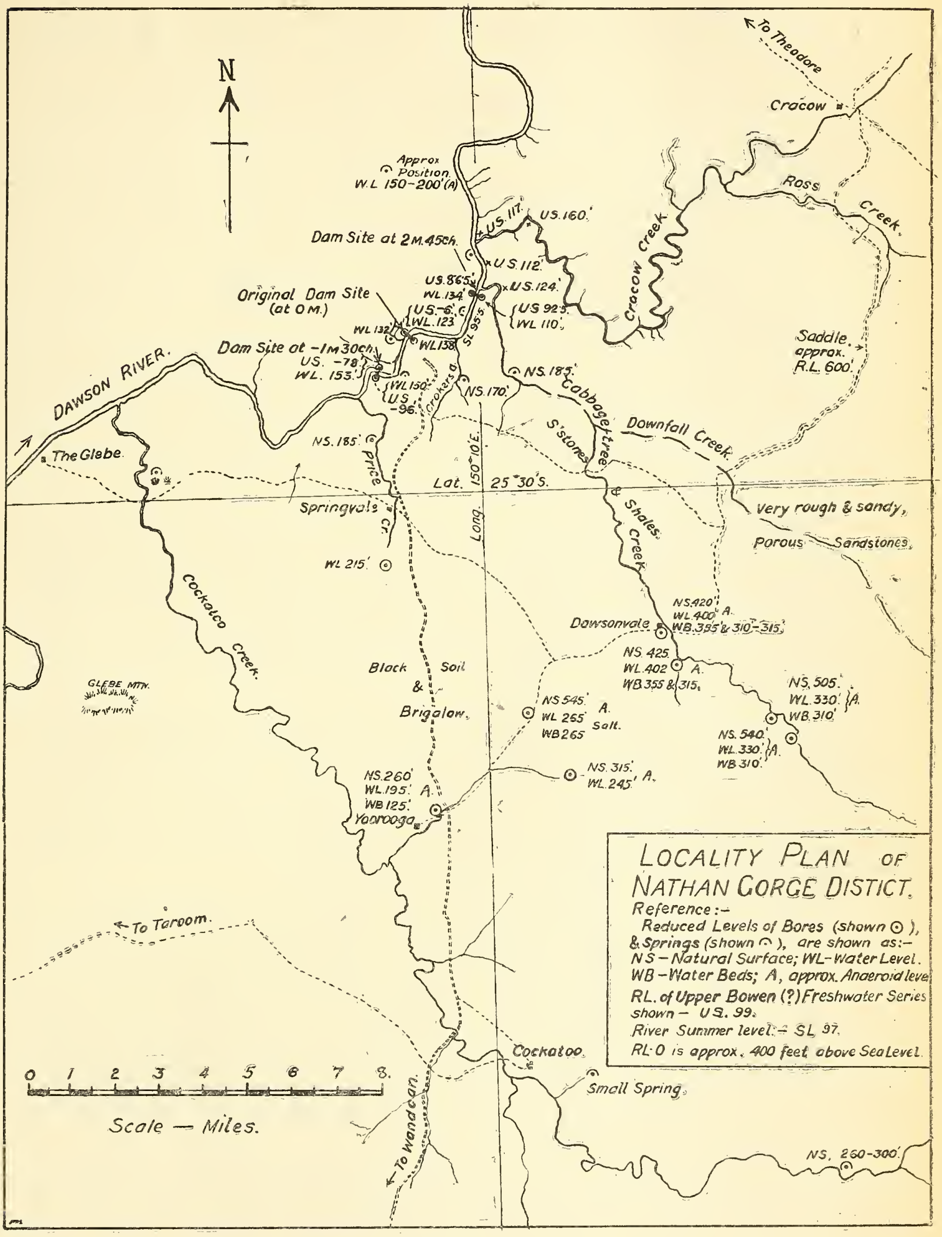


Fig. 1.

to be part of the Upper Permo-Carboniferous Freshwater series, but no fossil evidence could be secured. The fine-grained bands were found to show a certain amount of fragmental plant remains, but nothing complete enough to be identifiable. The series as a whole is hard and compact and apparently has been well impregnated with iron-bearing solutions.

Owing to there being few clear sections available, the true dip of the series could not be definitely determined. In Cracow Creek gorge the dip appeared to vary from 5 degrees to 9 degrees towards the west.

It is suspected that in the region to the north and east, these series are more folded and disturbed than near the gorge. The series was not examined in detail beyond 4 miles down the river from the point marked "Original Dam Site" on the locality plan, but the section visible from the river was superficially looked over for some 13 or 14 miles. The dip appeared to hold generally to the west, but in one place adjacent to the water some masses of rock showed a steep dip to the east. Lack of time on this occasion did not allow it to be determined whether the rock was part of continuous strata or detached masses disturbed by river action. At about 6 miles the junction must be near R.L. 140; and at 8 miles it seems about R.L. 200. From here to 10 miles the level may drop slightly. Below 10 miles no section of the lower rock is visible from the river owing to the cover of silt. From 6 miles to 10 miles the river follows a semi-circular path, bending some $1\frac{1}{2}$ miles to the east.

The section exposed in Cracow Creek was examined for about a mile, but local conditions at the time made anaeroid readings taken in this gorge unreliable, and the rise of the unconformity is uncertain. It seems, however, at least 50 feet per mile, and for the first mile the true dip seems continuously to the west without folding. Higher up the creek this dip may be steep, for a local resident described the rock as "standing on edge."

The series is believed to overlie the limestones and marine series which outcrop at Cracow Station, and also near "Neustella" on the Dawson River. These have been identified as part of the Lowen Bowen series. The area to the north and east of the gorge is very inaccessible and was not examined, but on the whole the unconformity rises more rapidly in an easterly than in a northerly direction.

Frequently a very soft layer occurs immediately above the unconformity, and this has led to the formation of wide benches on the older series in the northern part of the gorge and the adjacent valley, from which the mesozoic cliffs rise very steeply. In general, from just below Cracow Creek junction, the surface of the older rock forms the floor of the relatively flat-bottomed valley into which the gorge opens, and the present river channel has been eroded in this floor. The character of the lower part of the Cracow Creek gorge is similar.

The older mesozoic series of which the gorge sides are composed consists of massive sandstones with occasional thin bands of shale in the lower part, and hard clay-shales and sandstones above. These sandstones vary in texture indiscriminately from very fine to coarse, and a few conglomerate beds are found. Coarse-grained sandstones with extensive current bedding predominate, especially at lower levels. All the rock has high porosity, and the general composition is one of clear quartz grains with argillaceous cement. Some bands also contain mica.

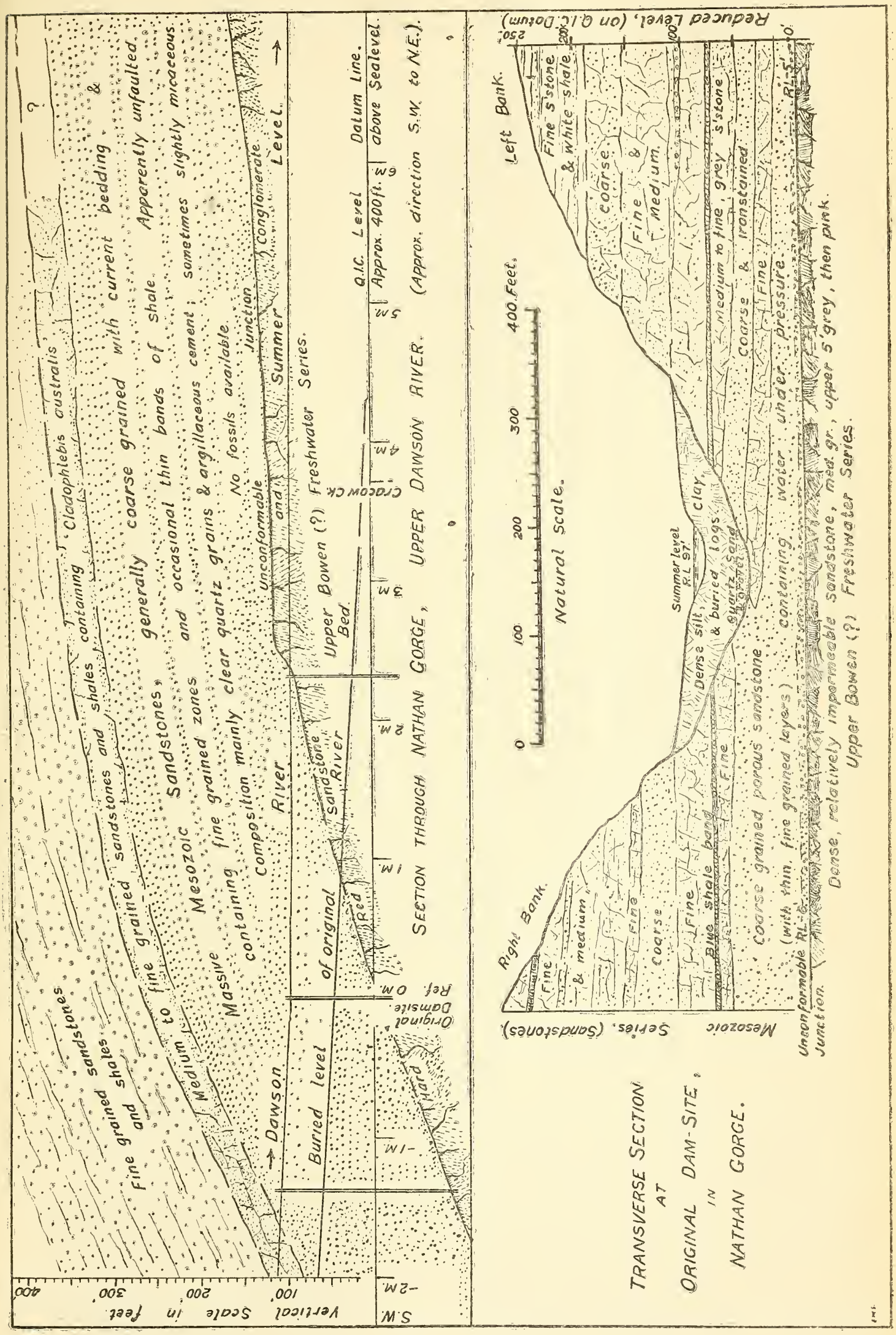

SECTION THROUGH NATHAN GORGE, UPPER DAWSON RIVER. (Approx. direction S.W. to N.E.)
Vertical Scale in feet
Fine grained shales and sandstones
Fine grained sandstones and shales containing Cladophlebis australis
Medium to fine grained Sandstones, generally coarse grained with current bedding & occasional thin bands of shale. Apparently unfaulted.
Massive Mesozoic zones and argillaceous cement; sometimes slightly micaceous.
fine grained zones containing mainly clear quartz grains & argillaceous cement
Composition ... No fossils available.
Unconformable Junction
Conglomerate
Dawson River Summer Level
Buried level of original Red Sandstone River Bed.
Upper Bowen (?) Freshwater Series.
Q.I.C. Level Approx. 400 ft. above Sealevel
Datum Line.
Cracow Ck.
Original Damsite
Hard
Ref. 0 M.
S.W.
TRANSVERSE SECTION AT ORIGINAL DAM-SITE, IN NATHAN GORGE.
Natural Scale.
0 100 200 300 400 Feet.
Right Bank.
Left Bank.
Reduced Level, (on Q.I.C. Datum)
Mesozoic Series, (Sandstones)
Fine s'stone & white shale
Coarse
Fine & Medium
Medium to fine, grey s'stone
Coarse & ironstained
Fine
Blue shale band
Dense silt, clay, & buried logs
Quartz Sand Gravel
Summer level RL 97'
Coarse grained porous sandstone (with thin, fine grained layers) containing water under pressure.
Unconformable Junction.
Dense, relatively impermeable sandstone, med. gr., upper 5' grey, then pink.
Upper Bowen (?) Freshwater Series.

Fig. 2.

Narrow bands of shale are often found, but seldom continue very far before they merge into fine sandstone or pinch out. It seems probable that nearly all the shale bands are lenticular beds of limited extent.

The beds of the lower part of the series extend right through the gorge section and appear to rise from about river level at the upper end to several hundred feet above at the northern or lower end. However, to the eye the series seems horizontal, and for the most part no dip can be read with a clinometer. Attempts were made to determine the dip from observations on beds of certain texture, but as fine-grained beds merge into coarse and shale bands merge into sandstones and *vice versa* without any continuity for more than short distances, no reliable readings were obtained. It is thought that probably the beds dip in a S.W. direction in the order of 80 feet to the mile, but this may be exceeded in some areas and seems less in others. Clinometer readings from near the junction of Cracow Creek along the tops of cliffs in the Dawson and Cracow gorges each gave elevations of approximately 0 degrees 41 minutes in directions bearing about 340 degrees and 60 degrees respectively. This suggests rises of about 60 feet per mile in these directions, and a fall of 90 feet per mile in the direction of the dip towards the south-west. However, these figures may be misleading owing to the lack of certainty that the readings followed accurately the one geological horizon.

Observations of rock strata bordering the waterhole in the section above Cabbage Tree Creek, though inconclusive, suggest that there is very little dip at all here in the north-south direction, in spite of the fact that the junction line of the two series drops at the average rate of some 60 feet in the mile towards the south (i.e., up river). Probably here the true dip is in a more westerly direction.

The upper half of this Lower Mesozoic series is much less porous rock than the lower. Owing to its containing more argillaceous material it weathers away much more easily and does not form steep cliffs, with the result that the tops of the lower sandstones seem usually to coincide with the top of the cliffs in the gorge.

(B.) Notes on Fossils.

The fossil fern *Cladoplebis australis* has been identified in strata at R.L. 250 feet at the old dam site and R.L. 300 feet near the junction of Cabbage Tree Creek. (Refer Text fig. No. 1.) This fossil seems the only common one, and it occurs in both the Ipswich and Walloon series. Another fossil (found at Croker's Gully) in beds corresponding to those at R.L. 150 feet at the upper site was *Coniopteris,* a genus common to the Ipswich and Walloon series. The nature of specimens obtained were considered to indicate the Ipswich rather than the Walloon series. Good specimens of fossil leaves, &c., are hard to obtain, and most indications are fragments too small or incomplete for identification. Near Dawsonvale Station, however, are beds containing very well preserved fossil fern leaves and seeds, &c., but the writer is unaware of their true identity.

(c.) Hydrological Notes.

In the porous lower mesozoic strata, water occurs under pressure. This water apparently accounts for the phenomenon of the "bogomoss" springs, so dangerous to stock, that are found in the bed of the gorge and some other localities, and the numerous large springs that are found in tributary gullies at the upper end of the gorge section. The "bogomoss" springs are areas of very soft boggy ground in which water wells up. They frequently are a little higher than the surrounding ground, and their size may vary from a yard or two across to several acres.

In the gorge these springs are found mainly between the Old Dam Site and the junction of Price (locally Springvale) Creek. Similar phenomona are found on Bogomoss Station on the left bank some 6 miles further west, and in the lower reaches of Cockatoo Creek.

All the deeper tributary gullies from Price Creek to Cabbage Tree Creek on the right bank and to Cable Creek on the left have big springs in them. The biggest are to be found on the right bank in Price Creek, Croker's Gully, and Cabbage Tree Creek, but that on the left in Cox's Creek near the Old Dam Site has probably as great a flow as any. This was not less than 1,000,000 gallons a day, but after the test bores were drilled at the dam site, a small decrease was observed.

In the creeks on the right bank the heads of springs are frequently some distance from the river, while those on the left bank below this dam site are small and head fairly close to the gorge. The one in Cable Creek, however, is several miles from the river and does not succeed in flowing to it before the water soaks away again. Between creek junctions water can often be observed seeping out of the lower rocks in the gorge. On the whole, most water seems to emerge between the two higher dam sites.

The fact that the water is not noticeable above Price Creek is probably due to the bed of the gorge being in the less permeable more shaley series which overlies the very porous sandstones. Probably where springs do occur above here, they are due to weaknesses in the upper rock through which the water escapes.

The origin of the water is uncertain, but undoubtedly it is collected by porous surface strata at higher levels from which it gravitates through permeable sandstones to escape in the gorge and nearby springs. The position of the intake beds is uncertain, but geological considerations suggest that they will be situated either to the south-east or the north-west of the upper gorge section. Probably water comes from both regions, travelling from either side to a common escape in the region of the gorge.

The general dip of the mesozoic beds is to the south-west, and the porous sandstones of the gorge area in which the water is found extend to the western limit of the gorge section and then are covered by the less porous shales and sandstones which are between these beds and the Bundamba Series of porous sandstones reported by Mr. J. H. Reid. Consequently water from any area to the south-west is not likely to find its way into the gorge, but will rather percolate towards the south-west following the general inclination of the strata.

Towards the north-east the impervious Upper Bowen (?) Series would act as a floor along which ground water would percolate and escape at the gorge, for beyond 1½ to 2 miles northwards on the river traverse—that is, from slightly above the junction of Cabbage Tree Creek—the dense clay silt in the bed of the gorge will be in contact with this series and cut off any flow. Any water would be expected to seep into the gorge, but in this area no springs are noticeable on the right bank, nor in Cracow Creek, nor in the lowest reaches of Cabbage Tree Creek.

The Downfall Creek catchment and surrounding country contains very sandy and rough areas from which the run-off, except in times of very heavy rain, is almost negligible. Sandstones are frequently exposed or covered by very sandy soil. The Auburn Range is on the western edge of the granite country, and it is reported that a bore some 8 or 10 miles east of Dawsonvale Head Station struck granite at a depth of 180 feet. This area is somewhat higher than that near the gorge. An igneous rock of granitic nature occurs on Cracow Station within 10 miles of the Cabbage Tree Creek and Dawson River junction, and bordering this igneous series are Lower Bowen beds steeply inclined and dipping to the west., It seems probable that water absorbed by the porous surface layers percolates down and along the pervious strata above an impervious floor consisting of granite or the Upper Bowen sandstones. There is a spring in Cockatoo Creek, some 6 to 8 miles above Cockatoo Head Station, which may obtain its water from a similar source. This spring is reported to have been influenced considerably by an earth tremor in 1918, and may be located over a fault.

Water levels in bores and springs are shown on the plan, but it must be stressed that these are only approximate. The natural surface levels were obtained by anaeroid readings, for the most part not repeated. The levels of water in bores could not be checked. The information relating to depth to water and water-bearing strata on "Dawsonvale" were kindly supplied by Mr. G. Hamilton, formerly of Dawsonvale Station, and are, I understand, based on the figures given by the well drillers. It is interesting to note that on Cabbage Tree Creek the four bores had a water-bearing stratum reported at the same level, but the free surface level in the two lower bores—which incidentally pass through a water-bearing stratum above—is much higher. The levels of each pair agree very closely.

The large springs on the right bank, several miles from the river, show that water must come from the east or south. Springs in the lower gorge section on the left bank show that water comes from the west of the gorge. Consideration of levels in bores, levels and volumes of springs, bogomoss, &c., lead to the conclusion that water finds its way from both sides to leak out into the river, and the total volume from the right side exceeds that from the left.

