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APPENDICES.

An Outline of a Theory of the Genesis of Protoplasmic Motion and Excitation.

By T. Brailsford Robertson, B.Sc.

From the Physiological Laboratory of the University of Adelaide.

Communicated by E. C. Stirling, M.D., F.R.S.

[Read April 4, 1905.]

Contents.

Introduction.

As far as I have been able to ascertain from the literature to which I have access, the theory which is put forward in this paper has not hitherto been propounded, at least in its entirety.

A number of authors have acknowledged the importance of surface tension in the vital processes of an organism,* but

* Butschli (Protoplasm and Microscopic Foams: Trans. by E. A. Minchin, 1894, page 289) gives an account of various theories as to the influence of surface tension upon the movements of organisms which had been put forward up to that date. In the same work he develops his own theory, which, however, is quite different in principle from mine.

the influence of electrolytes upon the surface tension, taken in conjunction with the ion-proteid theory, does not appear to have been worked out. Loeb* alludes to his conviction that the electrical energy of the ions in an electrolyte is transformed into surface energy at the surface of an organism suspended in it: but, as far as I have read his writings, he does not explain how this is accomplished, nor does he apply the idea. Mann† suggests that the electrical charge on colloid particles in solution may be due to the formation of definite compounds between the colloid and one or other of the ions in the solution, an hypothesis of which I make frequent use throughout this paper. Strong‡ has developed a theory of the nervous impulse, which regards it as due to free ions in the nerve, but as he does not adopt the ion-proteid theory he is forced to make assumptions—such as the semi-permeability of proteid to certain ions—which render his theory of very limited application.

I had already written the greater part of this paper when the *American Journal of Physiology* for March, 1904, arrived, containing Lillie's paper § on the toxic and anti-toxic effects of certain salts. In this he suggests that certain phenomena of movement in unicellular organisms may be due to surface tension alterations, due to ions in the medium, and he uses the analogy of the capillary electrometer: but, as far as contractility is concerned he does not appear to have applied the idea or to do more than throw it out as a suggestion: that is, so far as my acquaintance with his writings goes. Still more recently, Matthews' paper ‖ on the nature of chemical and electrical stimulation has appeared. In this he does not profess to give an explanation of the physico-chemical mechanisms of protoplasmic movement and excitation. Nevertheless, he concludes, as I do, "that the chemical composition of the ion is of little importance compared with the importance of its electrical condition." ¶ He also considers that electrical stimulation "is due simply to the accumulation of negative

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* Jacques Loeb: American Journal of Physiology, 1902, ii., page 411.

† Gustav Mann: Physiological Histology: Methods and Theory, 1902, pages 45 and 46.

‡ W. M. Strong: A Physical Theory of Nerve. Journal of Physiology, 1900, vol. xxv., page 427.

§ Ralph S. Lillie: The Relation of Ions to Ciliary Movement. American Journal of Physiology, March, 1904.

‖ The Nature of Chemical and Electrical Stimulation: 1. The physiological action of an ion depends upon its electrical state and its electrical stability. A. P. Matthews: American Journal of Physiology, August, 1904.

¶ American Journal of Physiology, vol. xi., No. 5, page 456.

or positive ions in different places in the tissue, or, in other words, to differences in concentration of the ions." *

These are the only important allusions to theories similar to mine which I have been able to find; but, as the literature to which I have access is limited, my apologies are due to any authors whose published theories I may have put forward as original.

I do not, by any means, regard the whole of the hypotheses and deductions put forward in this paper as proved. Indeed, this paper is rather to be looked upon as providing an outline to be in the future corrected and filled in by an extended series of experimental investigations. My theory of chemotaxis, put forward in section 3, and some of my views on the propagation of excitation in muscle, put forward in section 6, are, however, upon a somewhat different footing, inasmuch as they already receive strong support from the experiments described in these sections, on infusoria, on the one hand, and on the intestine of a fly, on the other. I may state that I am about to bring forward strong experimental evidence in support of my views in section 13 of this paper on rhythmicity in muscle, and, at the same time, of those in sections 6 and 7, on the influence of the *mass* of ions upon the formation of ion-proteids in excitable tissues. I also hope before long to publish further experimental evidence touching my views on the transmission of excitation, and also further experiments on chemotaxis.

In concluding these introductory remarks, I desire to express my gratitude to Professor E. C. Stirling, F.R.S., for his suggestions, for facilities afforded me for experiments, and for the interest which he has taken in the preparation of this paper, and in the experiments; to Dr. C. J. Martin, F.R.S., and to Mr. J. A. Craw, for the care with which they read the paper and for their criticisms; to Professor W. H. Bragg, for a valuable criticism; and to Mr. W. Fuller for his advice and practical assistance in some of the experiments. This paper was written nearly a year ago, but, owing to its having been put into the hands of others, at a distance, for their consideration, its publication has been delayed.

1.—Contact Difference of Potential between Electrolytes and its Influence upon Surface Tension.