Evidence is against the water being of river origin, percolating through the sand and gravel of the old river bed now buried beneath many feet of dense clay and silt.

The writer is indebted to Mr. M. B. Salisbury, Officer in Charge of the Queensland Irrigation and Water Supply Department, and to the members of the Land Administration Board, for permission to use official data in these notes. Also he desires to express his thanks to Dr. W. H. Bryan for helpful suggestions.

Plant Ecological Studies in South-East Queensland.*

By E. C. Tommerup, M.Sc., A.A.C.I.

One Map.

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CONTENTS.

I. INTRODUCTION.

The correlation of floristic distribution with environmental factors deserves increased attention from scientists. The original objects of the work described in this paper concern the economic utilization of the lands surveyed. The areas dealt with cover the flat coastal lands and slopes of the Coast Range near Maryborough, a mountain area near Kilkivan, and the forested lands at the head of the Brisbane River. The primary scientific aim of the work is to evolve a natural system of classification of the vegetation and to determine the reasons underlying its natural distribution. As the nature of the vegetation is very closely linked with the nature of the soil, the classification of the soils on a natural system becomes a second aim. A third important point of study concerns what might be termed the biological reactions of certain economically desirable species to their natural environment, and to artificial changes in their environment which are calculated to improve their growth and to extend their range. The successful introduction of exotic species depends largely upon the accuracy of one's judgment of the effects of ecological agencies.

Throughout the work of vegetation classification every endeavour has been made to follow recognised methods; in the case of the open forests this is not unduly difficult, but it does not seem possible to classify the rainforest interior exactly in accordance with the methods of Clements *et al.* Perhaps more intensive work will show that the rainforest formation can be broken up into communities which are capable of more exact definition than my somewhat overlapping rainforest subdivisions at present outlined (Bourne, 1934).

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* This paper is revised and abridged from portion of a thesis successfully sustained for the degree of Master of Science in the University of Queensland; it is based on work done by the writer when in the employment of the Queensland Forest Service.

In the majority of cases it is found that the detailed distribution of species is an expression of the combination of a large number of edaphic factors. Local climate, lithological origin, mode of formation, drainage, topography, the thicknesses, colours, consistences and textures of profile horizons, the chemical properties of the clay and humic colloids and the nature of the vegetation growing, all have a bearing on the ultimate fertility of the soil, and variations in these factors are associated with variations in the natural vegetation. No one of these agents can be claimed to be exclusive; each plays its own role in conjunction with the others, though in some circumstances one agent may be of more importance than others. This is the system of the U.S.A. Soil Bureau, and it is only by the adoption of this detail that a satisfactory correlation between soil type and fertility or natural vegetation can be obtained.

One of the factors which influences soil fertility is the consistence. This is too frequently included by British soil workers with texture; the Americans rightly restrict the term "texture" to cover the results of the mechanical analysis only: the per cent. sand, silt, and clay; and they use the term "consistence" to describe the intrinsic cohesive power of the soil colloids. Soil consistence varies from stiff to mellow, and it depends upon the composition of the clay and upon the humus content. Laboratory estimates of soil consistence may be made by means of a pachimeter (Schofield and Scott-Blair, 1932), and by the use of single value figures corrected for texture—e.g., loss on ignition, moisture equivalent or sticky point plotted against percentage of colloid. The texture can be accurately obtained by international mechanical analysis; and reference to my chart, which is based on the U.S.A. texture classification corrected to international grain sizes, gives the field textures for describing soil types within a soil series (Tommerup, 1934).

A detailed survey of Queensland soils would materially assist agricultural enterprise. The requisities are, first, a satisfactory system of soil description which emphasises the important factors, the American system seems to be the best; second, good base maps showing the position of land surveys, topography and geology (Tommerup, 1934). The particular requirement of geology in soil surveys is the nature of the lithology, and in this connection it is rather a pity that the excellent new geological map published by David (1932) groups different kinds of rocks together because they are of the same age—e.g., the Esk series includes both the shales and the andesites.

CLIMATE.

The climate of the region is outlined in some detail because of its direct influence on plant distribution (Herbert, 1928, Francis, 1927) and on regional soil formation and its indirect and more localised effects on soil formation, via the vegetation growing on the soil, particularly in the rain forests. The prevailing winds are usually south-easterly to easterly. Occasionally variable winds blow during the months of June to October, and sometimes southerly "busters" bring rain to the coast and easterly aspects of the hills during winter months. Dust from the western plains is sometimes carried in by hot dry winds and deposited on the westerly aspects of the hills during September and October. The region lies just north of the belt of anti-cyclones or high pressures. The insolation constant at summer solstice is ·97 and at winter solstice ·52. The mean monthly temperatures and rainfalls are as below:—

—	Maryborough.		Nanango.		Yarraman.	Kilkivan.
	Rainfall inches.	Mean Temp. °F.	Rainfall inches.	Mean Temp. °F.	Rainfall inches.	Rainfall inches.
January ..	7·5	77	4·5	74	3·9	5·5
February ..	6·3	77	4·1	73	2·5	5·0
March.. ..	6·2	75	3·4	70	2·6	4·0
April	3·4	71	1·8	65	1·3	2·1
May	3·2	65	1·6	58	1·4	2·0
June	3·0	61	2·0	54	1·6	2·0
July	2·0	59	1·7	52	1·3	1·6
August ..	1·7	60	1·4	53	1·4	1·6
September ..	2·0	66	1·9	60	2·2	1·6
October ..	2·6	70	2·3	75	2·4	2·5
November ..	3·1	75	2·6	71	3·4	2·6
December ..	4·8	77	3·8	73	4·1	4·5
Average Annual	45·8	69	31·1	63	28·0	35·0
Number Years	..	..	45	45	10	50

Possibly more rain falls on the hilly country inland from Maryborough than on the lower land at Maryborough, where records are taken; likewise the rainfall on R. 220 Kilkivan is probably about 3 inches more than at Kilkivan. The wet season is December to March, when 50 per cent. of the rain is precipitated. April to September are the driest six months of the year, when 33 per cent. of the total rain is precipitated. The average rainfall per wet day is ·4 inch at Nanango and ·5 inch at Maryborough; there are an average of seventy wet days per annum at Nanango and ninety wet days at Maryborough. Over 1 inch of rain falls uniformly each month, though dry spring months may occur in some years. The reliability of rain is over 20 per cent.—that is, the annual rainfall seldom varies more than 20 per cent. from the average, which is reasonably good; the proximity of the mountains tends to improve the reliability; exceptional variations do occur in certain cyclical years—e.g., at Kilkivan the driest year recorded was 1902 with 14 inches; the wettest, 1893 with 82 inches. Frost may occur from May to August.

The following places in the world have temperature and rainfall conditions more or less similar to those of the Maryborough district:—N. Siam, Formosa, S. Japan, Brazilian East Coast, Honduras, Florida to New York Coast and hinterlands, Kenya Colony, &c. For this reason the native pines of the S.E. U.S.A. (*Pinus caribœa, P. serotina, P. taeda, P. echinata, P. palustris,* &c.), have been proposed as possible plantation species for the Maryborough lands.

Griffith Taylor has noticed that the distribution of native vegetation depends upon the average monthly rainfall rather than on the total annual rainfall, and Swain (1928) has given 2 inches per month as the limit for Blackbutt (*E. pilularis*) forest and 1.50 inches per month as the limit for Hoop pine (*A. cunninghamii*). *E. pilularis* only occurs in the Yarraman district on the rain-catching S.E. aspects of the Blackbutt Range, where the rainfall of the driest month does not fall below about 1.75 inches.

The evaporation rate averages a little over 50 inches per annum, and it just balances the rainfall during January to July; in other months the evaporation exceeds the rainfall rate. This is important, because the actual moisture content of the soil can be greatly influenced by transpiring vegetation and vice versa.

In the Yarraman district the relative humidity ranges from about 57 per cent. in September-October to 70 per cent. in March-August; in Maryborough it is relatively constant at 65 to 70 per cent. throughout the year. At Nanango the average saturation deficit is ·2 and the Meyer ratio is about 150. This data places the Nanango district at the junction of Prescott's Podsol-Red Loam-Black Earth soil groups. (Prescott, 1931.) It also corresponds with the junction between Crowther's Transitional Prairie soils and his Chernozems. At Maryborough the saturation deficit is about 0·24 inches and the Meyer ratio is 190; further east on Fraser Island the Meyer ratio is 230 on account of higher rainfall and lower saturation deficit, whilst it diminishes as one goes inland for the opposite reasons. These climatic data place this area in the region of Prescott's Podsol-Red Loam group. The Crowther Leaching factor is 40 and the rainfall 115 cms, which puts the Maryborough lands in Crowther's Transitional Class close to the "ferruginous laterites" and the Prairie soils. The data for the true lateritic regions of Malaya are as follows:—Leaching factor 140 Rainfall 230 cms., Sat. Deficit 0·16 inches. Meyer ratio 600, average rainfall per wet day 0·5 to 0·6 inches. The true podsols occur in a climate having a leaching factor of about 70, and a Meyer ratio of usually over 400, due to a low saturation deficit associated with a cool climate.

The question as to which one of the major soil groups covers the Maryborough soils is not easily settled. Prescott (1931 and 1933) classified the Wallum soils in the zone of Podsolized soils. He regards podsolization as a very widespread process, which produces neutral to slightly acid conditions in the soil. Podsols are soils characteristic of a wet, cool climate with long more or less frozen winters and short summers. They usually support coniferous forest which produces an accumulation of undecomposed raw humus in the A0 horizon. Leaching action bleaches the A2 horizon, whilst organic matter and iron pan are deposited in the B horizon. Typical podsols are more usually found in light textured soils, but when heavy textured soils are podsolized, the surface layers become white, poorly structured, hard when dry, and infertile. Compare Jacks (1934.) There is very little accumulation of raw humus under most of the sclerophyll forest of coastal Queensland. The true podsols are restricted to the Great Lake districts of U.S.A. and Canada, Scandinavia, Northern Russia, &c.

Maryborough soils are not similar to the true laterites of Malaya, but appear to form a transition stage between the true podsols, the laterites, and the brown earths; they are similar in some respects to the descriptions given of the "ferruginous laterites" and the yellow soils of S.E. U.S.A. (Fowler, 1927). Prescott (1931) states that "the extensive Wallum country north and south of Maryborough, Queensland, shows concretions of iron oxide, and it is likely that these very fine sandy soils are waterlogged in summer and quite dry at the end of the dry season."

Though these soils may appear to be podsolized, it would be better if they were given a separate group name as is done in U.S.A., such as

Yellow Forest Soils, which are probably their closest allies. This view accords with the work of Bryan and Hines (1931). Whatever major group they may be included in, sight should not be lost of the fact that there are very important differences among the soil series and soil types themselves, which control their fertility, and the soil series must be used as the unit of soil definition.

II. AN ECOLOGICAL SURVEY OF LAND NEAR MARYBOROUGH.

Topography and Geology.

About 300 square miles of land north and north-west of Maryborough has been surveyed; and an east to west section across it represents to some extent a "profile" from low coastal strand with mangrove-lined river banks, to an altitude of roughly 700 feet above sea-level on the coast range. The block can be conveniently divided into three topographic sectors:—

I. East of the Main North Coast Railway, Maryborough to Howard.
II. West of the railway to a north to south line through Musket Flat (Eliott).
III. West of this N.S. Line to the Seaview Range.

I.—This sector consists of almost flat country, whose swamps are of the order of 50 feet above sea-level, and the low ridges 100 to 150 feet. The vegetation is usually poor and is characteristic of water-logged land.

II.—Excepting a patch of country near Oakhurst, which is similar to that just described, sector II. is of a better class than I. It is a gently undulating peneplain of altitude 100 feet to 200 feet on the average. The general slopes being of the order of 1 in 100 or steeper. The area is fairly regularly drained by a system of waterways and watercourses.

III.—The area west of Musket Flat is fairly rough and hilly with a rubbly clay soil. The altitudes are of the order of 300 feet to 600 feet above sea-level.

The district is characterised by clay formations, but some patches of sandy lands occur, notably a belt associated with the Graham's Creek series of tuffs, which extend through the southerly portion of sector II. from R. 216, parish of Warrah, to Oakhurst. In these sandy places much rainwater soaks in and reappears in seepage watercourses. On the clay lands the water runs off readily, and when much rain falls quickly there are high floods in the watercourses. The watertable is close to the surface on the clayey parts, and the ground readily holds water in small lagoons. The water usually carries clay in suspension in the wet seasons, but it is clear in the dry seasons. The water from the sand patches is always clear, save in some places where it is turned dark in colour in a dry time, probably owing to the presence of humic material. The waters of the district are usually soft, indicating that the lime content of the soil is at a minimum. Lower Doongul and Duckinwilla Creeks have never been known to dry up entirely, though water supply has been temporarily low.

For the most part the rocks of the district are covered by 3 to 5 feet of soils and subsoils, and an accurate mapping of the rock changes is difficult, consequently the geological maps available are only approximate. The geological map and section which has been prepared, however, is sufficiently accurate for the purpose, and is based upon the map in Queensland Geological Survey Publication 262, the work of Bryan and Massey (1925) and my own extensions of these descriptions.

The strata of the district belongs to the following conformable Mesozoic series, which overlie Palæozoic rocks:—

Lower Cretaceous ..	Burrum Coal Measures, shales with coal seams.
Upper Jurassic ..	Maryborough Marine beds, hard siliceous and fossiliferous shales.
Lower Jurassic ..	Graham's Creek tuffs, volcanic ash beds. Tiaro series, soft shales (Walloon horizon).
Upper Triassic ..	Myrtle Creek series, quartzites, and sandstones (Bundamba horizon).
	Brooweena series, hard sandy shales (Ipswich horizon).

(?) Permo-Carboniferous (?) Gympie series, slates, and sandstones extend towards Biggenden. Intrusive granites also occur which Dr. Bryan considers to be of (?) Tertiary age.

The Mesozoics form a geosyncline across the area studied and have a general strike N.W. and N.N.W. The dips are about 30 degrees E. in the west and 10 to 35 degrees W. on the east, but they are variable.

The Burrum Coal Measures are whitish lacustrine shales which produce whitish fairly stiff clay soils often containing scattered limonitic marbles; these are possibly fossilised indicators of white lateritic soils. The shales are fairly soft and usually form almost flat topography, and in consequence much of the outcrop carries partially water-logged soil and poor vegetation. It is of more than passing interest to note that the fossil flora of this and other series contain extinct Araucarias and other subtropical plants. The Burrum Series is covered by soil types *c, e, f,* and *g.*

The Maryborough Marine Series consist of hard silicified shales containing plant and animal fossils. They are readily recognised in the field by the presence of fossil shells in the rocks. This rock produces a rubbly soil, and on account of its relative hardness it weathers more slowly than the associated rocks, and consequently forms ridges and often appears as outcrops and outliers in somewhat unexpected places. It forms soil type *h.* These ridges carry good timber; possibly because they catch more rainfall, and because they are better drained, thus giving a more neutral soil than the flats, which are frequently acidic in reaction.

Closely associated with, and overlaid by, the Maryborough Marine is a somewhat variable series of rocks, the Graham's Creek series. It consists of bedded pinkish agglomerates and tuffs which are sometimes hardened, and which generally contain felspathic material together with grains of quartz. This rock is fairly soft and it produces flat topography and grey sandy clay soils, which are water-logged in low-lying places, typically types *d* and *b.*

The underlying Tiaro series is a soft lacustrine shale giving yellowish sandy clay soils of types *e*, *f*, and *g*.

The Myrtle Creek series consists of a narrow band of rocks which outcrop as massive hard white siliceous sandstones. It plays little part in soil formation, though its sands are probably blended with the clays from other rocks.

Below the Mesozoics and outcropping on the high ridges of the western sector is a fairly hard ferruginous sandy shale rock consisting of very fine sand set in a matrix of indurated clay which may be partly recrystallised. It produces dark yellow, red, and brown rubbly soils typically types *h*, *i*, and *k*. The ridges of the western sector are due in part to the hardness of the rocks of this series, though primarily caused by a folding action on the strata of the district: the Coast Range Fold. The rock strike is N.N.W. and dip 30 to 50 degrees to E.N.E.

Near Musket Flat (Eliott) a granite (with quartz, orthoclase, plagioclase, muscovite, hornblende) instrusion of considerable extent occurs which is regarded (verbal communication) by Dr. W. H. Bryan as being younger in age than the surrounding Mesozoics. It produces a typical grey granitic sandy clay soil in some parts, but forms brown clay soil in the mature watercourses.

The geology of the area is important from the points of view of topography and of soil formation. In general the soils of the ridges are rubbly sandy clays and well drained. Those of the flats and depressions are clayey. Though several series of sedimentary rocks occur, the soils produced by them have been largely blended into a fairly uniform class of sandy clay texture, whilst the actual soil types and the vegetation carried by them are dependent as much upon topographic, drainage, and climatic agencies as upon geological factors.

Soils and Vegetation.

The procedure adopted in the survey was to list the principal plants seen as upper storey, lower storey, breast high, and ground, followed by soil, timber value and miscellaneous notes. The distribution of the vegetation agrees with variations in soil.

(*a*) Swampy clay soils, pH 4·5 to 5·5, characterised principally by *Melaleuca* spp., *Hakea gibbosa, Banksia latifolia, Cladium glomeratum, Utricularia* sp., &c. Water table practically permanently at surface, greyish white very stiff clays or sticky sandy clay.

(*b*) Sandy soils, pH 4·5 to 5·5, characterised by *Melaleuca* spp. *E. corymbosa* (stunted), *E. acmenioides* (stunted), *Banksia latifolia, Banksia latifolia* var. *minor, Leptospermum flavescens, Acacia juniperina, Schizœa dichotoma, Caustis flexuosa, Hibbertia vestita.* Subsoil grey sticky sandy clay. Practically permanently waterlogged, drainage water sometimes black.

(*c*) Flat lands with yellowish sandy clay soil, water table near surface and occasionally waterlogged. pH 5·0 to 5·5, characterised by *E. acmenioides, E. corymbosa, Persoonia linearis, Hakea* spp. *Melaleuca leucadendron, Banksia latifolia* var. *minor, Xanthorrhœa macronema* (?). Correct use of ringbarking and fire treatment results in good natural regeneration of firewood and poles. Eucalypts less than 50 feet high. Samples of soil taken from a hole close to Colton Railway Station on typical type *c* land gave the following data. Surface soil yellow sandy loam, subsoil mottled yellow sandy clay:—

—	Surface soil.	Subsoil (24 in.)	Remarks.
	%	%	
Stones	10	50	Limonitic marbles
Sand in sieved soil	80	60	Quartz and Limonite grains
Silt plus clay	20	40	
Water of saturation (w) ..	27	28	Keen box on soil
Approximate pore space ..	40	42	Keen box on soil
Swelling (v)	5	11	Keen box on soil
Swelling calc. on 100 % silt and clay	25	27	Keen box on soil
Vol. wt. dry	1·6	1·7	Keen box on soil
Vol. wt. wet	1·9	1·9	Keen box on soil
Ratio (100 + w)/(100 + v)..	1·21	1·16	Keen box on soil
Air dry moisture	1	1·5	Keen box on soil
Moisture equivalent	10·6	..	Centrifuge method
Loss on ignition	2·8	5·5	
Loss calculated on 100% silt +clay ..	14	14	
Carbon	·85	·20	Robinson Kjeldahl method
Nitrogen	·055	·031	Robinson Kjeldahl method
C/N	15·5	6·5	Robinson Kjeldahl method

(*d*) Sandy ridges characteristically carrying *E. trachyphloia, E. acmenioides, E. corymbosa, Acacia flavescens, Casuarina torulosa, Cas. suberosa, Banksia latifolia* var. *minor, Patersonia glabrata.* Surface soil humic sandy loam about 2 feet deep on average, below greyish brown sandy clay sticky subsoil. Eucalypts 50 to 75 feet high.

(*e*) Brown to yellow sandy clay flats. pH 6 to 7. *E. acmenioides, E. corymbosa, E. trachyphloia* 50 to 75 feet high, *Grevillea banksii, Banksia integrifolia, Casuarina suberosa, Xanthorrhœa macronema* (?), and *Stylidium graminofolium* are characteristic plants. Soil with poor drainage, but water table not very close to surface. Subsoil at 12 to 18 inches depth; reddish brown to yellow brown stiff clay, sometimes showing bluish mottling on account of ferrous silicates caused by poor aeration; these poorly oxidised subsoils may be toxic to some cultivated plants.

(*f*) Low ridges with limonitic marbles, brown sandy clay pH 6 to 7, carrying *E. acmenioides, E. corymbosa, E. trachyphloia, Angophora lanceolata* (50 to 75 feet high), *Cas. torulosa, C. suberosa, C. banksii, B. integrifolia, Jacksonia scoparia, Petalostigma quadriloculare, Anthistiria ciliata, X. macronema.* Soil fairly well drained, subsoil reddish to yellow brown stiff clays with red streaks and ironstone concretions. Timber fair—practically no millable logs, but trees suitable for sleepers, mining props, fencing, &c., are found on better class *d, e, f* type country.

(*g*) Flat wide watercourses, with a channel in the centre of the larger ones which is fringed with *Melaleuca leucadendron* and *E. tereticornis.* The slopes of the watercourse grow *E. paniculata, E. exserta, E. acmenioides, E. corymbosa, Tristania suaveolens, Acacia aulacocarpa,* and *A. cunninghamii.* Illuvial clay soil. Trees over 75 feet high, a few millable logs and others undergirth. Timber values fairly good. Soil usually plastic buff brown clays, subsoils reddish brown stiff clay. Water table at about 4 feet, but fairly good drainage.

(*h*) Rubbly ridges carrying *E. citriodora, E. paniculata, E. siderophloia, E. acmenioides, E. propinqua,* sometimes *E. crebra. Acacia aulacocarpa, A. cunninghamii. A. fimbriata, Alphitonia petriei,* and

Tristania conferta may occur in fairly dense undergrowths. *Hardenbergia monophylla, Pultanœa ternata,* var. *cuspidata, Hovea longifolia* (ground creepers), and grass form a forest floor which is frequently strewn with leaves and raw humus. Soil pH 6·5 to 7. Rubbly yellow brown to hazel brown sandy clay. Timber value fairly good. Trees over 75 feet high, some millable logs and numerous undergirth growing trees.

(*i*) Rubbly fairly steep-sided gullies found in western sector. These carry much the same characteristic flora as *h*, but in addition *Zieria smithii* (oil-bearing shrub), *Trema aspera, Acacia arundelliana, Indigofera australis,* and the blady grasses, *Gymnostachys anceps* and *Lepidosperma concavum,* which grow up under open canopy after fires. Same class of soil as *h*. *Tristania suaveolens* also occurs in places. Trees 75 feet high, and timber value fairly good.

(*j*) Fringing rain forest which follows the larger creeks and rivers. The surface soils are chocolate coloured, alluvial, fairly mellow, clay loams; deep soils with humic surface and stiffer brownish clay and sandy clay subsoil, carrying *Eugenia ventenatii, Tristania conferta, Litsea dealbata, Exocarpus latifolia, Zingiber officinale, Geitonoplesium cymosum, Smilax australis,* &c. Sometimes *Agathis robusta, Eugenia hemilampra, Syncarpia subargentea,* and *Euc. saligna* occur in the forests.

(*k*) Drier mountain type rain forest carrying Hoop pine and numerous rain forest species. This type merges into type *j* on one hand and types *h* and *i* on the other. Soil humic brown rubbly sandy clay or clay loam. Fairly mellow consistence.

The soil descriptions have been tabulated and associated into soil series in accordance with the methods of the U.S.A. Soil Bureau. The accompanying map and section demarcates the geology and the distribution of the various soil series.

Soil Analyses for Similar Localities from Annual Reports, Agricultural Chemist, Queensland.

—	Locality.		
	Yerra.	Kawungan.	Nikenbah.
Probable type	*c*	*c*	*e*
Laboratory number	2544	Average 2566/8	Average 2754/5
Description	Grey clay	Y'low-grey loam	Brown loam
Reaction	Very acid	Very acid	Acid
	%	%	%
Humus (by NH_3)	3·1	1·83	1·98
Loss ignition	9·6	4·5	9·0
Chlorine	·02	·01	·008
Nitrogen	·3	·16	·22
36% HCl extract P_2O_5	·1	·06	·06
CaO	·2	·35	·37
MgO	·16	·05	·26
K_2O	·3	·03	·02
Insol. in HCl	68·6	81·1	57·6
1% Citric Acid extract P_2O_5	·006	·002	·0004
CaO	·056	·048	·09
MgO	·018	·009	·04
K_2O	·023	·003	·005
Jones' Acidity	201	83	Comber
Hopkins' Acidity	102	7	Method
Organic Acidity	99	78	Neutral
Average estimated lime requirement in cwt. per acre	134	56	Nil

SUMMARY OF GENERAL CHARACTERISTICS OF SOIL TYPES.

Type.	*a*	*b*	*c*	*d*	*e*
Geology	Shales mainly	Trachytic tuffs mainly	Sandy shales	Trachytic tuffs and sandy shales	Shales mainly
Topography	Flat	Trachytic tuffs mainly	Sandy shales	Low ridges	Fairly flat
Mode of formation	Swampy conditions	Trachytic tuffs mainly	Detrital, leached	Residual	Residual
Surface colour	Greyish white	Trachytic tuffs mainly	Yellowish grey	Brownish	Yellow brown
Surface texture	Clay	Loamy sand	Sandy clay loam	Sandy loam	Sandy clay
Surface consistence	Stiff	Sticky	Fairly friable	Friable	Fairly plastic
Subsoil colour	Greyish white mottled	Sticky	Greyish yellow mottled bluish and reddish	Greyish brown	Reddish or yellow brown mottled bluish
Subsoil texture	Clay	Sandy clay	Sandy clay	Sandy clay	Clay
Subsoil consistence	Very stiff	Very stiff or sticky	Fairly stiff	Fairly sticky	Stiff
Drainage	Impeded by stiff clay	Frequently waterlogged	Poor	Fair	Fair to poor
Depth of watertable	Practically permanently at surface	Frequently waterlogged	Close to surface	About 36″	Fair to poor
Fertility	Very poor	Frequently waterlogged	Poor	Fair	Fair
Series name proposed	Wallum clay	Wallum loamy sand	Wallum sandy clay, better drained transition phase	Warrah sandy loam	Warrah sandy clay
Remarks	..	..	May be ironstone concretions in subsoil	..	May be ironstone concretions in subsoil

Type.	*f*	*g*	*h* and *i*.	*j*	*k*
Geology	Shales	Partly alluvial	Siliceous shales	Recent alluvium	Hard, sandy shales
Topography	Low ridges	Flat	Ridges and gully slopes	Creek banks	Ridges
Mode of formation	Eroded residual	Illuvial	Residual and detrital	Alluvial	Residual and detrital
Surface colour	Brown yellow	Buff brown	Red brown, yellow brown, and hazel brown	Chocolate brown	Brown
Surface texture	Clay	Clay	Rubbly sandy clay	Clay loam	Rubbly clay loam
Surface consistence	Fairly plastic	Plastic	Friable	Mellow	Mellow
Subsoil colour	Yellow brown with red streaks	Reddish or greyish brown	Yellow brown	Brown	Brown
Subsoil texture	Clay	Clay	Rubbly sandy clay	Sandy clay	Rubbly sandy clay
Subsoil consistence	Stiff	Stiff	Fairly friable	Plastic	Plastic
Drainage	Fair	Fairly good	Good	Good	Good
Depth of watertable	Below 36″	Below 48″	Deep	Fairly deep	Deep
Fertility	Fair	Fairly good	Fairly good	Good	Good
Series name proposed	Warrah sandy clay, eroded concretionary phase	Cherwell clay	Doongul rubbly sandy clay { Ridge phase *h*, Gully phase *i*	Scrubby clay loam	Seaview rubbly clay loam
Remarks	Ironstone concretions	..	..	..	..

These analyses indicate that the addition of lime would be beneficial on type *c* soils. It would flocculate clayey colloids, improve consistence, and neutralise acidity. The values for phosphate are especially low in the Nikenbah samples, and suggest a phosphate deficiency. The cattle which graze on types *c, d, e, f,* and *g* have developed the bone-chewing and botulic habits and suffer from other symptoms of phosphate deficiency. Lime dressings and basic NPK fertilizers would most probably give good responses on these lands and suitable experiments might well be instituted to ascertain the value of these treatments.

The soils are noticeably greatly improved when humus is present in quantity, and agronomic operations should accordingly be planned so as to maintain and increase the supply of organic matter in the soils. Due attention must also be paid to subsoil drainage conditions. It is possible that many places on the gently undulating country can be drained easily by systems of deep furrows ploughed in suitable places.

Work similar to that described in this paper has been performed near Beerwah by A. H. Crane, and near Rockhampton by M. A. Rankin (unpublished data in Queensland Forest Service files). They found a close correlation between similar vegetation units and approximately similar soils in the two districts. They find that soil fertility is best on brown-coloured well-drained soils; the poorer-drained soils are grey. The soils are generally low in K_2O, P_2O_5, and CaO when analysed.

Crane concludes that, other things being equal, tree growth is better in the deeper yellow-brown or red-coloured soils than in the lighter-coloured soils. The colour is due to iron compounds, and it is a significant indicator of drainage, aeration, and plant food value. The white clay swamp soils are infertile, probably on account of leaching and bad aeration. The soils of water-logged areas which are black are also related to lack of aeration.

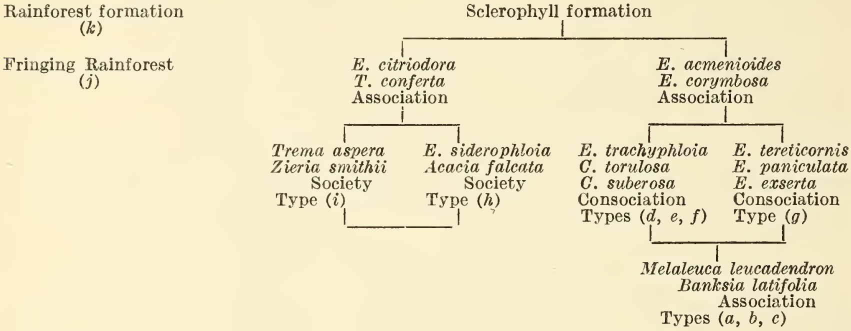
Crane's notes show that fertility is associated with ''soft, friable, loose clay'' soil consistence, whilst the ''hard, sticky, stiff, tight, and pug'' consistence clays are associated with infertility; softness is usually associated with brown clays, whilst stiffness is usually associated with grey and yellow-coloured clays. Some of the reddish subsoils of my Warrah series are rather stiff, and the soils are only of medium fertility.

The correlation between soil conditions and vegetation types is very close, and on each soil type the vegetation has reached an edaphic subclimax. There are apparently two climatic climax formations possible.

(i.) A fairly moist type of subtropical rain forest which is found fringing certain larger streams and high ridges; its extent is strictly limited by soil factors, which are slowly improved by the advance of the forest itself. This formation is evergreen broad-leaved rain forest, containing several storeys of trees, small trees, shrubs, a few herbs, and several lianes and climbers. A very few of the trees are deciduous, but this forest cannot be called monsoon forest, though the effect of the dry season is reflected to some extent in the species found, particularly on the drier ridges (type *k*) where the distribution of the rain forest is governed by edaphic factors, by aspect, and by fires. In India and Burma monsoon forest survives where periodic burning occurs, and burnt rain forest areas pass into monsoon brush. Examples of this can be seen on burnt-over areas in T.R. 8 Doongal, but usually the rainfall is sufficiently uniform and the edaphic conditions sufficiently good to support true rain-forest species, though some are the leathery leafed kind. The fringing rain forests depend on alluvial mellow soil conditions and on moving fresh ground water.

(ii.) The open Parkland Sclerophyll forest contains many xerophilous species, because the soils are not suitable for rain-forest species. There seems to be a slow sere from sea to coast range which can be roughly generalised by the following succession of subclimaxes: mangrove, strand, wallum, eucalypt forest, rain forest. This is general along coastal Queensland. (Herbert, 1927-32.)

The species identified have been listed according to distribution, and the communities classified according to the following diagram:—



Species Nos. 1 to 24 indicate poor soil and poor drainage—that is, mainly soil types *a, b, c*.

Poor soils which are fairly well drained are indicated by species Nos. 25 to 50, types *d, e, f*.

Soils with a moderate amount of plant food carry species Nos. 51 to 80, types *g* and *h*.

Species 81 to 97 represent fairly fertile soil conditions, whilst the richest soils are typified by the remaining species in the list.

LIST OF SPECIES ARRANGED ACCORDING TO SOIL TYPES.

No.	Name.	Family.	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
1	*Hakea gibbosa*	Proteaceæ	x										
2	*Utricularia* sp.	Lentibularaceæ	x										
3	*Cladium glomeratum*	Cyperaceæ	x										
4	*Hakea pleurinerva*	Proteaceæ	x	x									
5	*Melaleuca nodosa*	Myrtaceæ	x	x									
6	*M. eriofolia*	Myrtaceæ	x	x									
7	*Banksia latifolia*	Proteaceæ	x	x									
8	*Strangea linearis*	Proteaceæ	x	x	x								
9	**Melaleuca leucadendron* var. *viridiflora*	Myrtaceæ	x		x				x				
10	*Persoonia linearis*	Proteaceæ	x		x	x							
11	*Xanthorrhœa macronema*	Liliaceæ	x	x	x	x	x	x					
12	*Schizœa dichotoma*	Filices		x									
13	*Acacia juniperina*	Leguminosæ		x									
14	*Melaleuca thymifolia*	Myrtaceæ		x									
15	*Bœkia stenophylla*	Myrtaceæ		x									
16	*Caustis flexuosa*	Cyperaceæ		x									
17	*Hibbertia vestita*	Dilleniaceæ		x									
18	*Acacia plagiophylla*	Leguminosæ		x	x								
19	*Leptospermum flavescens*	Myrtaceæ		x	x								
20	*Petrophila shirleyœ*	Proteaceæ		x	x								
21	*B. latifolia* var. *minor*	Proteaceæ		x	x	x							

No.	Name.	Family.	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
22	*Eucalyptus corymbosa*	Myrtaceæ ..		x	x	x	x	x	x				
23	*Hakea saligna*	Proteaceæ ..			x	x							
24	**Xylomelum pyriforme*	Proteaceæ ..			x	x							
25	**Casuarina suberosa* (with *Loranthus longiflorus*)	Casuarinaceæ ..			x	x	x						
26	**Eucalyptus acmenioides* ..	Myrtaceæ			x	x	x	x	x	x			
27	*Pultanæa paleacea*	Leguminosæ ..			x		x						
28	*Prasophyllum patens*	Orchidaceæ ..			x		x						
29	*Drosera spathalata*	Droseraceæ ..			x		x						
30	*Acacia flavescens*	Leguminosæ ..				x							
31	*Lomatia silaifolia*	Proteaceæ ..				x							
32	*Patersonia glabrata*	Iridaceæ				x	x						
33	*Leptospermum stellatum* ..	Myrtaceæ ..				x	x						
34	*Grevillea banksii*	Proteaceæ ..				x	x	x					
35	**Banksia integrifolia*	Proteaceæ ..				x	x	x					
36	*Panicum bicolor*	Gramineæ ..				x	x	x					
37	**Jacksonia scoparia*	Leguminosæ ..				x	x	x		x			
38	*Eucalyptus trachyphloia* ..	Myrtaceæ ..				x	x	x					
39	*Casuarina torulosa*	Casuarinaceæ ..				x		x					
40	*Stylidium graminofolium* ..	Stylidiaceæ ..					x						
41	*Pimelia linifolia*	Thymeliaceæ ..					x						
42	*Xerotes filiformis*	Juncaceæ ..					x						
43	*Anthistiria ciliata*	Gramineæ ..					x	x					
44	*Diuris punctata*	Orchidaceæ ..					x						
45	*D. sulphurea*	Orchidaceæ ..					x						
46	*Caladenia carnea*	Orchidaceæ ..					x						
47	*C. cærula*	Orchidaceæ ..					x			x			
48	**Angophora lanceolata*	Myrtaceæ ..					x	x	x				
49	*Sterculia diversifolia*	Sterculiaceæ ..						x					
50	**Petalostigma quadriloculare* ..	Euphorbiaceæ ..						x	x				
51	**Hardenbergia monophylla* ..	Leguminosæ ..						x		x			
52	*Eucalyptus exserta*	Myrtaceæ ..							x				
53	*E. paniculata*	Myrtaceæ ..							x				
54	*E. tereticornis*	Myrtaceæ ..							x				
55	*Tristania suaveolens*	Myrtaceæ ..							x				
56	*E. tesselaris*	Myrtaceæ ..							x		x		
57	*Acacia cunninghamii*	Leguminosæ ..							x		x		
58	*A. aulacocarpa*	Leguminosæ ..							x	x	x	x	
59	*Livistona australis*	Palmaceæ.. ..							x			x	
60	*Acacia falcata*	Leguminosæ ..								x			
61	*A. podalyriæfolia*	Leguminosæ ..	(Ea	ste	rly	asp	ect	s o	nly)	x			
62	**Exocarpus cupressiformis* ..	Santalaceæ ..								x			
63	*Hovea longifolia*	Leguminosæ ..								x			
64	*Myoporum acuminatum* ..	Myoporaceæ ..								x			
65	*Celastrus bilocularis*	Celastraceæ ..								x			
66	*Pultanæa ternata* var. *cuspidata*	Leguminosæ ..								x			
67	*Macrozamia* { *mountperriensis* or *miquelii* }	} Cycadales ..								x			
68	**M. paulogulieimi*	Cycadales ..								x			
69	*Gahnia aspera*	Cyperaceæ ..								x			
70	*Sorghum fulvum*	Graminæ								x			
71	*Heteropogon contortus*	Graminæ								x			
72	*Dioscorea* sp.	Dioscoraceæ ..								x	x		
73	*Solanum seaforthianum*	Solanaceæ ..								x			
74	*Eucalyptus siderophloia* ..	Myrtaceæ ..								x			
75	*E. citriodora*	Myrtaceæ ..								x	x		
76	*E. propinqua*	Myrtaceæ ..								x	x		
77	*Acacia fimbriata*	Leguminosæ ..								x	x		
78	*A. complanata*	Leguminosæ ..								x		x	
79	*A. arundelliana*	Leguminosæ ..								x		x	
80	*Petalostigma quadriloculare* var. *glabrescens*	Euphorbiaceæ ..								x		x	
81	*Tristania conferta*	Myrtaceæ ..								x		x	
82	*Trema aspera*	Ulmaceæ									x		
83	*Zieria smithii*	Rutaceæ									x		
84	*Breynia oblongifolia*	Euphorbiaceæ ..									x		
85	*Gymnostachys anceps*	Aroidaceæ ..									x		
86	*Indigofera australis*	Leguminosæ ..									x		
87	*Lepidosperma concavum* ..	Cyperaceæ ..									x		
88	*E. hemiphloia*	Myrtaceæ ..									x	x	
89	*Pteris tremula*	Filices									x	x	
90	*Callitris arenosa*	Coniferæ									x	x	
91	*Araucaria cunninghamii* ..	Pinaceæ									x	x	x
92	*Flindersia australis*	Rutaceæ									x	x	x
93	*Alphitonia petriei*	Rhamnaceæ ..									x	x	x
94	*Cupania pseudorhus*	Sapindaceæ ..									x	x	x
95	*C. anacaroides*	Sapindaceæ ..									x	x	x
96	*Canthium buxifolium*	Rubiaceæ ..									x	x	x
97	*Eustrephus latifolius*	Liliaceæ									x	x	x
98	*Croton insularis*	Euphorbiaceæ ..									x	x	x
99	*Stenocarpus sinuatus*	Proteaceæ ..										x	
100	*Eucalyptus saligna*	Myrtaceæ ..										x	
101	*Eugenia ventenatii*	Myrtaceæ ..										x	
102	*E. hemilampra*	Myrtaceæ ..										x	
103	*Agathis robusta*	Pinaceæ										x	
104	*Rhodamnia argentea*	Myrtaceæ ..										x	
105	*Litsea dealbata*	Lauraceæ ..										x	