It is a well-known fact that when two electrolytes, or two solutions of different concentration of the same electrolyte, are in contact, there is a difference of electric potential between their bounding surfaces, just as there is a difference

* American Journal of Physiology, vol. xi., No. 5, page 457.

of potential at the contact surface of two metals, or of a metal and an electrolyte. Nernst explained the difference of potential existing between two solutions of the same salt when the concentrations differ by the ionic theory. If a strong solution of hydrochloric acid is in contact with pure water the acid will diffuse into the water. But, since the hydrions and chloridions are capable of independent motion—the velocity of the hydrion being greater than that of the chloridion—the hydrions will travel faster into the water than the chloridions. But the hydrions carry a positive charge, while the chloridions carry a negative charge; hence the water becomes positively charged owing to an excess of hydrions and the acid solution negatively charged owing to an excess of chloridions. In such a case as this, however, as the process goes on and the water becomes positively charged, an electrostatic repulsion will be produced, tending to retard the incoming hydrions and to accelerate the chloridions. This will go on until the electrostatic repulsion is so great as to cause the hydrions and chloridions to move into the weaker solution at the same rate. As the diffusion goes on the number of ions in the weaker solution will increase, and hence the tendency of the ions to diffuse in from the stronger solution will decrease, and the electrostatic repulsion necessary to maintain the equal velocities of the incoming hydrions and chloridions will diminish. Hence the contact difference of potential will, in this case, diminish as the concentrations of the two solutions approximate to each other.

It is on this principle that Lippmann and von Helmholtz explained the working of the capillary electrometer, and as we shall have to consider an analogous explanation of certain vital phenomena, it may be as well to glance at the method by which the capillary electrometer re-acts to electrical forces. The capillary electrometer in its simplest form consists of a capillary tube in which mercury and sulphuric acid meet. The end of the tube dips into the sulphuric acid, which rises to a point where it is in equilibrium with the mercury, which descends the tube under a certain pressure. At the meniscus there will exist a contact difference of potential; and, since the mercury and the sulphuric acid solution are both conductors, the difference of potential will lead to an accumulation of electricity on the two sides of the bounding surface. The mercury is positive to the solution, and therefore the double layer of electricity at the bounding surface consists of positive electrification on the mercury side and negative electrification on the solution side. If T be the observed surface tension of the surface separating two media, and the area of this surface is increased by an amount S, the work which is done is S T. Now, the surface of separation between the mercury and acid solution with its double layer may be regarded as a condenser of which the two armatures are charged to a potential difference E, where E is the contact difference of potential between the mercury and the solution.

In any condenser of which the plates are kept at a constant difference of potential, the electrical forces tend to *increase* the capacity of the condenser, and hence, in the case of this double layer, there is a tendency for the area of the double layer to increase. That is to say, that on account of the electrical forces the area of the surface of separation between the mercury and the solution tends to increase, so that the electrical forces reduce the amount of work which has to be done against the surface tension when the area of the surface of separation is increased. Thus, if T^1 is the value the surface tension would have, supposing no electrical double layer were present, the work done in increasing the area of the surface of separation by an amount S would be S T^1. Therefore, S T, the actual amount of work done, is less than S T^1, the amount of work which would have been done if no electrical double layer existed, by the amount of work done by the electrical forces owing to the increase in capacity of the double layer. Thus, T, the observed surface tension, is less than T^1, the surface tension if no double layer were present.

"Suppose the contact difference of potential between the mercury and the solution be E, the mercury being at the higher potential. Then, if an external E M F be applied so that the wire X" (leading to the mercury) "is positive, the difference of potential between the mercury and the solution will be greater than E by the amount of the applied E M F, and hence the charges on the double layer will be increased, so that the surface tension will be decreased, and to keep the meniscus in its sighted position the head of mercury . . . must be reduced. If, however, the applied E M F is in such a direction that it acts in the opposite direction to the contact difference of potential at the meniscus, then the strength of the double layer will decrease, and hence the surface tension will increase. This increase will go on till the applied E M F is exactly equal, and opposite to the contact difference of potential, for when this occurs there will be no double layer, and hence the surface tension will possess the value which it would have if no electrical charges were present. If the applied E M F is further increased, then a double layer will again be formed, but with the negative charge on the mercury side. This inverted double layer will cause a decrease in the surface tension, since the presence of such a double layer must decrease the surface tension, whichever side is positive. Hence, by applying an external E M F, so as to make the mercury negative, and increasing it till the surface tension, as indicated by the pressure which has to be applied to bring the meniscus to its sighted position, is a maximum, will be exactly equal and opposite to the contact difference of potential between the mercury and the sulphuric acid solution. In this way Lippmann found that the contact difference of potential between mercury and sulphuric acid solution was about 1 volt."*

2.—The Ion-Proteid Theory.

This theory, due to Loeb, is that when an ionised electrolyte diffuses into protoplasm the ions after this diffusion do not remain dissociated, but that they enter into loose combination with some proteid constituent of the protoplasm, this compound being known as ion-proteid. Loeb has brought forward many facts in support of this view,† which we need not enter into here, as we shall find many even more cogent reasons for adopting it in the sequel. I will only quote, after Loeb, a statement made by Dr. W. Pauli, of Vienna:—"We cannot doubt the general existence of ion-proteid compounds in the living organism. We have even urgent reasons for assuming that all the proteids of the protoplasm exist there only in combination with ions." Thus it would appear that the bulk of protoplasm is formed of ion-proteid compounds, and, indeed, it seems probable that they represent the culminating point of anabolism. We shall see the reasons for this view later.

If this be true, then it follows that, owing to metabolism and to dissociation analogous to the dissociation into ions of electrolytes, a number of these ions must, in general, exist in the protoplasm in a dissociated state, so that there will, in general, be a contact difference of potential between any protoplasmic body and the (liquid) medium in which it is suspended. This has been directly proved by W. B. Hardy‡ in the case of particles of albumin suspended in acid and alkaline solutions. He states his conclusions thus:—"The proteid particles, therefore, have this interesting property: that their electrical characters are conferred upon them by the nature of the re-action, acid or alkaline, of the fluid. If the latter

* Watson: Textbook of Physics, 1900, page 814.