No.	Name.	Family.	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
106	*Tarrietia argyrodendron*	Sterculiaceæ										x	
107	*Strychnos arborea*	Loganiaceæ										x	
108	*Callistemon viminalis*	Myrtaceæ										x	
109	*Flagellaria indica*	Flagellaraceæ										x	
110	*Kibara macrophylla*	Monimiaceæ										x	
111	*Hibiscus splendens*	Malvaceæ										x	
112	*Exocarpus latifolia*	Santalaceæ										x	
113	*Notalœa longifolia*	Oleaceæ										x	
114	*Pittosporum revolutum*	Pittosporaceæ										x	
115	*Alpinia cœrulœa*	Scitaminaceæ										x	
116	*Geitonoplesium cymosum*	Liliaceæ										x	
117	*Vitex lignum-vitæ*	Verbenaceæ										x	x
118	*Mallotus philippinensis*	Euphorbiaceæ										x	x
119	*Panax elegans*	Araliaceæ										x	x
120	*Aphananthe philippinensis*	Ulmaceæ										x	
121	*Euroschinus falcatus*	Anacardiaceæ										x	x
122	*Laportea moroides*	Urticaceæ										x	x
123	*Diospyros pentamera*	Ebenaceæ										x	x
124	*Ficus* sp.	Moraceæ										x	x
125	*Syncarpia subargentea*	Myrtaceæ										x	x
126	*Hemicyclia australasica*	Euphorbiaceæ										x	x
127	*Myrtus hillii*	Myrtaceæ										x	x
128	*Owenia venosa*	Meliaceæ										x	x
129	*Canthium lucidum*	Rubiaceæ										x	x
130	*Capparis nobilis*	Capparidaceæ										x	x
131	*Myrsine variabilis*	Myrsinaceæ										x	x
132	*Polypodium rigidulum*	Filices										x	x
133	*Cleistanthus cunninghamii*	Euphorbiaceæ										x	x
134	*Alchornea ilicifolia*	Euphorbiaceæ										x	x
135	*Hoya australis*	Asclepiadaceæ										x	x
136	*Smilax australis*	Liliaceæ										x	x
137	*Alyxia ruscifolia*	Apocynaceæ										x	x
138	*Carissa ovata*	Apocynaceæ										x	x
139	*Lantana camara*	Verbenaceæ										x	x
140	*Pleiogynium solandri*	Anacardiaceæ											x
141	*Flindersia collina*	Rutaceæ											x
142	*Castanospermum australis*	Leguminosæ											x
143	*Canthium latifolium*	Rubiaceæ											x
144	*Justicia hygrofiloides*	Acanthaceæ											x
145	*Abutilon* sp.	Malvaceæ											x
146	*Melodorum leichhardtii*	Anonaceæ											x
147	*Solanum discolor*	Solanaceæ											x
148	*Ixora beckleri*	Rubiaceæ											x
149	*Taburnæmontana orientalis*	Apocynaceæ											x
150	*Capparis sarmentosa*	Capparidaceæ											x
151	*Cassia sophera* var. *schinifolia*	Leguminosæ (Cæsalpineæ)											x

* See page 117.

Land Utilization Possibilities.

Apart from physiological diseases caused by impeded drainage and deficient soil conditions, the trees are usually fairly healthy. Occasional patches of eucalypts, &c., are attacked by *Loranthus* spp., which should be destroyed to prevent spread of the mistletoe by birds. Many large trees suffer from heart rot probably directly caused by members of the Polyporaceæ, and no doubt insect injury is fairly frequent. The fungi are able to attack the growing trees through injuries caused by fire, wind, axe, &c., and these agencies are fairly potent throughout the area. Most of the country has been fire-swept at more or less frequent intervals, and parts of the western sector have suffered very considerable damage. Some of the pine forests were swept in 1902 with disastrous results, and the open forest shows the effects of destructive blazes which occurred in 1926 and other years. *Lantana camara* grows prolifically on burnt-over rain-forest soils. All over the area there are signs of the havoc played by the destructive axe of the timber-getter and the trapper, while the neighbouring selectors often ringbark timber, both good and bad, which results in the formation of a heavy undergrowth of *Acacia* spp. and *Tristania conferta* on the rubbly ridges and along the watercourses, and of quantities of dead litter which makes splendid tinder for bush fires on the poorer lands.

Where ringbarking is followed by clearing and continuous grazing, satisfactory grassland can be obtained along the large watercourses, but it probably requires phosphatic fertiliser. Where the present timber growing is faulty, because it has been damaged by fire, storms, and indiscriminate ringbarking, it may be improved in some cases by expert silvicultural treatment.

Natural regeneration of Eucalypts would lead to valuable hardwood forest in many places at low cost. Vegetation types *a, b,* and *c* are of little value from this point of view, but types *d, e,* and *f* are capable of reproducing second-class hardwood (*E. acmeniodes,* &c.). If exotic conifers are a success, this land would doubtless be better utilised for softwood production or perhaps mixed growth of softwoods on suitable soils, with eucalypts filling in the gaps. Type *d* requires careful treatment, because if the present stands of timber are cleared by fire and axe, the sere is thrown back very considerably owing to the destruction of the humus in the sandy soil. *Casuarina* spp. are particularly valuable soil-makers on types *d* and *c*. On the open flat watercourses (type *g*) dense stands of good poles of *E. tereticornis, E. paniculata,* &c., develop in places where ringbarking has been practised. Natural regeneration of hardwood strips, with or without a softwood, could thus be readily carried out along these waterways, and the network so produced would prove valuable as windbreaks against the storms which occasionally leave trails of broken timber through the countryside. These open watercourses are subject to flooding in a very wet season. Type *h* may pay better as a lemon irongum producer with or without a softwood.

It is likely that hardwood propositions would be found to fit in where softwoods fail, and so help to make a forest-working plan successful over a wide area. The softwoods which have shown most promise are those originally obtained from South-Eastern U.S.A.

Pinus caribbœa, P. serotina, and *Taxodium distichum* grow on poorly drained wet coastal flats with fairly stiff clay loam soils, such as types *c, e,* and *g*.

P. tœda prefers moist clay loam soils, fairly well drained, about 100 feet above sea-level, such as types *e, f,* and *g*.

P. echinata and *P. palustris* develop on the well-drained rubbly and sandy clay soils of the foothills from about 300 feet to 2,000 feet above sea-level, such as types *f, h,* and *i*. Experience has indicated that these are more expensive forestry propositions. All require special mycorhiza for proper development. The timber weighs 30 to 36 lb. per cubic foot, and has a bending stress at rupture of about 10,000 lb. per square inch. Clean logs of 50-feet lengths, and 60 inches g.b.h. develop at an age of about sixty-five years in America. They readily regenerate naturally when once established, and the presence of lower-storey hardwoods is an advantage in forcing the pines to produce tall, straight boles.

Experimental plantings in Queensland and New South Wales have given promising results with *P. caribbæa* and *P. tæda,* and the growth rate equals that of *P. radiata* (*P. insignis*). Further experimental work and commercial planting is eminently desirable. The best results have been obtained on fairly well-drained sandy clay soils near Beerwah. Fused needle disease, which affects a small percentage of plants in the field, is being investigated by the Queensland Forest Pathologist.

III. ECOLOGICAL RECONNAISSANCES IN THE YARRAMAN AND KILKIVAN DISTRICTS.

Topography and Geology.

The physical features and geology of about 1,000 square miles of country between Linville and Nanango have already been mapped and published by Tommerup (1930) and Hill (1930).

Timber Reserve 220, Kilkivan and Brooyar, is situated 6 miles south-east of Kilkivan township; it contains 10,000 acres, and covers a dissected plateau which slopes away on all sides from the central point, called Mt. Sinai (1,700 feet). Gap Creek, where it leaves the reserve on the north, is 400 feet. The general configuration is inclined to be rugged, with steep-sided gorges in many places, and the ground is frequently strewn with fragmental stones which have weathered out from the country rock. A contour and geological map is attached to the original thesis.

Geologically, the block consists of massive sub-basic and sub-acid igneous intrusions into older metamorphosed amphibolites and schists.

The oldest rock series outcrops in the north, and is a silicified amphibolite which is probably continuous with a similar outcrop at Manumbar, which has been regarded as possibly Cambrian in age. To the west of the reserve a wide band of rocks—the Kilkivan serpentines—outcrop; they are part of the Brisbane schist series. Schists are seen on the south-west corner and also just east of the reserve. In the south-east corner of the reserve an intrusion of pinkish microgranite and hornblende rhyolite porphyry outcrops over a fairly wide area. In the region of Mt. Sinai andesitic agglomerates and intrusive flows of glassy andesite are visible. A porphyritic andesite overlies the amphibolite on plantation Cpt. 5B. On the road down to Fat Hen Creek, on the western edge of the reserve, dark-coloured porphyritic andesite overlies a syenite.

Soils and Vegetation.

The soils on the amphibolite series are dark-brownish grey rubbly sandy clay loams in texture, whilst those derived from the andesitic rocks are rubbly grey to dark-brown clay loams, and unless humus is present they are liable to cake hard when wetted and allowed to dry. The principal difficulty in operating upon them lies in the steepness and stoniness of the ground. Compare soil survey of R. 355, Kilkivan, made by Rankin (1928). With equal moisture conditions, the andesitic soils are probably more fertile than the amphibolite soils; moist gullies in the andesites are superior sites to moist gullies in the amphibolites. The andesite soils usually occur above the 1,250-feet contour line; they grow hoop pine over 100 feet high and tall (over 70 feet) rain forest rich in moisture-loving species, similar to those found in the coastal-fringing rain forests. The amphibolites occupy lower altitudes and grow hoop pine to an average height of 100 feet and g.b.h. 60 inches; the rain-forest species are of medium height and tolerate fairly dry conditions. The rain-forest species are tabulated according to site on pp. 114 to 115.

There are several types of open forest on Reserve 220: (I.) In the south-west corner, at a height of 1,400 feet, and with a north-westerly aspect, a shaly grey soil carries *E. crebra, E. propinqua, E. maculata, A. lanceolata, E. hemiphloia, E. acmenioides, T. conferta*, with a lower storey of *Acacia podalyriæfolia* (Silver Leaf), *Jacksonia scoparia, Exocarpus cupressiformis, Oxylobium trilobatum, Indigofera australis,* and *E. corymbosa*. (II.) The eastern edge is hilly; species present include *E. acmenioides, E. crebra, E. tereticornis, E. propinqua, Cas. torulosa,* and *C. suberosa* occurring, with coarse blady grass below. The soil is rubbly and originates from silicified schists. (III.) Outside the reserve, on the low hills towards Kilkivan, the rock consists of schists, serpentine, amphibolite, and in places andesitic outcrops, and the principal trees are *E. crebra* and *E. melanophloia*. (IV.) Along the creeks a moister type of forest develops, consisting of *Casuarina glauca, E. tereticornis, E. corymbosa, E. tesselaris, E. hemiphloia, A. subvelutina, T. suaveolens, T. conferta, Cas. torulosa, Exocarpus cupressiformis, Melaleuca nodosa*, and blady grass where not grazed, otherwise good grazing land. In several places *Lantana camara* is spreading, and it is particularly bad in Serpentine Creek and neighbouring ridges.

The topographical and geological features divide the Yarraman district into two principal ecological formations: (I.) Rain forest-clothed highlands—(*a*) The hills with an open easterly aspect down the Brisbane River valley over 1,200 feet in height (Blackbutt Range and Mt. Stanley), (*b*) the hills of the Jimna-Brisbane-Cooyar Range and Bunya Mountains over about 1,700 feet; (II.) Sclerophyll forest land. Generally found (*a*) on land below about 1,500 feet, (*b*) on higher land with granitic or schist soils, (*c*) on higher lands which have andesitic soils but which are apparently shielded from rainfall by other highland areas—e.g., eastern slopes of Cooyar Range, and Brisbane Range north-east of Marbletop.

Rain forest is found on soils derived from rocks of the Cooyar basalts, the Bunya basalts, the Esk andesites, the Esk conglomerates, the Gympie slates, and more rarely on granites and Brisbane schist. The climatic factor seems to be dominant, but the edaphic factor is considerable, and the rain-forest edge frequently follows the geological boundaries, though this does not always occur. Where rainfall is marginal, the rain forests prefer basaltic soils to soils derived from more acid igneous rocks or from sedimentary rocks; conversely, where the rainfall is sufficient, rain forest will grow on the less suitable soils.

The actual distribution of rain forest is a complex depending partly on climatic and partly on edaphic factors, which in turn depend on the lithological nature of the rocks from which they are derived.

The rain-forest edge in this district forms a rather interesting example of an ecological equilibrium line at which the complementary factors of soil fertility, precipitation, and in some places the frost line, together or singly fail to constitute the standard required by rain-forest species. Furthermore, the actual soils themselves vary not only with the geology, but also are partially controlled by climatic agencies. Thus the soils of the Cooyar Range are basaltic and red, whilst those of the Bunya Mountains are basaltic and black—probably because chernozemic processes have become dominant in the more westerly and drier Bunya Mountains. Climate thus affects soil formation even over small distances, but it is of less importance than the chemical composition of the rock which produces the soil. The soil is also modified by the nature of the vegetation which climatic and edaphic factors have imposed on it. The rain-forest soils are much richer in organic matter than open-forest soils; this is not characteristic of the more humid tropical rain forests as found in Malaya. Furthermore, the forest ecotone tends to build up its own friable soil as the sere develops, both by addition of organic matter and by root action on the underlying weathered rocks and clay; this soil is distinct from the more compact humic soils of the sclerophyll and grass lands. The accumulation of organic matter in the soil increases moisture-retaining capacity, which in turn encourages shallow-rooting species such as the Indo-Malayan type of forest trees. Rain forests transpire large quantities of water, and after their removal a greater flow of water percolates through the creek beds.

A table describing the principal soil series in the Yarraman district is set out on page 110, but facilities were not available for mapping them. Some analyses taken from the Annual Reports of the Agricultural Chemist relate to the red basaltic soils, which are the most important agriculturally.

—	Locality.					Average.
	Benarkin.	Benarkin. S.F.R.	Benarkin Subsoil.	Tingoora.	Tingoora.	
Laboratory No.	2,200	2,450	2,450	2,721	2,722	..
Description	Red loam	Yellow brown lo.	Red brown clay loam	Choc. lo.	Choc. lo.	Red loam
Reaction	acid ..	..	acid ..	sl. acid ..	sl. acid ..	sl. acid
Humus (ammonia sol.) ..	1·11	1·37	·73	1·23	1·21	1·13
Loss on ignition	12·4	6·0	7·3	11·6	12·2	9·9
Chlorine	·01	·01	·01	·01	·013	·01
Nitrogen	·12	·09	·04	·16	·17	·116
Sol. in 1·115 HCl P_2O_5	·04	·02	·02	·05	·08	·04
Sol. in 1·115 HCl CaO	·36	·20	·21	·39	1·28	·45
Sol. in 1·115 HCl MgO	·27	·12	·14	·58	·49	·32
Sol. in 1·115 HCl K_2O	·02	·02	·005	·03	·03	·017
Sol. in 1·115 HCl Insol.	44·8	83·9	72·2	51·4	45·6	59·6
Sol. in 1% Citric P_2O_5	·0012	·002	..	·001	·001	·0015
Sol. in 1% Citric CaO	·014	·05	..	·109	·186	·090
Sol. in 1% Citric MgO	·061	·03	..	·124	·168	·096
Sol. in 1% Citric K_2O	·004	·004	..	·002	·008	·0045

The hardness of the water in creeks and the general high fertility of the red soils indicate that they are rich in available CaO, P_2O_5, K_2O, and nitrogen.

The following data was obtained from samples taken after surface leaves had been swept away from the forest floor:—

—	Locality.			Remarks.
	84v. Cooyar.	S.F.R. 151 Neumgna.	S..R. 289 Cooyar.	
Stones sieved %	19	..	16	% of total sample
Sand %	41	17	12	% of sieved soil
Silt plus clay %	59	72	73	% of sieved soil
Humus destroyed by Bromine	..	11	15	Troell's method
(W) Water of saturation	35·5	61	62	Keen box
(P) Apparent pore space	46	53	52	Keen box
(V) Swelling	4·0	33·3	29·2	Keen box
Vol. wt. dry	1·34	1·16	1·07	Keen box
Vol. wt. wet	1·74	1·41	1·40	Keen box
(A) Air-dry moisture	4	9	7·5	Keen box
Moisture equivalent (E)	26·7	47·5	48·5	Centrifuge Rothamsted
Loss ignition (I)	9·5	46·0	41·0	
Loss calculated on 100 % clay	16·0	65·0	56·0	
Ratio I/E	·35	·97	·84	
Carbon	1·96	4·97	8·78	Robinson-Kjeldahl
Nitrogen	·178	·584	·783	Error ·01 C and ·001 N.
C/N Ratio	11	8·5	11	av. duplicate analyses
pH air-dry sample	..	6·7	7·2	After storage
Vegetation	Euc. hemiphloia Acacia, &c., open forest	F. oxleyana, Tar. argyrodendron rain forest	F. oxleyana Tar. argyrodendron rain forest	
Lithological origin	conglomeratic	basalt	basalt	
Soil colour	Yellowish	Black	Choc. red	
Soil texture	Clay	Clay	Clay	On mechanical analysis
Soil consistence	Fairly stiff	Friable and mellow	Mellow	On feel of soil

The stones sieved from 84v sample were Esk conglomeratic quartzite pebbles and pieces of schist. The stones in S.F.R. 289 are mainly small black limonitic grains. Although the R. 289 and R. 151 samples fall into the "red loam" soil group, they are really clays, but have a "loamy" consistence when felt. This is partly due to the nature of the red clay itself, and partly due to the high percentage of humus, which is also responsible for the high values for swelling, water of saturation, air-dry moisture, and pore space. These results are rather different from those obtained by Hines (1931) for his group D, "red loam" soils. The averages for his 8 group D soils are compared with the average of my two (S.F.R. 151, Neumgna, and S.F.R. 289, Cooyar), and also with the average of his 16 group E soils and his 3 group F soils.

Single Value.	W	P	V	A	I	$\frac{100+W}{100+V}$
Average Hines' Group D	60·4	53·8	5·3	4·1	14·0	1·43
Average my two	61·5	52·5	31·2	8·2	43·5	1·23
Average Hines' Group E	54·3	55·0	15·6	7·8	6·8	1·34
Average Hines' Group F	61·9	57·6	22·8	10·2	7·4	1·32

The evidence suggests that my soils are on the borderline between the red coastal rain-forest basaltic soils and the dark-coloured calcareous soils of the drier inland areas. My carbon averages 6·9 per cent. and nitrogen ·68 per cent., against the Agricultural Chemist's average value of ·12 for nitrogen; possibly his value is low, because the samples may have been taken from cleared land on which fire had destroyed much of the organic matter. For classification purposes my soils should be included with the red basaltic soils (Hines' Group D).

CHARACTERISTICS OF SOIL SERIES IN YARRAMAN DISTRICT.

Geology	Coarse andesitic agglomerates tuffs and andesitic intrusions	Basalt	Brisbane schists and Esk shales and Conglomerates	Granitic
Topography	Slopes sometimes fairly steep	Slopes seldom very steep	Slopes	Gentle slopes
Drainage	Very good	Very good	Good to fairly good	Fairly good
Depth watertable	Several feet down	Several feet down	Below 3-ft. usually, may be "perched"	Below 3-ft. usually
Mode of formation	Residual and detrital	Residual and detrital	Residual and detrital	Residual and detrital
Surface colour	Dark brown to chocolate	Red phase: Morocco red chocolate reddish brown Bunya phase: Black to chocolate	Brownish yellow to grey white	Brownish yellow to grey
Surface texture	Rubbly loams, clay loams	Clay and clay loams	Usually clayey, may have quartzitic and other stones	Usually sandy clay.
Surface consistence	Friable and mellow	Friable and mellow	Often fairly stiff	Often fairly stiff
Surface structure	Crumby, fairly rich in organic matter	Crumby, rich in organic matter	Compact to crumby	Rather compact; crumbs associated with sand grains
Subsoil colour	Brown colour	Red	Mottled reddish to grey	Yellow to slightly reddish
Subsoil texture	Clay loam and clay	Clay	Clay	Clay
Subsoil consistence	Plastic	Plastic	Fairly stiff to impervious hardpan at 3 or 4-ft. in places	Stiff and sometimes almost impervious
General fertility	Good	Very good	Medium fertility; better on Esk conglomerates than on Brisbane schists	Usually not good
Typical vegetation	Usually rain forest	Usually rain forest	Sometimes carries rain forests, usually open forest and undergrowth	Seldom carries rain forest, usually open forest and grassland
Typical locality	Mount Stanley area	Cooyar Range	Rocky Creek and parts of Yarraman Creek, &c.	Near Pidna and along lower Yarraman Creek
Series name proposed	Stanley	Cooyar	Linville	Pidna

The Rain-forest Formation.

The rain forest is a complex formation which is difficult to analyse satisfactorily; yet a close observer cannot fail to notice that it has communities which graduate into one another, with much overlapping. Several factors operate in determining the distribution of species within the rain forest and its ecotone. The important species have been classified in accordance with their environment. The list on pp. 114 to 115 is neither a complete flora nor a complete indicator, but it establishes the main physiognomic alliances. The distribution marked * refers to the occurrence in the Cooyar Range (Tarong-Yarraman, &c.) forests, the distribution marked — refers to the Mt. Stanley-Brisbane Range forests, whilst that marked † refers to R. 220, Kilkivan. The distribution in the three areas agree quite well, but it is not easy to draw definite lines of demarcation between groups, nor it is always easy to give either definite or generalised reasons for the alliances, save that the available soil moisture seems to be the controlling factor—*cf.* McLuckie and Petrie (1927), Rankin (1930), Craik (1929). This in turn is governed by the humus content, the topography, localised rainfall, drainage, and to some extent by the intrinsic chemical and physical properties of the soil clay.

Within the forest the distribution of species may be partly related to the light conditions prevailing (Herbert, 1928). Rankin (unpublished) listed the important species in the Yarraman district according to their observed stratification, and used it as a measure for degree of tolerance of shade. It is important to notice the intrinsic nature of the individual species—the size and form it naturally grows to at maturity and its physiological characteristics—before judging its light requirements by the method of comparison with neighbouring dominant or dominated plants. Rankin made series of observations on thirty-eight particular species. He considered that the distribution of species is not due to light only, but that light requirement is one of the factors which decide the position of species in the forest strata. In a recent communication he states that "As an observational study in stratification it will pass, but any reference to 'light requirements' needs careful critical handling, since I am now dubious about this aspect of it." He classified the species in two ways, which give practically the same grouping in each case, so that H and X, M and Y, L and Z can be grouped together and contingency tables prepared for comparison with other factors; H, M, and L, and X, Y, and Z, have been counted as halves in the contingencies:—

I.—(X) Trees never observed growing in shade, marked X in Species List on pp. 114 to 115.

(Y) Observed growing in full sunlight and slight shade, strongly competitive, marked Y.

(Z) Partly or wholly shaded, marked Z.

II.—(H) Trees apparently requiring a high optimum light intensity for healthy, vigorous development, and frequent distribution.

(M) Ditto medium optimum.

(L) Ditto low optimum.

CONTINGENCY TABLE.

"Light Intensity."	Habitual Tree Height.				Soil Type.			
	Tall 70–100 ft.	Medium 50-70 ft.	Small Below 50 ft.	Totals.	a & ab.	abc & bc.	bcd, c & cd.	Totals.
H. and X.	5	1	1	7	4	2·5	·5	7
M. and Y.	7	8	4	19	5	7·5	6·5	19
L. and Z.	1	7	4	12	2	4	6	12
Totals	13	16	9	38	11	14	13	38

This table indicates that "light intensity" is correlated with both tree height and soil type. In reality, habitual tree height varies directly with soil fertility. It is thus possible that this method of measurement of reaction to light intensity is unsatisfactory and really measures relative height only; in any case, it is clear that soil type has the greater influence on distribution of species.

The general form and size to which rain-forest trees grow is often dwarfed by their immediate competitive environment (White, 1930). The *Diospyros pentamera* of the Macpherson Range, for example, is a much bigger and more vigorous tree than the same species in the Yarraman-Kilkivan area. McLuckie and Petrie (1927) have studied the photosynthetic organs of some temperate rain-forest and sclerophyll-forest trees. Francis has described the vegetative anatomy, growth rings, and the formation of buttress roots in some rain-forest trees; it would appear that buttress-rooted trees are most commonly found in the moister portions of the rain forest, such as my subdivisions *a* and *b*.

The Rain-forest Ecotone.

The several factors concerned in the limitation of spread and in the succession of rain-forest species are of interest. It has already been explained how the nature of the soil, the local rainfall, and the distribution of soil moisture control the regional spread of rain forest.

In some cases, instead of extending down the creeks, the rain-forest edge follows the contour and avoids the valleys. An example is the "natural paddock" at the head of Gooroomjam Creek; another the forest nursery and arboretum grounds on R. 220, Kilkivan. These valleys frequently contain a rather heavy black clay soil which is suitable for grass but not for rain-forest trees. Not only do fires readily sweep over it, but young trees find difficulty in establishing themselves even after they germinate on suitable patches, because of overheating of the soil during summer. An instance of heat-girdling of plantation hoop pine seedlings of over two-years age on such black soil was given by the writer at the June, 1930, meeting of the Royal Society of Queensland. In such situations even Eucalypts find it difficult to establish themselves. These black soils also radiate their heat faster at night, and, cooling quickly, encourage heavy frosts.

The spread of rain forest depends largely upon the advance guard of resistant species such as *Croton insularis, Canthium buxifolium, Erythrina vespertilio, Myoporum acuminatum,* &c., which apparently are able to withstand the rigours of unsheltered situations in their young stages; in time other species—e.g., *A. cunninghamii*—establish themselves under the shelter of these pioneers as the rain-forest type of soil is gradually formed.

Growth-ring counts of hoop pine trees on the Cooyar Range demonstrate that they took about 110 to 120 years to grow from 1-inch girth to 72-inch g.b.h. and 100 feet high. In the Imbil forests Grenning (1928) has estimated from annual girth-increment data that a 60-inch g.b.h. tree is about 160 years old. On plantations it is estimated that hoop pine should reach 60-inch g.b.h. in about forty-five years (*loc. cit.* p. 30). The growing tree progresses slowly in open competition with naturally surrounding plants.

It is on the rain-forest edges that the subsequent floristic composition of the forest is largely determined. The establishment of a particular species on any site depends upon the ability of its germinating seeds to grasp whatever ecological opportunities are available and to resist natural competition. The silky oak, *Grevillea robusta,* is seldom found away from the moister parts of the forest, and it does not readily develop in mature rain forest; yet plantations of this species are readily established over a wide range of sites where it is not found in nature so long as the young plants are raised in a nursery and put out from planting tubes. The seedlings cannot withstand heavy frosts, dense shade, or root competition—i.e., moisture competition. The essential conditions for this species are thus early partial shelter with high soil moisture and later protection from competition; it is clear that its distribution in nature will be restricted to the creek banks. Similar remarks apply to *Flindersia oxleyana,* except that it is not so strongly affected by suppression as *G. robusta,* and is consequently found in moist spots away from creek banks (Swain, 1928). Hoop pine, on the other hand, though very liable to destruction in its early stages by heat, drought, &c., is able to tolerate considerable shade and root competition as well as relatively dry situations. One of the most limiting factors in its early establishment in the forest is that, although the seeds germinate during the wet season on the leaf litter on the forest floor, yet before the young plant can push its tap root into mineral soil drier weather may appear and desiccate the seedlings. In nature only two or three hoop pine per acre occur in the forest, but the species extends further afield than *G. robusta* and *F. oxleyana.* It develops poorly on the majority of non-rain-forest soils, which are devoid of decaying organic matter.

These few examples indicate how the varied conditions of shelter and moisture in the rain-forest ecotone permit the germination and seedling development of the various species in different parts of the transition zone. As the young plants grow up, however, they compete with one another for soil nutrients, moisture, and light, and those taller-growing species which can also withstand root competition may oust the pioneer shrubs. The reaction of the various species to their physiological environment in the ecotone is only in temporary equilibrium at any one time and is continually changing.

Distribution of Important Species within the Rain-forest.

(*a*) Moist ridges catching rainfall, creeks, &c.

(*b*) Moist slopes and better soil patches on flat lands within the forest.

(*c*) Better-class ridges and slopes.

(*d*) Drier ridges and slopes.

(*e*) Rain-forest ecotone on drier slopes and ridges.

(*f*) Rain-forest ecotone in moister places, fringing creeks, &c.

(*e*) and (*f*) are seral communities.
(*a*) to (*d*) are climax communities.

Useful indicators of distribution are:—

(1) *Tarrietia argyrodendron* .. .. .. *a*
(19) *Flindersia australis* .. .. .. *a, b*
(36) *Geijera salicifolia* .. .. *a, b, c*
(52) *Geijera mulleri* .. .. *b, c, d*
(59) *Flindersia collina* .. .. *c, d*
(70) *Alstonia constricta* .. .. .. *d*

Mt. Stanley Range shown by .. .. –
Cooyar Range shown by .. .. *
Kilkivan Res. 220 shown by .. .. †

			a	*b*	*c*	*d*	*e*	*f*	Family.
M Y	(1)	*Tarrietia argyrodendron*	*†–						Sterculiaceæ
Y	(2)	*Harpullia pendula*	*†–						Sapindaceæ
M	(3)	*Mallotus philippinensis*	*†–					*–	Euphorbiaceæ
	(4)	*Litsea dealbata*	*						Pauraceæ
	(5)	*Castanospermum australe*	*						Leguminosæ
	(6)	*Rhodamnia trinervia*	*					*	Myrtaceæ
Y	(7)	*R. argentea*	*					*	Myrtaceæ
	(8)	*Endiandra discolor*	*					*	Lauraceæ
	(9)	*Panax elegans*	*						Araliaceæ
	(10)	*Melia composita*	*					*	Meliaceæ
	(11)	*Cedrela toona*	*					*	Meliaceæ
H Y	(12)	*Ficus* spp.	*†						Moraceæ
	(13)	*Syncarpea subargentea*	*†						Myrtaceæ
	(14)	*Ailanthus malabarica*	*						Simarubaceæ
	(15)	*Randia chartacea*	†						Rubiaceæ
	(16)	*Tabernæmontana orientalis*	†						Apocynaceæ
	(17)	*Kibara macrophylla*	†						Monimiaceæ
	(18)	*Weinmannia lachnocarpa*	†						Cunoniaceæ
H X	(19)	*Flindersia australis*	*–	*					Rutaceæ
H X	(20)	*Flindersia oxleyana*	*	*					Rutaceæ
L Z	(21)	*Baloghia lucida*	*†–						Euphorbiaceæ
	(22)	*Cordyline* sp.	–	–					Liliaceæ
	(23)	*Flindersia schottiana*	*	*				*	Rutaceæ
H Y	(24)	*Rhodosphæra rhodanthema*	*–	*				*	Anacardiaceæ
H X	(25)	*Euroschinus falcatus*	*†–	*†–				*	Anacardiaceæ
	(26)	*Canthium lucidum*	*†–	*–					Rubiaceæ
	(27)	*Notelæa microcarpa*	–	–					Oleaceæ
	(28)	*Carissa ovata*	*–	*				*	Apocynaceæ
L Z	(29)	*Pseudomorus brunoniana*	*	*					Moraceæ
	(30)	*Aphananthe philippinensis*	*–	*–	–			*–	Ulmaceæ
M Y	(31)	*Jagera anacaroides*	*–	*	*			*	Sapindaceæ
H Y	(32)	*Siphonodon australe*	*†–	*–	*				Celastraceæ
	(33)	*Lianes*	*†–	*†–	*†–				..
	(34)	*Celastrus dispermus*	*–	*–	–				Celastraceæ
L Z	(35)	*Nephelium faveolatum*	*–	*–	*–				Sapindaceæ
H Y	(36)	*Geijera salicifolia*	*†–	*–	–				Rutaceæ
M Y	(37)	*Jagera (Cupania) pseudorhus*	*	*	*–			*	Sapindaceæ
H Z Y	(38)	*Araucaria cunninghamii*	*†–	*†–	*†–		*–	*†–	Pinaceæ
	(39)	*A. bidwilli*	*–	*–	*–			*	Pinaceæ
M Y	(40)	*Owenia venosa*	†	*					Meliaceæ
	(41)	*Alchornea ilicifolia*		*					Euphorbiaceæ
	(42)	*Diospyros pentamera*	†	–	*				Ebenaceæ
L Z	(43)	*Strychnos arborea*		–	*				Loganiaceæ
M Y	(44)	*Denhamia pittosporoides*	*–	*†–	†			*	Celastraceæ
	(45)	*Laportea moroides*	*–	*–					Urticaceæ
Y	(46)	*L. photiniphylla*	*–	*–					ditto

			a	*b*	*c*	*d*	*e*	*f*	Family.
	(47)	*Hoya australis*	–						Asclepiadaceæ
L Z	(48)	*Capparis nobilis*	*	–					Capparidaceæ
M Z	(49)	*Canthium latifolium*	*	*				*	Rubiaceæ
H Y	(50)	*Melicope erythrococca*	*–	*–				*	Rutaceæ
M Z	(51)	*Excœcaria dallachyana*		*–	*–	–			Euphorbiaceæ
M Z	(52)	*Geijera mulleri*		*	*†	†–			Rutaceæ
L Z	(53)	*Zanthoxylum brachyacanthum*		–	†–	†–	–	–	Rutaceæ
M Y	(54)	*Hemicyclia australasica*			*–				Euphorbiaceæ
	(55)	*Elæodendron australe*			*–			*	Celastraceæ
	(56)	*Alyxia ruscifolia*			*				Apocynaceæ
L Z	(57)	*Exocarpus latifolia*			*				Santalaceæ
M	(58)	*Jagera xylocarpa*			–				Sapindaceæ
M Y	(59)	*Flindersia collina*			*†–	*†–			Rutaceæ
M Y	(60)	*Vitex ligum-vitœ*	†		*	*–			Verbenaceæ
L	(61)	*Myrtus hillii*	†		*–	*		†–	Myrtaceæ
L Z	(62)	*Canthium vacinifolium*			*	–		*	Rubiaceæ
M Y	(63)	*C. buxifolium*			*	*–	–	–	Rubiaceæ
H Y	(64)	*Bursaria incana*				*–	*		Pittosporaceæ
	(65)	*Hormogyne cotinifolia*				–			Sapotaceæ
L Z	(66)	*Cleistanthus cunninghamii*			*	*			Euphorbiaceæ
	(67)	*Brachychiton diversifolia*			*	–		–	Sterculiaceæ
	(68)	*B. discolor*			*	–		–	ditto
	(69)	*B. rupestris*				†	†		ditto
	(70)	*Alstonia constricta*			†	*†			Apocynaceæ
	(71)	*Acronychia lævis*				*			Rutaceæ
	(72)	*Erythrina vespertilio*				*	*	*	Leguminosæ
	(73)	*Myoporum acuminatum*				*			Apocynaceæ
	(74)	*Cassia sophera*						*	Leguminosæ
	(75)	*Alphitonia petriei*	†					*	Rhamnaceæ
	(76)	*Callistemon viminalis*						*	Myrtaceæ
	(77)	*C. salignus*						*	Myrtaceæ
	(78)	*Breynia oblongifolia*						*	Euphorbiaceæ
	(79)	*Bryonia laciniosa*						*	Cucurbitaceæ
	(80)	*Petalostigma quadriloculare*					*	*	Euphorbiaceæ
H	(81)	*Croton insularis*				†	*†–	*	ditto
	(82)	*Olearia elliptica*					*–		Compositæ
	(83)	*Solanum discolor*					*–		Solanaceæ
	(84)	*Dodonœa viscosa*					–		Sapindaceæ
	(85)	*Acacia* spp. (*fasiculiflora*)				†	*†–		Leguminosæ
	(86)	*Grevillea robusta*	†					*†	Proteaceæ
	(87)	*Trema aspera*					†		Ulmaceæ
	(88)	*Eucalyptus saligna*	†					†	Myrtaceæ

The Sclerophyll Forests.