† *Vide* On Ion-proteid Compounds and their *rôle* in the Mechanics of Life Phenomena. American Journal of Physiology, 1900.

‡ On the Coagulation of Proteid by Electricity. Journal of Physiology, June, 1899.

is alkaline the particles become electro-negative and *vice versa.*"

It must be assumed that the ion-proteid is highly unstable in the presence of an excess of ions, and that therefore the nature of the ion-proteid formed depends upon the proportions of the ions present. If this be granted (and we shall see that it is an indispensable assumption in accounting for the various phenomena observed in muscle and nerve) we can at once see that the reason for the proteid particles becoming electro-positive in an acid solution is the high velocity of the hydrion which is the characteristic ion of acids; for far more kations are diffusing into the proteid particle than anions, and therefore the ion-proteid formed is, for the greater part, kation-proteid, and the particle becomes positively charged. Similarly, in alkalies the fastest ion is the anion, and therefore the proteid particles become electro-negative when the solution is alkaline.

3.—The Chemotaxis and Galvanotaxis of Unicellular Organisms.

We have now to consider the application of the principles which we have enunciated to unicellular organisms. We have seen that it is a characteristic of the proteid part of the ion-proteid molecule that it readily forms compounds with any ions which happen to be present in excess, while Hardy's experiments, referred to in the last section, show that the electrical character of the resulting ion-proteid depends upon the relative velocities of the ions in the solution in which the proteid is suspended. In the first case, consider the effect upon a unicellular (amœboid) organism of a constant current in the direction shown in the diagram (A = Anode, K = Ka-

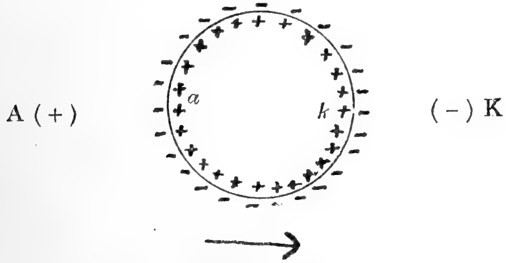

Figure 1.

thode), the organism being supposed to be laden with kation-proteid by virtue of the metabolism and dissociation of which a difference of potential is maintained between the protoplasmic surface and that of the medium (indicated by the small + and − signs).*

Just as in the analogous case of the capillary electrometer (section 2), the effect of a current travelling from A to K will be to *diminish* the contact difference of potential at points such as *a*, which form the physiological anode, and to *increase* it at points such as *k*, which form the physiological kathode.

Therefore, as we have seen (section 2), the effect will be to *increase* the surface tension at points such as *a*, and to *decrease* it at points such as *k*. The surface, and, consequently, the volume on the kathodic side of the organism will therefore *increase*, while on the anodic side they will *decrease*. The organism will, therefore, move over towards the kathode, as indicated by the arrow—it will be "negatively galvanotactic." Consider now the effect of a similar current upon a "negative" amœboid organism; that is, one which is laden with anion-proteid, so that the difference of potential between the protoplasmic surface and that of the medium is as represented in the diagram. In this case the contact difference of potential will be *increased* at the physiological

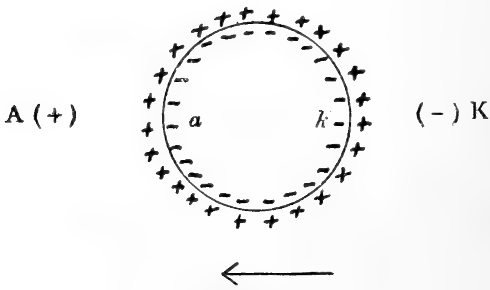

FIGURE 2.

anode, and *decreased* at the physiological kathode: hence, reasoning as before, the organism will move towards the *anode* —it will be "positively galvanotactic." The effects upon ciliated organisms will be similar, for if the diagram represents one of the cilia of a "positive" organism subjected to a constant current in the sense indicated, the P.D. (difference of

* As such organisms are electro-positive to the solution in which they are suspended, I will in the future distinguish them as "positive," those which are laden with anion-proteid being designated "negative."

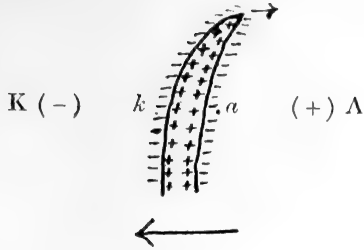

FIGURE 3.

potential) at the surface forming the physiological anode will be diminished, and that at the physiological kathode increased; hence the former surface will diminish owing to the increased surface tension, and the latter will increase; hence the cilium will bend towards the anode, as indicated by the small arrow, and the organism will be propelled towards the kathode —it will be "negatively galvanotactic." The effect of the same current on a "negative" ciliated organism will, of course, be the reverse. Hence, we may formulate the rule that *"positive" organisms will be attracted to the kathode, and "negative" organisms to the anode.* When a very strong current is passed, the lowering of the surface tension at kathodic points in a "positive" organism or at anodic points in a "negative" organism may be so excessive that the parts of the surface no longer cohere, and the organism breaks up. This is the explanation of the disintegration of certain organisms under the action of a constant current, *e.g.*, Pelomyxa.* The effect of the constant current upon organisms which are neither "negative" nor "positive"—that is, which are equally loaded with anions and kations—must obviously be *attraction to both electrodes*, since a contact P.D. would be artificially produced at both surfaces; thus, such organisms would not exhibit any marked preference for either electrode. We have now to consider the effects of chemical re-agents upon these organisms.