On the lower slopes, flats, and creeks around Mt. Stanley, *E. crebra*, with the lichen *Usnea* sp. growing on it, dominates an open undergrowth of *Acacia implexa*. With increasing altitudes *E. melliodora* appears, and on the higher hills is more abundant than *E. crebra;* on slopes with a northerly or north-easterly aspect *E. melliodora, E. crebra, E. tereticornis,* and *A. subvelutina* are the commonest trees. On high unsheltered ridge tops one finds *E. crebra, E. corymbosa, E. acmeniodes,* and occasionally *Banksia integrifolia, Acacia aulacocarpa,* and *A. cunninghamii.* On slopes with a south-easterly aspect the commonest trees are *E. tereticornis, E. melliodora, A. subvelutina,* and a well-developed understory of *Casuarina torulosa.* In all cases the ground vegetation consists mainly of thick grass, and on the south-east slopes ground orchids such as *Caladenia* sp. and some leguminous creepers occur.

In the Tarong-Yarraman area several communities exist. The moister slopes, flats, and creeks with deeper detrital or alluvial soils are stocked by *E. decorticans, E. propinqua, E. punctata, E. paniculata, E. tereticornis, E. hemiphloia, Angophora subvelutina, E. corymbosa, Tristania suaveolens,* &c. On the open drier slopes with shallower rocky soils *E. crebra, E. melanophloia, E. siderophloia, E. decorticans, Angophora lanceolata, Cas. torulosa, Petalostigma quadriloculare, Exocarpus cupressiformis, Erythrina vespertilio, Cudrania javanensis,* *Acacia cunninghamii, A. aulacocarpa, A. glaucocarpa, A. fimbriata,* &c., may be found, and in places a dense undergrowth of *Olearia elliptica* occurs. On south-east slopes near Benarkin *E. pilularis, E. microcorys, E. paniculata,* and other species which demand soils of better consistence and higher moisture are frequently found. Sometimes the rain forest has invaded the Eucalypt areas ("bastard scrub"), and one finds *E. siderophloia, E. hemiphloia, E. paniculata, E. crebra,* &c., surrounded by the smaller rain-forest species which occur in the rain-forest ecotone. White (1920) published ecological notes on the open grass-lands and forests at 2,000 feet altitudes on the Bunya Mountains west of Cooyar.

The conditions in the sclerophyll forest are very different from those in the rain forests. There is no closed canopy overhead; the species tend to occur in consociations rather than in mixtures. The crowns of the trees are, in general, more open and the leaves long and narrow compared with rain-forest species. The forest floor is usually covered with grass and herbs as well as shrubs and small or young trees. In the rain forest the forest floor is practically bare of vegetation excepting for the butts of the trees and lianes. Rain-forest trees are generally surface-rooting and may have large buttress roots; likewise the eucalypts have many surface-feeding lateral roots, but they are also provided with deep tap roots. The surface layers of rain-forest soils are rich in humus, whilst fallen leaf litter decays fairly rapidly on account of higher humidity. In the eucalypt forest the surface soil is seldom as rich in humus, and the fallen litter is often dry and rots slowly; more often than not it lies until the next forest fire destroys it. In the ash beds so produced eucalypt seed readily germinates with the arrival of the rainy season. Usually eucalypt seed will germinate within five to fourteen days under these conditions, whereas under the best nursery conditions many rain-forest species require ten to fifty days for germination. Young seedlings are killed by heat and frost, and successful management involves close attention to weather conditions. The role of fire in natural regeneration of eucalypts is of considerable importance. The fire converts undesirable ground litter into readily soluble mineral plant-food. Eighty per cent. germnation of *E. crebra* has been obtained in ash bed when only 20 per cent. took place in grass or humic soils. The ground vegetation receives a severe setback, so that the newly germinated seedling obtains an even start in the succession. The fire affects the seed trees so that they tend to throw a heavy seed fall more or less simultaneously. After establishment of this young forest adequate fire protection is then necessary. Immediately the stage is reached at which the transition from the broad young leaf to the narrow adult form of foliage is complete, the eucalypts will no longer tolerate dense shade. If the stand is left unthinned, the combined effect of root competition and shade tends to produce loss of crown and girth development. An original stand of, say, 1,000 *E. crebra* per acre of 3 inches diameter breast-high may have to be thinned to 150 per acre when the g.b.h. reaches 30 inches, in order to obtain optimum growth. The rate of growth varies with locality and climate. In Queensland coastal districts *E. crebra* takes about thirty to forty years to reach 36 inches g.b.h., whereas in the drier inland localities it takes about 100 years to reach this size.

A point of special interest in regard to the distribution of plants in Queensland concerns the occurrence of certain species in the moist coastal soils of the Maryborough area and also in the relatively dry inland country round Inglewood, which is usually stocked by xerophilous plants (Doggrell, 1929). Species common to the cypress pine plains at Inglewood and to the Maryborough district are marked with an *in the table on pp. 102 to 104. Species common to the ironbark ridges of Inglewood and those of Yarraman district are: *Acacia cunninghamii, Alphitonia excelsa, Myoporum acuminatum, Olearia elliptica, Dodonæa viscosa, E. decorticans, E. siderphloia, E. crebra, E. melanophloia, E. trachyphloia.* These observations suggest that conditions on types *d, e, f,* and *h* of Maryborough are similar to the 25-inch rainfall cypress pine plains, which suggests that the Maryborough types *d, e, f,* and *h* are physiologically dry. Conversely, the ironbark ridges must have conditions comparable to the Yarraman open forest areas. A plausible explanation is that the greater humus content of the neutral inland soils retains more moisture and so simulates the conditions of the higher rainfall coastal areas; with present data it is only possible to guess. That the edaphic conditions, generally, are drier in the inland areas than on the eastern slopes of the Main Divide is indicated clearly by the extent of the prickly-pear belt (Johnston, 1925).

IV. SUMMARY AND CONCLUSIONS.

1. Ecological descriptions of localities covering a gradation of conditions from the coast to the Main Divide are presented. Special attention has been paid to edaphic conditions, and the soils are classified on the basis of a full range of descriptive data according to modern practice.

2. An examination of the coastal plain and foothills near Maryborough reveals that floristic distribution and soil type are closely correlated. Soil type is largely governed by subsoil drainage conditions, which depends in turn upon topography, aspect, lithological origin, and the consistence of subsoil clay. Six soil series, apparently belonging to the Yellow Earth Climatic Soil group, are described and the distribution of plant species is set out in detail in relation to the soil types. The utilisation of these lands is discussed and some reforestation possibilities are outlined.

3. The distribution of rain forest and sclerophyll forest in the Yarraman-Kilkivan district is governed partly by fundamental soil differences and partly by precipitation, the rain-forest edge representing an interesting equilibrium line. A general classification of four soil series is outlined.

4. A study of the internal structure of the rain forests indicates that the species can be grouped in association with soil-moisture conditions. A list of species is tabulated according to occurrence in this fashion. The dynamic conditions obtaining in the rain-forest ecotones appear to be of considerable importance in determining the subsequent arrangement of species within the forest and in building up the rich friable rain-forest soils.

5. The utilitarian classification of land is materially assisted by a comprehensive study of ecological agencies—in particular, by a full study of soil conditions in the field and laboratory. The U.S.A. Bureau of Soils method of soil classification agrees closely with classification based upon the natural distribution of plant species.

6. The consistency of the soil clay at various depths in the soil profile is of considerable importance, and it should be distinguished from the soil textures. The consistence and the physical and chemical nature of soil clay depends upon general mode of formation and lithological origin.

ACKNOWLEDGMENT.

It gives the writer pleasure to express his appreciation to all those whose help and criticism made possible the compilation of these investigations. Particular thanks are due to Messrs. C. T. White and W. D. Francis, Government Botanists, for numerous checks of botanical material; to Mr. V. Grenning, Director of Forests, for permission to utilise data collected during forest surveys; to Messrs. M. A. Rankin, M.Sc., Dip. For., A. H. Crane, M.F., B.Sc., Dip. For., R. H. Doggrell, Dip. For., and T. Nicholls for suggestions and interchange of notes; to Mr. C. Woods for assistance in drafting the maps; and to Drs. Bryan and Herbert for their encouragement and interest in my efforts.

BIBLIOGRAPHY.

Bourne, R., 1934, Empire Forestry Journal 13, p. 15.

Bryan, W. H., and Massey, C.H., 1925, P.R.S.Q. xxxvii., pp. 108–120.

Bryan, W. H., and Hines, H. J. G., 1931, Soil Research, p. 264.

Craik, I. J., 1929, Yale Univ. Bull. 25, and S. Af. Jnl. Sc., 1930, pp. 247–257.

David, T. W. E., 1932, Geological Map of Australia and Notes.

Doggrell, R. H., 1929, Unpublished Ecological Notes on Inglewood District.

Fowler, F. D., 1927, Proc. Int. Con. Soil Sc. Comm V., pp. 435–441: Soils of South-Eastern U.S.A.

Francis, W. D., 1930, Australian Rain-forest Trees.

Francis, W. D., 1927, P.R.S.Q., xxxix., pp. 107-114.

Grenning, V., 1928, Working Plan for Mary Valley.

Herbert, D. A., 1927-32, Qld. Naturalist: Ecology of Palm Island; 1927, pres. add.; 1929, p. 51; 1930, p. 68, p. 87; 1932, p. 24.

Herbert, D. A., 1927, Qld. Naturalist, pp. 58–66.

Herbert, D. A., 1932, P.R.S.Q., xliv., p. 2.

Herbert, D. A., 1928, P.R.S.Q., xl., pp. 165-193.

Hill, D., 1930, Proc. Roy, Socy. Qld. xlii., p. 28

Hines, H. J. G., 1931, Proc. Roy. Socy. Qld. xliii., p. 37.

Jacks, G. V., 1934, Imp. Bur. Soil Science, Tech. Communication 29.

Johnston, T. H., 1925, Trans. Roy. Socy. S. Aust., p. 269.

McLuckie, J., and Petrie, A. H. K., 1927, Proc. Linn. Socy. N.S.W., lii., p. 161.

Prescott, J. A., 1931, C.S.I.R., Bull. 52: Soils, Vegetation, and Climate of Australia.

Prescott, J. A., 1933, Soil Research, p. 133.

Rankin, M. A., 1928, Aust. For. Jnl., Dec., p. 138.

Rankin, M. A., 1930, Adelaide University M.Sc. Thesis: ''Measurements of Soil Moisture in relation to Forest Type, Imbil.''

Schofield, R. K., and Scott-Blair, G. W., 1932, Chem. & Industry, March, p. 205: Rothamsted Pachimeter.

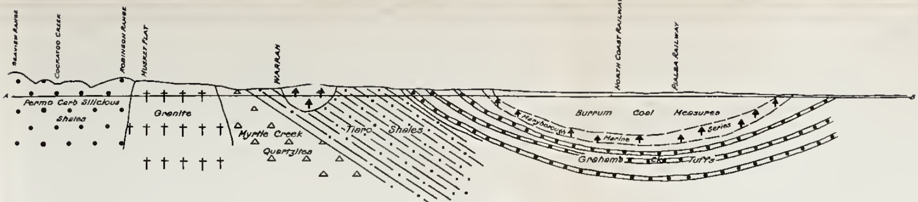
Swain, E. H. F., 1928, Forest Conditions of Queensland; Timber and Forest Products of Qld.; and Q.F.S. Bulls. 9 and 11.

Tommerup, E. C., 1930, Proc. Roy. Soc. Qld. xlii., pp. 19–27.

Tommerup, E. C., 1934, Int. Socy. Soil Science, Paris, Trans. 1st Comm., p. 155, Field Description of Physical Properties of Soils.

Tommerup, E. C., 1934, Australian Surveyor, Vol. 5, pp. 74–77: Soil Surveys.

White, C. T., 1920, Qld. Ag. Jour., p. 25: Flora of Bunya Mountains.



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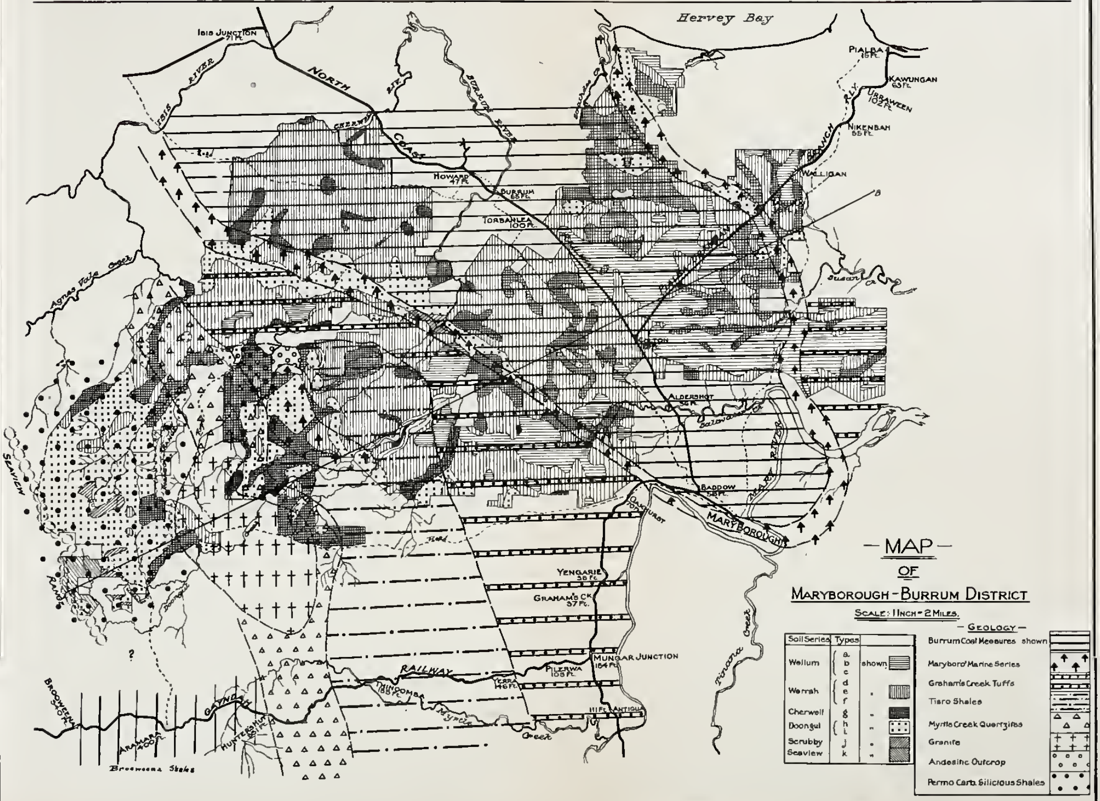

The Royal Society of Queensland.

Report of Council for 1933.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its report for the year 1933.

There is nothing of outstanding importance to report, the activities of the Society, as heretofore, being concerned chiefly with a steady adherence to those unpretentious but important objectives for which the Society was founded just fifty years ago.

Twelve original papers on several different aspects of scientific research were accepted for publication in the Proceedings. Six of these were actually read at ordinary meetings of the Society.

During the year your Council arranged a number of lectures on different topics as follows:—Mr. C. T. White on ''The Vegetation of New Guinea, New Caledonia, and Solomon Is.''; Dr. R. W. Cilento on ''Natives and Native Customs in Melanesia''; Dr. E. Hirschfeld on ''Biological Problems in Western Queensland''; Mr. W. W. Bryan, B.Sc. Agr., on ''Maize Breeding in Queensland''; Mr. C. T. White on ''Queensland Grasses''; Dr. A. J. Turner on ''Observations on the Nutrition of our Western Children.''

In addition, one evening was devoted to a discussion on the discovery and natural history of the Glass Houses, the leading speakers being Professor Cumbrae Stewart, Dr. F. W. Whitehouse, Mr. C. T. White, and Mr. Longman.

Your Council takes this opportunity of thanking the gentlemen who assisted in these phases of the Society's work.

At most meetings numerous exhibits were displayed for the interest of members.

The Council is indebted to a number of individuals and institutions in various ways, and wishes to thank the University of Queensland for housing the library and providing accommodation for meetings; the Assistant Librarian of the University, Miss McIver, for superintending the lending of periodicals from the Library; the Scientific

Publications Committee of the Commonwealth of Australia, and the Research Fellowship Committee of Newnham College, Cambridge, for financial assistance in the printing and publication of "The Lower Carboniferous Corals of Australia," by Dr. Dorothy Hill.

The Library Committee has continued its work of rearranging the periodicals on the shelves, and it is a pleasure to report that owing to the untiring efforts of Mr. L. F. Hitchcock, the European and Oriental sections are now in very good order. Several new and valuable exchanges were arranged. The resignation of Mr. W. D. Francis, Hon. Librarian of the Society for the last six years, 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 only source of 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.

The membership roll consists of 5 corresponding, 6 life members, and 176 Ordinary members. During the year there were 4 resignations, one name was removed from the list under Rule 15, and 14 new members were elected. It is with deep regret that the death is reported of Dr. T. L. Bancroft, Mr. B. Dunstan and Mr. D. W. Gaukrodger, all of whom were old and valued members of the Society.

There were eleven meetings of the Council during the year, the attendance being as follows:—E. W. Bick, 10; W. H. Bryan, 11; R. W. Cilento, 7; W. D. Francis, 3; D. A. Herbert, 11; L. F. Hitchcock, 10; T. G. H. Jones, 8; J. S. Just, 4; H. A. Longman, 4; E. O. Marks, 6; F. A. Perkins, 10; H. C. Richards, 7; C. T. White, 8.

In terms of the amendment of Rule 19, Dr. E. O. Marks, Senior Member of the Council, automatically retires, but will be eligible for re-election in 1935.

R. W. CILENTO, President.

F. A. PERKINS, Hon. Secretary.

THE ROYAL SOCIETY OF QUEENSLAND.

Cr. STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDED 31st DECEMBER, 1933. **Dr.**

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
Bank Balance, 31st December, 1932	37	9	11	H. Pole and Co. Ltd., Printing, Abstracts, Rule Books, Annual Report	10	7	0
Subscriptions	147	16	0	H. Pole and Co. Ltd., Printing Proceedings, 1933, Payment on Account	101	12	0
Sale of Reprints and Volumes	12	16	8	State Government Insurance on Library	0	13	0
Exchanges	0	4	9	Donation to C.S.I.R. Index Printing Account	5	0	0
Interest	3	5	0	Hon. Secretary (Postages)	9	0	0
				Hon. Librarian (Postages)	1	0	0
				Hon. Treasurer (Postages)	1	0	0
				Lanternist	0	10	0
				Balance in Commonwealth Bank, 31st December, 1933	72	10	4
	£201	12	4		£201	12	4

Examined and found correct with Books of Account.

JOHN S. JUST, Hon. Auditor.

27th February, 1934.

E. W. BICK, Hon. Treasurer.

Abstract of Proceedings, 26th March, 1934.

The Annual Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 26th March, 1934. The Vice-President, Dr. T. G. H. Jones, occupied the chair in the unavoidable absence of the President, Dr. R. W. Cilento, and about sixty members and visitors were present. Apologies were received from His Excellency the Governor, Dr. R. W. Cilento, Dr. C. F. Marks, and Mr. O'Connor. The minutes of the previous Annual Meeting were read and confirmed. Messrs. L. A. Thomas, M.Sc., and G. M. Roscoe, M.A., were unanimously elected Ordinary Members of the Society. The following were proposed for ordinary membership:—Messrs. S. T. Blake, M.Sc., W. P. Hamon, B.Sc.Agr., W. J. S. Sloan, B.Sc.Agr., A. F. S. Ohman, B.V.Sc., Drs. A. Livingstone and A. J. Lynch, by Mr. Perkins and Dr. Herbert; Messrs. K. Fraser, B.Sc., and D. J. Grant, B.Sc., by Prof. Bagster and Mr. Jones; and Mr. G. Shaw, B.Sc.Agr., by Dr. Duhig and Mr. Perkins. The Annual Report and Balance-sheet were adopted.

The following officers were elected for 1934:—President, Mr. J. S. Just; Vice-Presidents, Dr. R. W. Cilento (*ex officio*), and Mr. R. Veitch; Hon. Treasurer, Mr. E. W. Bick; Hon. Secretary, Mr. F. A. Perkins; Hon. Librarian, Mr. L. F. Hitchcock; Hon. Editors, Dr. W. H. Bryan and Dr. D. A. Herbert; Hon. Auditor, Mr. A. J. Stoney; Members of the Council, Prof. L. S. Bagster, Mr. H. A. Longman, Prof. H. C. Richards, Dr. J. Vickery, and Mr. C. T. White.

The minutes of the inaugural meeting of the Society, held on the 8th January, 1884, were read by the first Hon. Secretary, Mr. Henry Tryon.

Hon. Dr. C. F. Marks and Mr. J. H. Simmonds, who, with Mr. H. Tryon, are the surviving foundation members, were unanimously elected Honorary Life Members.

Prof. F. W. Cumbrae Stewart delivered a short address in which he gave a brief account of the activities of some of the foundation members.

In the absence of the retiring President, Dr. R. W. Cilento, the Presidential Address was read by Prof. H. C. Richards.

A vote of thanks to the retiring President for his address, moved by Mr. Longman and Dr. Duhig, was carried by acclamation.

F. A. PERKINS, Hon Secretary.

Abstract of Proceedings, 30th April, 1934.

The Ordinary Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 30th April, 1934. The President, Mr. J. S. Just, occupied the chair, and about sixty members and visitors were present. Apologies were received from Dr. Bryan and Mr. Hitchcock. The minutes of the previous meeting were read and confirmed. Messrs. S. T. Blake, W. P. Hamon, W. J. Sloan, A. E. S. Ohman, K. Fraser, D. J. Grant, G. Shaw, and Drs.

A. Livingstone and A. J. Lynch were unanimously elected members of the Society. Messrs. A. Trist, B.Sc., and R. K. McPherson, B.Sc., were proposed for Ordinary Membership by Mr. Perkins and Dr. Herbert.

Mr. B. Blumberg gave a brief account of a paper entitled "The Life Cycle and Seasonal History of Pink Wax Scale (*Ceroplastes rubens*)."

Ceroplastes rubens is a serious Queensland citrus pest probably originating from Ceylon. Four instars are distinguishable, the complete life cycle occupying four to six months for the summer generation and six to eight months for the winter generation. In Brisbane there are two laying seasons in the year. The first begins at the end of January and ends in May or June; the second period commences late in September and ends in November or December. Emergence of young is intermittent. Observations on resistance to starvation, mortality, parasites and predators and the wax glands are also included.

This paper was discussed by Messrs. Gurney, Veitch, and Tryon.

A paper entitled "A Previously Undescribed *Dendrobium* from Papua," by Messrs. C. T. White and B. D. Grimes, was commented on by the former.

Dr. F. W. Whitehouse delivered an address entitled "Some Geological and Geographical Problems of Central Australia." The stratigraphical sequence in this region so far as is known was outlined and the structural problems associated with it. Evidence for relatively recent topographical changes (as shown for example by the river systems), and a suggested change operating at present towards increasing aridity were discussed. Movements of sand dunes, types of "desert," peculiarities in the soils, rivers, lakes and hills were touched upon and the lecture concluded with an account of the distribution of known meteorites and obsidianites in the province.

A vote of thanks, moved by Mr. Longman and Dr. Marks and supported by Mr. F. Bennett, was carried by acclamation.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 28th May, 1934.

The Ordinary Meeting of the Society was held in the Chemistry Lecture Theatre of the University at 8 p.m. on Monday, 28th May, 1934. The President, Mr. J. S. Just, occupied the chair, and about fifty members and visitors were present. Apologies were received from Prof. Richards and Messrs. Kemp and Perkins.

The minutes of the previous meeting were read and confirmed. Messrs. A. Trist and R. K. McPherson were unanimously elected ordinary members of the Society. The following were proposed for ordinary membership:—Messrs. N. E. Caldwell, B.Sc.Agr.; W. A. T. Summerville, M.Sc.; J. A. Weddell, by Messrs. Veitch and Perkins; and Mr. J. Robertson, by Drs. Duhig and Herbert.

Dr. J. V. Duhig showed some microphotographs of an anopheline mosquito taken by means of infra-red photography.

Mr. H. A. Longman exhibited—(*a*) A specimen of *Diprotodon* collected at Ranges Bridge, Condamine River, near Dalby, and presented to the Queensland Museum by Mr. T. Jack. It was a fragment of the palate containing two molars which showed an extraordinary state of wear. (*b*) A fossil claw, or ungual phalanx of an unknown animal sent in with fragments of crocodiles and tortoises from Boat Mountain, near Murgon, collected by Mr. R. A. Cooper, this being a new locality for Pleistocene fossils. (*c*) A fragment of the upper jaw of a gorilla with the upper incisors. The maximum of the series, 54.5 mm., the laterals being little smaller than the medians. This unusually large specimen was purchased in a second-hand shop in Brisbane.

Dr. T. G. H. Jones exhibited samples showing marked differences in cineol content in the oil of *Melaleuca linarifolia.*

Mr. E. A. O'Connor demonstrated a few experiments illustrating the phenomena of combustion.

Mr. E. W. Bick showed some fruits of *Kigelia pinnata.*

Mr. W. W. Bryan exhibited a specimen of *Chloris virgata* from Gatton, showing proliferation of the inflorescence.

Mr. C. T. White showed specimens of *Gomphrena decumbens* from Torrens Creek. This weed is now distributed from Townsville to Logan River, although it has only recently appeared in Queensland.

Dr. E. O. Marks exhibited scoria of remarkably fresh appearance from the Carnarvon Range.

Mr. Veitch discussed the contents of an exhibition case illustrating the various stages in the life history of the Noogoora burr seed fly, *Euaresta æqualis* Loew., a number of colonies of which have recently been liberated in Queensland by the Department of Agriculture and Stock, acting on behalf of the Council for Scientific and Industrial Research. This parasite has been introduced by the Council from Kansas. He also exhibited a series of specimens illustrating the type of damage inflicted on vegetable ivory buttons by the Scolytid beetle, *Coccotrypes dactyliperda* Fabr., a species which in recent years has been responsible for a considerable amount of damage in Queensland warehouses and retail shops.

Dr. D. A. Herbert showed a sheet of glass from a glasshouse showing a heavy growth of sooty mould fungi, the dominant type being a species of *Eurotium.*

Dr. Herbert and Mr. L. Lynch showed a series of experiments showing the diffusion of ethylene through fruits of banana and orange; *Stellaria media,* the chickweed, the leaves of which bend downwards in the presence of traces of ethylene, and other gases, was used as a test plant.

A vote of thanks to the exhibitors, moved by Dr. Bryan and supported by Messrs. Henderson and Bennett, was carried by acclamation.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 25th June, 1934.

The Ordinary Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 25th June, 1934. The President, Mr. J. S. Just, occupied the chair, and about sixty members and visitors were present. Apologies were received from Messrs. Ohman, Kyle, and Hines. The minutes of the previous meeting were read and confirmed. The following were unanimously elected ordinary members of the Society:—Messrs. N. E. Caldwell, W. A. Summerville, J. A. Weddell, and T. Robertson The following were proposed for ordinary membership:—Mr. A. R. Brimblecombe, by Mr. Perkins and Dr. Herbert; Mr. T. Gaffney, by Dr. A. J. Lynch and Mr. L. J. Lynch; Dr. A. Tarleton, by Prof. Cumbrae Stewart and Mr. Perkins and Mr. G. W. Shell, by Prof. Bagster and Mr. Jones.

Mr H. A. Longman exhibited on behalf of Mr. L. C. Ball, Chief Government Geologist, a series of photographs of fossil footprints taken in the Lanefield Colliery, in the Jurassic coal measures of Rosewood, South-eastern Queensland. These footprints and the manner of their occurrence were first described by Mr. Ball in the "Queensland Government Mining Journal," 15th December, 1933, where their resemblance to the imprints of three-toed dinosaurs was recorded. Mr. Longman expressed his indebtedness to Mr. Ball for an opportunity of viewing these remarkable fossil footprints, which were very numerous. He briefly reviewed the work done by ichthiologists on fossil footprints, and concisely outlined some salient features in the classification of dinosaurs. The evidence presented in the Lanefield Colliery demonstrated a bipedal dinosaur, a new record for Australia, and he congratulated Mr. Ball on this significant discovery.

Dr. F. W. Whitehouse exhibited a plaster cast of one of the footprints, and commented upon the age of the deposits.

Professor H. C. Richards expressed the view that Mr. Ball's discovery was of very great scientific interest, and he was to be congratulated on bringing before people the existence of these imprints which he recognised as those of dinosaurs. No doubt much interest would be aroused in other centres.

On behalf of Mr. L. C. Ball, Dr. E. O. Marks exhibited a fragment of shale forming the "cast" of the impression of a middle toe of one of the dinosaur footprints at Lanefield Colliery. The fragment shows a curious double slickensided jointing, parallel to the long axis of the toe.

Mr. C. T. White exhibited specimens of *Salvia reflexa* Hornem., and read the following notes on the synonymy of the species:—

Salvia reflexa Hornem. is a very common naturalised weed on parts of the Darling Downs in Queensland. It also occurs in the neighbourhood of Springsure, Central Queensland. It probably occurs in other localities, though I have not seen specimens.

The plant has come into prominence of recent years owing to the way it has spread over some of the best land on the Darling Downs. It is extremely difficult of eradication on account of its habit of starting seeding at a very early stage, when only 2 or 3 inches high, and continuing throughout its life.

It is a native of the United States and Mexico, and was first recorded as a naturalised alien for Queensland by myself in the "Queensland Agricultural Journal" for May, 1925, page 417, under the name of *Salvia lanceifolia* Poir.

As the weed was assuming considerable importance, due to the fact that it had been reputed to have caused serious losses of stock in Queensland, I sent specimens to the Royal Botanic Gardens, Kew, for checking, and in a letter dated 24th September, 1932, the Director, Sir Arthur W. Hill, informed me that the specimens had been examined by Mr. Summerhayes, who determined them as *Salvia lanceolata* Brouss., and stated that Professor Carl Epling, who was monographing the American *Labiatæ*, had left all the Kew specimens of the species under this name. On receipt of this I got into communication with Dr. Carl Epling, of the University of California at Los Angeles, and he wrote:—

> "I have been some time in receipt of your letter and two specimens of *Salvia*. It happened at the time that I received your letter that I was working upon the group to which your species belongs, and had written to the herbarium at Copenhagen for information and a photograph of *Salvia reflexa* Horneman. I have just received this information, and am thus able to give you a complete synonymy for your species. In naming up the material at Kew, I used the commonly accepted name, since at that time I had not had the opportunity of investigating the nomenclature of the species.
>
> *S. reflexa* Hornem. Enum. Hort. Hafn. 1:34.1807, based upon a garden specimen grown from seed sent by Broussonet under the name of *S. lanceolata*.
>
> *S. lanceolata* Brouss. App. Elench. Pl. Hort. Monsp. 15:1805, based upon a garden specimen. (Not *S. lanceolata* Lamarck, Illustr. 1:72.1791.)
>
> *S. lanceolata* Willd. Enum. Hort. Berol. 1:37.1807, based upon a garden specimen.
>
> *S. lanceæfolia* Poir., Encycl., Suppl. 5:49.1817, based on a garden specimen grown from seeds supposedly of Peruvian origin.
>
> *S. trichostemmoides* Pursh. Fl. Am. Sept. 1:19.1814, based upon a specimen collected by Lewis and Clark.
>
> *S. aspidophylla* Roem. and Schult. Sybt. Mant. 1:206.1822, based upon a garden specimen.
>
> "I have been unable to find the types of *S. lanceolata* Brouss., *S. lanceæfolia* Poir, and *S. aspidophylla* R. and S."

It will thus seem that our plant has to be recorded as *Salvia reflexa* Hornem., this name having priority.

A paper entitled "A Review of the Queensland Charophyta," by Messrs. Groves and Allen, was communicated by Dr. R. Hamlyn Harris.

Prof. L. S. Bagster delivered a very interesting lecturette on "Heavy Water and the New Hydrogen." It was explained that the new hydrogen has the same chemical properties as ordinary hydrogen, but the new atom was twice as heavy. It is one of a large class of elements where a similar phenomenon is found, except that in other cases the different atoms have much the same weight. The heavy water formed shows interesting physical and physiological differences from ordinary water, the melting and boiling points are different, and growth is hindered or inhibited.

Messrs. Henderson, Bennett, and White took part in the discussion on the exhibits and papers, and a vote of thanks to the various speakers moved by Prof. Murray and Dr. Vickery was carried by acclamation.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 30th July, 1934.

The Ordinary Meeting of the Society was held in the Chemistry Lecture Theatre of the University at 8 p.m. on Monday, 30th July, 1934. The President, Mr. J. S. Just, occupied the chair, and about fifty members and visitors were present. Apologies were received from Professor Murray and Messrs. Kyle and White. The minutes of the previous meeting were read and confirmed. Dr. J. J. C. Bradfield was proposed for ordinary membership by Drs. J. V. Duhig and L. S. Bagster. Dr. A. Tarleton and Messrs. A. Brimblecombe, T. Gaffney, and W. G. Shell were unanimously elected ordinary members of the Society.

Dr. J. V. Duhig exhibited, on behalf of Dr. J. J. C. Bradfield, part of a petrified tree exposed near the base of the Brisbane tuff in the quarry face overlooking the wharves at Petrie Bight. Petrified tree trunks have been located at many places in the Brisbane district under similar circumstances, and the late Benjamin Dunstan in his Annual Report as Chief Government Geologist for 1919 refers to one exposed in the Ann street and Gotha street excavations that he considered may have reached a length of 120 feet. Professor Sahni has described a specimen from below the tuffs on Boggo road as *Cedroxylon,* and he is now engaged on additional material from various quarries in the city collected and submitted to him by Mr. L. C. Ball. Occasionally the fossilised trunks are deeply charred, as in this case, but usually preservation of the tissues has been by silicification. The large size of many of the trunks unearthed is surprising, and it may be inferred that the ancient land surface was thickly timbered when overwhelmed by the eruption of volcanic material that ultimately, on lithification, became tuff. Dr. Marks and Mr. Tryon commented on this exhibit.

The main business of the evening was a very interesting and informative address entitled, "Some Recent Advances in Plant Genetics and Cytology," by Dr. L. G. Miles. The address was illustrated by means of the epidiascope. A vote of thanks moved by Dr. Herbert and Professor Goddard was carried by acclamation.

F. A. PERKINS, Hon Secretary.

Abstract of Proceedings, 27th August, 1934.

Ordinary Monthly Meeting, 27th August, 1934. Mr. J. S. Just (President) in the chair, and about forty members and visitors present. Dr. J. J. C. Bradfield was unanimously elected an ordinary member of the Society.

Mr. H. Tryon exhibited (*a*) specimens of stone implements collected at Russell Island and (*b*) several species of Musci.

A paper by Mr. F. Chapman, entitled "Report on Samples of Surface Tertiary Rocks and a Bore Sample containing Ostracods from Queensland," was communicated by Dr. F. W. Whitehouse. Ostracods in shales of Tertiary age were described from three different localities—Redbank Plains, Dunn's Farm at Beaudesert (in a bore at 160 feet), and Lowmead (in a bore at 200 feet). Species were described belonging to the genera *Erpetocypris, Cypridopsis, Pontocypris, Cythere, Krithe,* and *Paradoxostoma.* On the evidence of associated freshwater and estuarine or marine types, Mr. Chapman concludes that these basins had some intermittent connection with the sea. He states that the forms give no very decisive data as to the age of the various beds other than Tertiary.

Mr. J. H. Reid and Professor H. C. Richards discussed the paper, and, while welcoming the addition to our knowledge of Tertiary Faunas, were of the opinion that the field evidence could not support marine incursions to these basins.

Dr. W. H. Bryan communicated a paper entitled "An Interpretation of the Silverwood Lucky Valley Upper Palaeozoic Succession," by A. H. Voisey. In this paper the author records the finding of *Monilopora* on a new horizon in the Permo-Carboniferous rocks of the Silverwood-Lucky Valley area, namely, below the *Eurydesma cordatum* beds in the Eight-mile Fault Block. In view of this discovery, the Condamine Beds (which also contain the genus *Monilopora*) are regarded as older than the Eurydesma Beds. The author agrees with the view of J. H. Reid that the Volcanic Series should also be placed on a lower horizon than that originally assigned them by Richards and Bryan in order to equate them with the Lower Bowen Volcanics. On the other hand he suggests, after a re-examination of the list of fossils from various horizons, that the Wallaby Beds should occupy a relatively higher place in the sequence. The author disagrees with Reid's contention that the Condamine Beds should be regarded as occupying a pre-Kamilaroi horizon, and regards the lowest beds of the Fault Block Series as equivalent with the Lower Marine Beds of the Hunter River sequence.