From the point of view of the theory which I have put forward, the phenomena of chemotaxis must be attributed to the diffusion of the ions in the re-agents into the protoplasm in different proportions. Consider the effect upon a "positive" amœboid cell (A, Fig. 4), of a salt such as KCl, in which the kation has a greater velocity than the anion, diffusing from a capillary (B). Since the quicker-moving kations will diffuse faster than the anions, more kations will enter the

* Verworn: General Physiology: Trans. by Frederic S. Lee, page 419.

organism, in a given time, than anions; that is, the contact P.D. at points such as *a* (Fig. 4), will be augmented, and

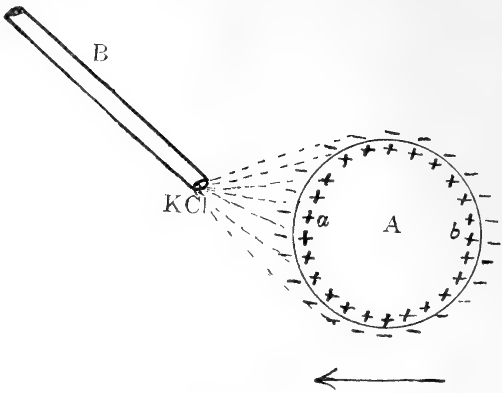

FIGURE 4.

at points such as *b* unaffected or much less augmented (since the concentration of the KCl is as the inverse square). Hence the surface tension at *b* will be greater than that at *a*, and the organism will move *towards* the capillary.

With a salt like $CaCl_2$, in which many more anions would enter the organism, in a given time, than kations, the reverse would be the case.

If the organism were "negative" the above effects would be reversed.

Of course, leaving a "positive" organism within the sphere of influence of $CaCl_2$ for a sufficient time would convert its initial repulsion from the $CaCl_2$ into attraction, for the organism would become "negative" owing to the excess of anions entering from the $CaCl_2$. Similarly, a "negative" organism, exposed for too long a time to the influence of a re-agent in which the kations move faster than the anions (*e.g.*, KCl, or an acid) would become "positive."

"Isotactic" organisms—as we may call those organisms which are equally loaded with anions and kations—would, of course, be attracted by both kinds of re-agents, for an artificial P.D. would be established on the side nearest the re-agent, and the surface tension therefore decreased at those points; but, as this P.D. would be very small except in organisms quite close to the capillary, such organisms would exhibit no marked re-action.

The theoretical results at which we have arrived may be tabulated as below:—

State of Organism.	Nature of Re-agent.		Galvanotaxis.
	Kation faster than Anion.	Anion faster than Kation.	
Positive	Attraction	Repulsion	Attraction to Kathode
Negative	Repulsion	Attraction	Attraction to Anode
Isotactic	Attraction	Attraction	Attraction to Anode and Kathode

The stimulation effect of a re-agent will be proportional to the difference of potential between the organism and the medium. This will be $= k \dfrac{\frac{u}{y_1} - \frac{v}{y_2}}{u + v} \log._e \dfrac{c_2}{c_1}$. Where k is a constant (the temperature being constant), u and v are the velocities of the kation and anion respectively, y_1 and y_2 are their valencys respectively, and c_2 and c_1 are the concentrations of the electrolyte in the medium and in the organism respectively.* If $\dfrac{c_2}{c_1}$ be constant, and it is probably nearly so when equivalent solutions are used throughout, we have that the stimulation effect of an electrolyte is proportional to $\dfrac{\frac{u}{y_1} - \frac{v}{y_2}}{u + v}$, which we may call the "stimulation efficiency" of the electrolyte.† Since $\dfrac{v}{u + v}$ is Hittorf's "transport number," and is usually denoted by n, the stimulation efficiency may also be expressed by $\dfrac{1 - n}{y_1} - \dfrac{n}{y_2}$, which reduces to $1 - 2n$, if the ions are mono-valent.

We cannot assume, it is true, that the stimulation effects of different re-agents will be strictly proportional to their

*Vide Whetham: A Treatise on the Theory of Solution, 1902, page 382.

† I originally defined the "stimulation efficiency" as $\dfrac{u - v}{u + v}$ which, of course, is only true for univalent ions. I am indebted to Mr. J. A. Craw for the above correction.

"stimulation efficiencies" partly because it is uncertain whether $\frac{c_2}{c_1}$, referred to above, is constant, and also because of the ion-proteid already present in the organism, the influence of which will be to lessen or to increase the effect of the testing re-agent. Still, the "stimulation efficiency" of a re-agent will serve as a rough index of its probable effect, and I therefore append a rough table of the re-agents most commonly used as stimuli in physiology, with their ionic velocities and "stimulation efficiencies," the sign + before the stimulation efficiency denoting attraction of a "positive" organism, and the sign − attraction of a "negative" organism.

If the stimulation efficiency be calculated from the ionic velocities it will not be accurate except for very dilute, completely ionised, solutions. A more accurate method is to calculate the stimulation efficiency from the value of the transport number n, at the dilution which we are using. But, in order to make the table more general, I have, except in the cases of the carbonates and $MgCl_2$, calculated the stimulation efficiency from the ionic velocities. It is necessary to bear in mind, however, that solutions of a salt formed by the neutralisation of a strong base by a weak acid, as, for example, Na_2CO_3, always contain OH ions, which have a very high velocity, and which tend to render the stimulation efficiency negative. Finally, in order to observe any proportion between the stimulation effects of different re-agents we must use equivalent solutions. The ionic velocities of Cu, Ba, Ca, SO_4, and Ag, in the accompanying table, are taken from the results given by W. C. D. Whetham in the Philosophical Transactions of the Royal Society.* Those of Cl and I are from Kohlrausch's results, quoted by Whetham.† Whetham found that his results, obtained by a direct method, corresponded very closely with Kohlrausch's. Those of K, Na, Li, H, NO_3, and OH are from Kohlrausch's results quoted by Watson.‡ The stimulation efficiencies of K_2CO_3, Na_2CO_3, and $MgCl_2$ are calculated from the transport numbers for dilute solutions (·029, ·093, and ·087 equivalent gramme molecules per litre respectively) given in Fitzpatrick's "The Electro-Chemical Properties of Aqueous Solutions."§

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* Vol. clxxxiv. A, page 337; and vol. clxxxvi. A, page 507.

† *Ibid.*

‡ Textbook of Physics, 1900, page 798.

§ British Association Report, 1893. Reprinted by Whetham in his Theory of Solution and Electrolysis.

The re-agents are in the order of their "stimulation efficiencies."

TABLE OF STIMULATION EFFICIENCIES.

Substance.	Velocity of Kation in Centimetres per Second.	Velocity of Anion in Centimetres per Second.	Stimulation Efficiency.
H_2SO_4 ...	320×10^{-5}	45×10^{-5}	+ ·815
HCl ...	320×10^{-5}	53×10^{-5}	+ ·716
HNO_3 ...	320×10^{-5}	64×10^{-5}	+ ·667
K_2CO_3 ...	—	—	+ ·547
K_2SO_4 ...	66×10^{-5}	45×10^{-5}	+ ·392
Na_2CO_3 ...	—	—	+ ·289
Na_2SO_4 ...	45×10^{-5}	45×10^{-5}	+ ·250
KCl ...	66×10^{-5}	53×10^{-5}	+ ·109
KI ...	66×10^{-5}	60×10^{-5}	+ ·048
KNO_3 ...	66×10^{-5}	64×10^{-5}	+ ·015
NaCl ...	45×10^{-5}	53×10^{-5}	− ·082
$CuSO_4$ ...	31×10^{-5}	45×10^{-5}	− ·092
$AgNO_3$ ...	49×10^{-5}	64×10^{-5}	− ·133
NaI ...	45×10^{-5}	60×10^{-5}	− ·143
$NaNO_3$ ...	45×10^{-5}	64×10^{-5}	− ·174
LiCl ...	36×10^{-5}	53×10^{-5}	− ·191
$BaCl_2$ ...	39×10^{-5}	53×10^{-5}	− ·364
$CaCl_2$ ...	35×10^{-5}	53×10^{-5}	− ·403
$CuCl_2$ ...	31×10^{-5}	53×10^{-5}	− ·446
KOH ...	66×10^{-5}	182×10^{-5}	− ·468
$MgCl_2$ ...	—	—	− ·517
NaOH ...	45×10^{-5}	182×10^{-5}	− ·604
LiOH ...	36×10^{-5}	182×10^{-5}	− ·670
$Ba(OH)_2$ ...	39×10^{-5}	182×10^{-5}	− ·735
$Ca(OH)_2$ ...	35×10^{-5}	182×10^{-5}	− ·758

The third decimal place in the column of stimulation efficiencies is the nearest approximation.

To test the conclusions arrived at in this section, it is necessary to ascertain the state, "positive" or "negative," of the organism, and then to test its re-actions to various re-agents, and to the constant current, under the same conditions.

This appears not to have been done hitherto. H. H. Dale, it is true, has made investigations of this nature,* but he nearly always uses acetic acid in his media or in his test

* Journal of Physiology, 1901, vol. xxvi., page 291.

solutions. For our purposes this choice is most unfortunate, as the dissociation of acetic acid is very small, even in dilute solutions; indeed, it is only half dissociated when the solution contains only about two parts of acetic acid per million.* Moreover, the amount of hydrion due to acetic acid is greatly reduced on its diffusion into a medium containing highly ionised salts (as was the case in Dale's experiments), while the acetanions are not correspondingly reduced, and the resultant proportions of ions depend upon the electrolytes into which it is diffusing.† Hence the theoretical effects of acetic acid are highly uncertain, and this corresponds with the uncertainty of Dale's results. Such sources of ambiguity do not arise when we use strong acids in dilute solution and perfectly ionised solutions of salts. A number of other investigators have tested the effects of various re-agents upon unicellular organisms, but as they did not previously ascertain the nature of the ions in the medium in which the organisms were tested their results tell us nothing with regard to this theory. I therefore carried out a series of experiments with a view towards systematically testing the accuracy of the conclusions put forward in this section. The organisms used were the infusoria in the large intestine and rectum of a frog *(Ranaodea aurea)*. Four species were found and used in these experiments, namely:—1. A species of *Spirostomum*, closely resembling, if not identical with, *S. ambiguum*. 2. A species of *Opalina*, probably *Opalina ranarum*. 3. A large disc-shaped species, more than half the length of *Spirostomum sp.*, and nearly as wide as it is long, much flattened laterally, endoplasm in front of the mouth, triangular in shape, slightly recurved. 4. A much smaller species, only about half the length of *Opalina sp.*, but otherwise resembling the last-mentioned species. The two latter species, in the absence of any expert knowledge of the subject, I am unable to name. I will, therefore, designate them, respectively, species A and species B.