Mr. J. H. Reid stressed the fact that further field work is not required so much as critical palaeontological work on the Permo-Carboniferous collections. He disagreed with the correlation of any portion of the Wallaby Beds with the Greta Coal Measures, and with the numerical method of comparing the faunas in the different blocks as a means of placing the upper Wallaby Beds at the base of the Upper Marine. *Monilopora* has a range above the *Eurydesma* beds in Springsure, and *Glossopteris* occurs many thousand feet below the topmost *Monilopora* horizons.

Dr. W. H. Bryan was prepared to agree with the author of the paper and with Mr. J. H. Reid that no great weight could now be placed on *Trachypora wilkinsoni* as an indication of Upper Marine age, and that consequently the Condamine Beds might be somewhat earlier in age, but that very little weight could as yet be placed on *Monilopora* for stratigraphical purposes. The author's scheme possessed one serious disadvantage in that the base of the rhyolitic volcanics (which was assumed by Richards and Bryan to be on the same horizon on each of the closely adjacent blocks of the Fault Block Series) could no longer be used as a datum, Mr. Voisey's interpretation of the sequence showing two distinct volcanic epochs separated by normal marine sediments.

Dr. F. W. Whitehouse, in considering the general question, was not satisfied with any scheme of classification yet proposed. He pointed out that in the Upper Carboniferous and Permian there were greater extremes of climate over the globe than at any other time. This was reflected in the extraordinary differences in facies of the floras and faunas of the world which make long-range correlation very difficult. Also in Australia there were important climatic fluctuations of glacial and non-glacial conditions. In the floras and faunas corresponding effects are to be seen in the markedly intermittent range of many forms (*e.g., Gangamopteris, Trachypora,* and *Eurydesma hobartense*). Because of this he thought it unwise at present to assume in any scheme of correlation that the horizon of some one species (*Eurydesma cordatum,* for instance) is constant and limited. Furthermore, in Eastern Australia, except in the Hunter River Geosyncline, four genera occur prolifically—*Trachypora, Monilopora, ''Anidanthus,''* and *Taeniothaerus.* Some of them occur as close to the Hunter River basin as Kempsey. Since when they occur they do so in such abundance and since, with the exception of *Trachypora,* they have never been found in the Hunter River basin, he did not favour a correlation of such beds with horizons in the Hunter River section that did not yield these faunas. Rather he would think that they indicated a stage (divisible into several zones) not represented by marine beds in the Hunter River section. From the forms that were associated with these genera and which did occur in the latter region he believed them rather to represent a ''Middle Marine Stage,'' of considerable thickness, between the Lower and Upper Marine Series where a cessation of marine conditions is indicated by the Greta Coal Measures. He did not comment on the more detailed correlation within the blocks.

A paper, entitled ''The Relative Penetrability of Various Tissues of the Orange and Banana to Ethylene,'' by D. A. Herbert and L. J. Lynch, was read by Dr. Herbert. Ethylene was placed in a series of vessels plugged with oranges and bananas, so treated that any diffusion out into the surrounding vessel containing the test plant had to take place through (*a*) whole fruit, (*b*) endocarp and mesocarp, (*c*) endocarp only. Traces of ethylene passing into a surrounding vessel produced a pronounced and characteristic epinastic response in *Stellaria* leaves. This response also takes place in laboratory air, and due precautions were taken to have the experiments carried out in uncontaminated air. It was found that diffusion took place readily through epicarp and endocarp, but that the mesocarp offered some resistance, though it was permeable. Control experiments indicated that ethylene was not produced by the fruits themselves in sufficient amounts to affect the test plant. It was concluded that the differences in the ripening of oranges and bananas in an atmosphere containing ethylene are not due to a barrier against diffusion into the orange pulp, as the mesocarp of the banana offers approximately the same resistance as that of the orange, according to the evidence of the test plant. The paper was discussed by Mr. Gurney, who pointed out the difficulty of arriving at a suitable maturity test for fruit to be treated, and by Mr. Grant, who sketched the chemical differences of the ripening processes of citrus and of bananas.

Mr. C. T. White read a paper entitled ''Notes on the Genus *Ptychosperma* in Queensland.'' The author reviews the genus Ptychosperma in Queensland and recognises two species, *P. elegans* Bl.

and *P. Capitis-Yorki* Wendl. and Drude. The former is abundant along the eastern coast extending as far south as Keppel Bay, the latter is confined to the region of Cape York. In the past there has been considerable confusion in the nomenclature of these palms, and a full synonymy of each species is given.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 24th September, 1934.

Ordinary Monthly Meeting, 24th September, 1934. The President, Mr. J. S. Just, in the chair, and about fifty members and visitors present.

The President drew attention to the death of Sir Edgeworth David, and referred to his great achievements in the realms of science and exploration. A resolution was carried expressing the deepest sympathy with Lady David and family in their bereavement.

The business of the evening was a series of short addresses on Moreton Bay.

Professor Cumbrae-Stewart said that the Royal Society in 1768, James Douglas, sixteenth Earl of Morton, being President, promoted the expedition which discovered our east coast. Two Fellows of the Royal Society were in the "Endeavour," James Cook, R.N., the Commander, and Joseph Banks, Ch. Ch., Oxford. Cook named the point seen on 16th May, 1770, Cape Morton, and the bay to the south of it Morton Bay. The bay to the west of the cape he named Glass House Bay from the Glass Houses seen on the western shore. In July, 1799, Flinders examined Morton and Glass House Bays, discovering the land of Cape Morton to be an island. He examined Glass House Bay and found it extended southward for a considerable distance. Deceived by the editor of "Cook's Voyage," he called the cape Moreton and Glass House Bay became Moreton Bay. In December, 1823, Oxley was directed to a large river said to flow into the bay between Redcliffe and Sandgate. Finding the river thus indicated was merely a creek he called it the Deception (Pine) River, and passed on to discover the Brisbane River.

In June, 1827, Captain Logan, 57th Regiment, discovered the Logan River, and about the same time Captain Rous, H.M.S. "Rainbow," discovered the Boat Passage. The island thus found to exist was officially named the Isle of Stradbroke, after Captain Rous's father, Lord Stradbroke.

In 1848 Captain Yule, in the "Bramble," tender, examined the bay between Bribie Island and Redcliffe. The names Deception Bay and Bramble Bay have been transposed. Green Island was called "Fisherman's Island" by Flinders. Islands at the mouth of the Brisbane not noticed by Flinders are now called Fisherman's Island. Cook's Glass Houses are now called Glass House Mountains, or, worse still, Glass Mountains.

Professor H. C. Richards stated that geologically the area was generally comparable with that of South-Eastern Queensland, and that in the southern portion at Russell Island, and especially near Canaipa, the Brisbane Schist Series was well developed, both greenstones and phyllite occurring. Further south, in the neighbourhood of Southport, the greywackes were developed. Mesozoic lacustrine deposits occurred at Coochie Mudlo, Goat, Bird, and Peel Islands, at Dunwich, on Stradbroke Island, St. Helena, and Mud Island, at Cape Moreton, Humpybong, Deception Bay, and Toorbul Point amongst other places. At the two latter localities probably the Bundamba sandstone was developed, whereas in the other localities in all probability the material belonged to the Ipswich Series, *Thinnfeldia* being found at Peel Island and Goat Island. Tertiary volcanic basaltic rocks occur at Redland Bay, Cleveland, Wellington Point, Lytton, St. Helena, and Humpybong. With the latter there was associated much chalcedony and sometimes waterstones. Acid volcanic rocks of a rhyolitic nature were developed at Point Lookout, the north-eastern extremity of Stradbroke Island. Tertiary lacustrine deposits were associated with the volcanic material at Humpybong. The recent sand dunes, as developed at Stradbroke and Moreton Islands, were of particular interest, and it was noteworthy that those at Mount Tempest, Burnett Peak, and Cone Hill, on Moreton Island, reached heights approximately 1,000 feet above sea-level. As far as is known these are the biggest and highest coastal sand dunes which have been recorded. They are composed entirely of wind-blown silica sand, with which is associated very fine particles of broken shell material. The dunes have the characteristics, form, and shape of coastal sand dunes which have been blown up by prevalent south-easterly winds, and have a general length along a north-west south-east line. The dunes have been fixed naturally by native vegetation, which is surprisingly abundant in view of the nature of the material constituting the dunes.

Within the bay itself at Peel Island a very fine development of coral is found, whereas on Mud Island, as a result of coralline growth (both of corals themselves and of calcareous algæ), there has been accumulating a tremendous amount of material which is largely composed of calcium carbonate. This material is about to be exploited commercially by the Queensland Cement and Lime Company.

Dredgings from the mouth of the Brisbane River have given in mud nodules the interesting genus *Thalassina,* which has been found under similar circumstances in many places on the Australian coast.

The Ipswich Series of rocks near Sandgate have been very highly folded and faulted to an extent unusual for them.

The Moreton Bay area as a whole, probably in Post-Tertiary volcanic times, was affected by a general foundering movement, resulting in the submergence of a large area, which brought about the drowning of the Brisbane River. Borings associated with the foundations of the Grey Street Bridge would suggest that this foundering was at least 100 feet. The last movement of the area, however, has been a slight emergence in geologically recent times. Raised beaches may be seen at Moreton Island near Cowan Cowan, and it is interesting to note that in 1854 Samuel Stutchbury, in his Twelfth Tri-monthly Report, spoke of the evidence of recent emergence on Peel Island, in Moreton Bay.

Mr. J. H. Simmonds said that the marine fauna of Moreton Bay can be divided into three main associations, namely, the mangrove flat, the coral reef, and the Halophila flat. Of these the Halophila flat provides the most interest to the marine biologist. The essentials required for the formation of the typical Halophila association are (*a*) fresh ocean water, (*b*) freedom from silting sand and mud, and (*c*) permanency of the bed. The last requirement is obtained by the presence of the dugong weed, *Halophila ovala,* which forms a short, grass-like mat, binding the upper layers of sand together. Here the Coelenterata and Echinoderms are particularly well represented, among the many interesting forms being *Edwardsia rakaiyæ* and a species of *Cavernularia.* Commensulism is common, as, for example, *Cerianthus,* with its associate *Phoronis australis,* and the mollusc *Pinna menkii,* which may contain several of the commensual crabs *Pinnotheres.*

The coral reef areas are found off the shores of the islands and mainland facing the South Passage. At the present time they are probably being adversely affected by the silting up of this passage and by the mud and silt liberated into the bay as a result of denuding the river banks of their natural vegetation.

The mangrove flat, though presenting many interesting features, is not as varied in its fauna as the forementioned areas.

Mr. H. A. Longman referred to the large number of species of vertebrates from Moreton Bay in the Queensland Museum. Many northern species here reached their southern limit, and, alternatively, southern species had their northerly extension. Of over 1,000 species of fishes described from Queensland the majority were found in or around Moreton Bay. The atherine, *Rhadiocentrus ornatus* Tate Regan (1914), once thought to be peculiar to Moreton Island, had since been found on the mainland. A paper on the Aborigines by Geo. Watkins appeared in these Proceedings (Vol. VIII., 1891). A black dingo on Moreton Island was noted by Major Lockyer (1825). On Moreton Island the larger marsupials had long been exterminated and wild pigs were now common. On Stradbroke the marsupials included *Macropus agilis, ualabatus, welsbyi,* and *giganteus.* Sugar-squirrels (*Petaurus*), bandicoots, and native porcupines were present. The common 'possum had been reintroduced. The rodents included *Rattus youngi* from Moreton Island. The common reptiles were similar to those of the mainland. Lists of birds have been recorded for Stradbroke Island by Captain S. A. White, "The Emu," XIX., 1920; for Peel Island by Noel V. I. Agnew, "The Emu," XIII. and XXI., 1913 and 1921; for Moreton Island by Miss Hilda Geismann, "Queensland Naturalist," IV., 1924; whilst later records have been made by Mrs. L. M. Mayo.

Mr. C. T. White said that the flora of Moreton Bay is of particular interest to the botanist, as it is a meeting place of tropical forms such as the Mangroves and a few rain-forest types and the more temperate endemic Australian forms, such as the Eucalypts, Tea Trees, Bush Peas, Australian Heaths, Proteaceæ, &c. At least six distinct kinds of Mangroves are found round the shores of Moreton Bay, being particularly well developed in the estuarine swamps at the mouths of the Brisbane and Pine Rivers. Of these three belong to the Rhizophoraceæ, the family of true Mangroves, and three to other families.

On the sand dunes the outstanding trees are the Coast Oak and Pandanus. The latter was known to the aborigines as "Wynnum," and gave its name to the seaside resort of that name. Several trailing sand-binders, including a low species of Wattle and a number of sand-binding grasses, and several sorts of succulents are common on the dunes. Lying close in from the beach in several places are very large freshwater swamps, in which the outstanding tree is the common Paper Bark or Broad-leaves Tea Tree (*Melaleuca*), the ground underneath the trees being often covered with a thick growth of the Bungwall Fern (*Blechnum*). In some parts, particularly where the water is more brackish, the Tea Tree is displaced by the Swamp Oak (*Casuarina*).

On the islands much of the country consists of Wallum, a term applied in Queensland to barren country in the coastal belt, consisting largely of peat swamps alternating with sandy ridges, covered with a sclerophyllous woodland, consisting of low, stunted Eucalypts, legumes, Myrtles, Australian Heaths or Epacrids, and Proteaceæ.

In the open forest the Eucalypts are represented by some fifteen or sixteen species. The allied genera—*Angophora*, *Tristania,* and *Syncarpia*—are also present, though they may be only represented by one or two species. Other trees making up the open forest are various Wattles (*Acacia*), Honeysuckles (*Banksia*), She Oaks (*Casuarina*), Geebungs (*Persoonia*), Cypress Pines (*Callitris*), Native Cherry (*Exocarpus*), &c.

In some places on Stradbroke Island and a few localities on the mainland light rain-forests are found. In these species of *Moraceæ, Lauraceæ, Sapindaceæ, Euphorbiaceæ,* and other tropical types are moderately well developed. In places where the ground is a little more moist palms such as the Piccabin Palm (*Archontophœnix*) and the Cabbage Tree Palm (*Livistona*), particularly the latter, may be well developed.

Dr. Marks, Mr. Tryon, and Dr. Bradfield took part in the discussion which ensued, and a vote of thanks moved from the chair was carried by acclamation.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 29th October, 1934.

Ordinary Monthly Meeting, 29th October, 1934. Dr. D. A. Herbert in the chair, and about forty members and visitors present. The minutes of the previous meeting were read and confirmed. Mr. R. J. Donaldson was proposed for ordinary membership by Dr. E. O. Marks and Mr. Perkins.

Mr. E. M. Shepherd read a very interesting paper entitled "Notes on the Geological Structure at Nathan Gorge, in the Upper Dawson Valley."

Mr. W. M. Kyle exhibited a series of copies of pictures done in colours by colour-blind subjects tested in the psychological laboratory during the year. These pictures showed the errors usually made by red-green blind persons in greens and reds of all tints, browns, light-blues, and buffs. The interesting point is that there seems to be no constant factor governing colour-vision among colour-blinds.

Mr. H. A. Longman exhibited the skin and skull of a Polecat (*Mustela putorius*), which had been killed in the fowlyard at the residence of Mr. E. R. Pace, Hastings street, New Farm, on 18th

September, and sent to the Museum. This was an escapee from a series recently introduced to Queensland. He expressed the opinion that Polecats and allied races of ferrets might prove unmitigated pests, unless kept in captivity, and that their introduction should be prohibited.

Mr. S. T. Blake exhibited about twenty-five of the lesser known members of the Western Queensland grass flora. Two—*Cleistochloa subjuncea* and *Homopholis belsonii*—represent very recently described genera. The former is noteworthy on account of its peculiar solitary cleistogamous spikelets borne in the leaf sheaths. Five species of *Aristida* were shown, one of which, *A. arenaria,* or Mulga Grass, is one of the chief fodder grasses in some places. Some of the grasses of secondary importance in the Mitchell grass pastures as well as some more typical of sandy country were also shown.

Professor L. S. Bagster exhibited sections of two brass condenser tubes of similar chemical composition, together with microphotographs showing their crystalline structure. One tube, which had corroded badly in use, showed coarse crystals; the other less corroded tube had fine crystalline structure.

Dr. Livingston showed some specimens of odontomes and other various aberrations of growth of the teeth. He explained how the teeth develop in the jawbone, and how, by variations of the formative tissues, these conditions arise, and may vary from a bent root up to a multiple tangle of tissues.

Mr. T. A. Weddell exhibited a series of eleven photographs taken during recent investigational work on the grasshopper outbreak on the Western Downs country, together with an insect case containing specimens and illustrations of the essential life history stages of the species concerned (*Calataria terminifera* Walk.). The photographs included typical views of the infested territory, and showed swarm formations and the slight migratory habit of the older hoppers. The positive phototropic response of the hoppers was also demonstrated by the photographs. Mr. Weddell briefly reviewed the grasshopper position and the measures that are being adopted for coping with the outbreak.

Dr. F. W. Whitehouse, Mr. F. Bennett, Professor Richards, Dr. Marks, Mr. I. Jones, Dr. Livingstone, Mr. Tryon, and the Chairman took part in the discussion on the paper and the exhibits.

F. A. PERKINS, Hon. Secretary.

Abstract of Proceedings, 26th November, 1934.

Ordinary Monthly Meeting, 26th November, 1934. The President, Mr. J. S. Just, in the chair, and about ninety members and visitors present. The minutes of the previous meeting were read and confirmed. Apologies were received from Prof. Richards and Dr. J. J. C. Bradfield. Mr. R. J. Donaldson was unanimously elected an ordinary member of the Society. The following were proposed for ordinary membership:—Mr. J. Mann, by Messrs. Hitchcock and Perkins; Dr. C. Thelander and Mr. F. de Visme Gipps, by Mr. Longman and Dr. E. O. Marks; and Miss U. McConnel, M.A., by Mr. Just and Dr. Marks.

The business of the evening was a very interesting address, illustrated by lantern slides, by Miss Ursula McConnel, the subject being "The Place of Drama and Ritual in Wikmunkan Society."

A vote of thanks moved by Mr. Longman and Dr. Hamlyn Harris and supported by Messrs. Bleakley and Bennett and Dr. J. V. Duhig was carried by acclamation.

Abstract of Proceedings, 3rd December, 1934.

A special meeting was held in the Geology Lecture Theatre of the University at 8 p.m. on 3rd December, 1934. The President, Mr. Just, in the chair, and about fifty members and visitors present. Apologies were received from Profs. Richards and Murray, Dr. Herbert, and Mr. Graham. The following were proposed for ordinary membership:—Dr. Graham Brown and Dr. Clifford Croll, by Mr. Longman and Dr. Marks; and Mr. St. G. Thorn, by Messrs. Smith and Perkins.

The business of the evening was a very interesting address entitled "Tick Fevers (Piroplasmic Diseases) of Cattle in Queensland," by Dr. J. Legg.

A vote of thanks moved by Prof. Goddard and supported by Mr. Henderson and Dr. Gilruth was carried by acclamation.

Publications have been received from the following Institutions, Societies, etc., and are hereby gratefully acknowledged:—

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