A cell of wax was made on a glass slide. It measured about $\frac{3}{4}$ in. square, and the walls were about 1 millimetre deep. In two opposite walls of the cell were grooves, which were the same depth as the walls. A small portion of the intestinal or rectal contents was placed in the cell, and a large drop of a given solution, the medium, was placed in the cell with it. This was left for a varying period, and then a cover-glass was placed on the cell, any spaces in the cell being

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* Walker: Introduction to Physical Chemistry, third edition, page 236.

† *Vide* Walker: Introduction to Physical Chemistry, third edition, pages 304 and 316.

filled up with some more of the solution. Capillaries containing the test-solutions were then inserted through the grooves, so as to project slightly into the cell, and the remainder of the capillary was sometimes slightly raised by resting it on slips of paper, in order to aid diffusion by gravity. The various parts of the cell, etc., are indicated in the diagram (Fig. 5). The cell was then examined under the low power of a microscope, or with a magnifying glass.

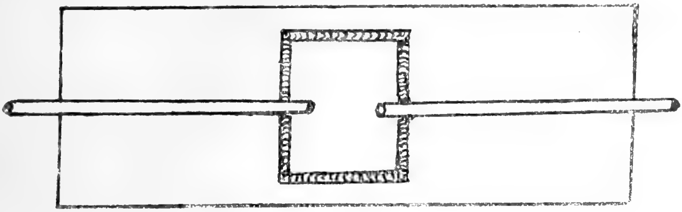

FIGURE 5.

The object of placing the organisms first in a known medium was to ensure their being "positive" or "negative," as desired. Thus an organism which had been placed for ten minutes in a decinormal solution of KCl would be positive, owing to the excess of kations which had entered it; and its reaction, if our reasoning has been correct, should be attraction to a solution with a positive stimulation efficiency, and repulsion from a solution with a negative stimulation efficiency. Of course, it is quite uncertain what salts have been introduced with the rectal contents, but as the proportion of rectal contents in the cell to the volume of the medium was, in each experiment, small, the influence of the introduced salts was negligible. The results of the experiments, as the accompanying table shows, are in entire harmony with the theory I have put forward—in every case the theoretical and actual results are the same. Experiment No. 14 might be thought to be an exception, but when we remember the extremely low stimulation efficiency of KNO_3, and that its effect might be very easily neutralised by small quantities of salts with negative stimulation efficiencies introduced with the rectal contents we see that the organisms, in this case, were very probably isotactic. It will also be observed that the re-action always takes place quickly when media with a high stimulation efficiency were employed; and delay, as in experiment No. 9, only occurred when the stimulation efficiency of the medium was low. As there were generally individuals of more than one species in the cell, some of the results were obtained simultaneously, *e.g.*, experiment No. 3 gave results for *Spirostomum*, *Opalina*, and species B.

No. of Experiment.	Organism.	Medium.	Tested with	Re-Action.	Remarks.
1	*Spirostomum*	$\frac{N}{10}$KI	$\frac{N}{50}$HCl and $\frac{N}{50}BaCl_2$	Attraction to HCl and repulsion from $BaCl_2$	The specimens were washed in $\frac{N}{10}$NaCl and then placed in $\frac{N}{10}$KI for a few minutes—they formed a thick cluster in the HCl capillary almost at once, the space about the $BaCl_2$ capillary being left free.
2	*Spirostomum*	$\frac{N}{10}$KI	$\frac{N}{50}$HCl and $\frac{N}{50}BaCl_2$	Attraction to HCl	The specimens were placed in $\frac{N}{10}$KI and left for 1 hr. 5 min., then tested with $\frac{N}{50}$HCl and $\frac{N}{50}BaCl_2$, the organisms formed a thick semicircular cluster some distance from the $BaCl_2$ tube, some entered the HCl tube. Left the capillaries in the chemotaxis cell for 1 hour. The infusorians had formed a thick cluster in the acid tube, and a few had entered the $BaCl_2$ tube. On testing with litmus the contents of both tubes were acid, but those of the HCl tube much more acid than those of the $BaCl_2$ tube.

3	*Spirostomum*	$\frac{N}{10}$ KCl	$\frac{N}{10}$ HCl and $\frac{N}{10}$ $BaCl_2$	Attraction to HCl and repulsion from $BaCl_2$	A small portion of the rectal contents was placed in $\frac{N}{10}$ KCl and left for half an hour, then tested with $\frac{N}{10}$ HCl and $\frac{N}{10}$ $BaCl_2$. The organisms were uniformly and thickly distributed through the cell at the beginning of the experiment Within 5 mins. the half of the cell into which the acid capillary was inserted was distinctly more thickly populated than the half into which the $BaCl_2$ capillary was inserted. In a quarter of an hour the whole of the $BaCl_2$ half of the cell was deserted, and in half an hour the organisms had formed a thick mass immediately in front of the HCl capillary. In three-quarters of an hour the acid tube was completely choked with infusoria for an inch of its length. Temperature, 27° C.
4	*Spirostomum*	$\frac{N}{10}$ NaCl	$\frac{N}{10}$ HCl and $\frac{N}{10}$ $BaCl_2$	Repulsion from acid—no marked attraction to $BaCl_2$	A portion of the contents of the same rectum as in the last experiment was placed in $\frac{N}{10}$ NaCl and left for 1 hr. 10 mins. Then tested with $\frac{N}{10}$ HCl and $\frac{N}{10}$ $BaCl_2$. The space round the mouth of the HCl tube remained clear even after 40 minutes. The space round the $BaCl_2$ tube was not markedly affected; the organisms swam freely round the mouth of the tube, and a few entered it, but they were not markedly thicker in this locality than in other parts. Temperature, 27° C.

No. of Experiment.	Organism.	Medium.	Tested with	Re-action.	Remarks.
5	*Spirostomum*	$\frac{N}{10}BaCl_2$	$\frac{N}{10}HCl$ and $\frac{N}{10}BaCl_2$	Repulsion from acid	Some of contents of rectum placed in $\frac{N}{10}BaCl_2$ for 40 minutes, then tested with $\frac{N}{10}HCl$ and $\frac{N}{10}BaCl_2$, marked repulsion from the acid at once. After half an hour the organisms had distinctly moved over to the $BaCl_2$ half of the cell, and the acid half contained only scattered individuals. At the end of 50 minutes a large area in front of the acid tube was completely clear of organisms and there was a thick cluster round the $BaCl_2$ capillary. Temperature, 27° C.
6	*Spirostomum*	$\frac{N}{10}KNO_3$	$\frac{N}{10}HCl$ and $\frac{N}{10}BaCl_2$	Attraction to acid and repulsion from $BaCl_2$	Some of contents of same rectum as in the previous experiment placed in $\frac{N}{10}KNO_3$, and left for 50 minutes, then tested with $\frac{N}{10}HCl$ and $\frac{N}{10}BaCl_2$. In 10 minutes the infusoria had crowded up the acid tube; in half an hour the $BaCl_2$ half of the cell was almost deserted, and the acid tube was choked up with infusoria. Temperature, 27° C.

7	*Spirostomum*	$\frac{N}{10}$KCl	$\frac{N}{10}$HCl and $\frac{N}{10}$KOH	Attraction to acid and repulsion from alkali	Some of contents of rectum placed in $\frac{N}{10}$KCl and left for half an hour, tested with $\frac{N}{10}$KOH and $\frac{N}{10}$HCl. After 5 minutes no infusoria were near the mouth of the alkali tube, and several had entered the acid tube, in front of which a number of infusoria had congregated. In quarter of an hour there was a marked clearance-area round the mouth of the alkali tube, and the infusoria were thickly congregated round the acid tube. After three-quarters of an hour the alkali half of the cell was absolutely deserted, while the acid half was thickly populated, the acid tube being choked up with *Spirostomum* and *Opalina* for about an inch. Temperature, 21° C.
8	*Spirostomum*	$\frac{N}{10}CaCl_2$	$\frac{N}{10}$HCl and $\frac{N}{10}$KOH	Attraction to alkali and repulsion from acid	Some of contents of rectum placed in $\frac{N}{10}CaCl_2$ and left for three-quarters of an hour, tested with $\frac{N}{10}$HCl and $\frac{N}{10}$KOH. The organisms were initially scanty, but active, and spread uniformly over the cell. In 10 minutes the space for some distance round the acid tube was quite clear, and there was a small cluster round the alkali tube, which was being continually added to by freshly arriving individuals. In 20 minutes the whole cell was deserted, except immediately in front of the alkali tube, where there was a thick cluster. Temperature, 21° C.

No. of Experiment.	Organism	Medium.	Tested with	Re-Action.	Remarks.
3	*Opalina*	$\frac{N}{10}KCl$	$\frac{N}{10}HCl$ and $\frac{N}{10}BaCl_2$	Attraction to acid and repulsion from $BaCl_2$	Contents of rectum in $\frac{N}{10}KCl$ for half an hour, then tested. The organisms were initially scanty but uniformly spread over the cell. In quarter of an hour none were left in the $BaCl_2$ half of the cell, and the organisms had formed a cluster round the mouth of the acid tube. In half an hour this cluster contained all the specimens of *Opalina* in the cell, and several had entered the tube. Temperature, 27° C.
6	*Opalina*	$\frac{N}{10}KNO_3$	$\frac{N}{10}HCl$ and $\frac{N}{10}BaCl_2$	Attraction to acid and repulsion from $BaCl_2$	Contents of rectum in $\frac{N}{10}KNO_3$ for 50 minutes, then tested. The *Opalina* were numerous but sluggish. In 10 minutes the organisms had crowded up the acid tube, and in half an hour the $BaCl_2$ half of the cell was deserted except for a few inert, apparently dead, individuals. Temperature, 27° C.
7	*Opalina*	$\frac{N}{10}KCl$	$\frac{N}{10}HCl$ and $\frac{N}{10}KOH$	Attraction to acid and repulsion from alkali	Contents of rectum in $\frac{N}{10}KCl$ for half an hour, then tested. After 5 minutes a clearance-area had been formed in front of the alkali tube, and there was a cluster in front of the acid tube. After three-quarters of an hour the alkali half of the cell was absolutely deserted, and there was a thick cluster round the mouth of the acid tube, into which many of the infusoria had entered. Temperature, 21° C.

9	*Opalina*	$\frac{N}{10}$KI	$\frac{N}{10}$HCl and $\frac{N}{10}$KOH	Repulsion from alkali—no marked attraction to acid	Rectum of frog left in tap-water overnight; some of contents then placed in $\frac{N}{10}$KI and left three-quarters of an hour, then tested. *Opalina* very sluggish—at first no marked re-action, but after 20 minutes the space in front of the alkali tube was for some distance clear of *Opalina*, except for a few inert, apparently dead, individuals. Temperature, 20° C.
10	*Opalina*	$\frac{N}{10}$NaCl	$\frac{N}{10}$HCl and $\frac{N}{10}$KOH	Attraction to alkali and repulsion from acid	Some of contents of same rectum as in previous experiment. Left in $\frac{N}{10}$NaCl for 55 minutes, then tested. Organisms numerous and fairly active. In 5 minutes there was a marked cluster round the alkali tube, and there was a clear space round the acid tube. In half an hour the acid half of the cell was deserted, and the alkali half thickly populated, especially just in front of the mouth of the alkali tube. Temperature, 20° C.
11	*Opalina*	$\frac{N}{40}Na_2CO_3$	$\frac{N}{10}$HCl and $\frac{N}{10}$KOH	Attraction to acid and repulsion from alkali	Rectum left 24 hours in tap-water; some of contents placed in $\frac{N}{40}Na_2CO_3$ which did not affect *Opalina* injuriously. Left for 10 minutes, then tested. The organisms immediately swam towards the acid tube, and within 2 minutes had formed a thick cluster in the mouth of the tube, while a dense cluster was formed just outside. The space round the alkali tube was almost clear, and the few individuals left there appeared dead, being motionless, and many of them contracted into a spherical form.

No. of Experiment.	Organism.	Medium.	Tested with	Re-Action.	Remarks.
12	*Opalina*	$\frac{N}{40}BaCl_2$	$\frac{N}{10}HCl$ and $\frac{N}{10}KOH$	Attraction to alkali and repulsion from acid	Some of contents of same rectum used in previous experiment placed in $\frac{N}{40}BaCl_2$, which did not affect *Opalina* injuriously. Tested in 10 minutes. Marked attraction to the alkali tube. Within 2 minutes several had entered the tube, and stopped there motionless, while a cluster of very active individuals had been formed in front of the tube. The acid tube was clear, and one or two individuals in its vicinity were motionless.
9	Species A	$\frac{N}{10}KI$	$\frac{N}{10}HCl$ and $\frac{N}{10}KOH$	Attraction to acid and repulsion from alkali	Rectum left in tap-water overnight; some of contents placed in $\frac{N}{10}KI$ and left three-quarters of an hour, then tested. Organisms of this species scanty. At first no marked re-action, but after 20 minutes there was a small cluster of this species round the mouth of the acid tube, and five minutes later a number of individuals had entered the tube. The space in front of the alkali was quite clear. Temperature, 20° C.

10	Species A	$\frac{N}{10}$ NaCl	$\frac{N}{10}$ HCl and $\frac{N}{10}$ KOH	Attraction to alkali and repulsion from acid	Some of contents of same rectum used in above experiment placed in $\frac{N}{10}$ NaCl for 55 minutes, then tested. Organisms of this species were scanty. In five miuutes several had gathered round the mouth of the alkali tube; in quarter of an hour the acid half of the cell was deserted, and there was a small cluster of this species round the mouth of the alkali tube which comprised all the individuals in the cell. Temperature, 20° C.
3	Species B	$\frac{N}{10}$ KCl	$\frac{N}{10}$ HCl and $\frac{N}{10}$ $BaCl_2$	Attraction to acid and repulsion from $BaCl_2$	Some of contents of rectum placed in $\frac{N}{10}$ KCl and left for half an hour, then tested. Organisms numerous. In a quarter of an hour the half of the cell into which the $BaCl_2$ tube was inserted was deserted and a thick cluster had formed in front of the acid tube. This cluster in half an hour contained all the individuals of this species in the cell, but none of them entered the tube. Temperature, 27° C.
6	Species B	$\frac{N}{10}$ KNO_3	$\frac{N}{10}$ HCl and $\frac{N}{10}$ $BaCl_2$	Attraction to acid and repulsion from $BaCl_2$	Some of contents of rectum placed in $\frac{N}{10}$ KNO_3 and left for 50 minutes, then tested. In 10 minutes all the infusoria of this species had gathered in front of the acid tube, the alkali tube being clear. Temperature, 27° C.

No. of Experiment.	Organism.	Medium.	Tested with	Re-Action.	Remarks.
7	Species B	$\frac{N}{10}$KCl	$\frac{N}{10}$HCl and $\frac{N}{10}$KOH	Attraction to acid and repulsion from alkali	Some of contents of rectum placed in $\frac{N}{10}$KCl and left for half an hour, then tested. In five minutes the space round the mouth of the alkali tube was deserted and the organisms formed a small cluster in front of the acid tube; in three-quarters of an hour this cluster contained all the individuals of this species in the cell and was much larger. Temperature, 21° C.
9	Species B	$\frac{N}{10}$KI	$\frac{N}{10}$HCl and $\frac{N}{10}$KOH	Attraction to acid and repulsion from alkali	Rectum left in tap-water overnight. Some of contents placed in $\frac{N}{10}$KI and left three-quarters of an hour, then tested. No marked reaction at first – but in about 20 minutes there was a small cluster of this species round the acid tube, while the space round the alkali tube was free from them. A quarter of an hour later a number of individuals had entered the acid tube. Temperature, 20° C.
10	Species B	$\frac{N}{10}$NaCl	$\frac{N}{10}$HCl and $\frac{N}{10}$KOH	Attraction to alkali and repulsion from acid	Some of contents of same rectum used in above experiment placed in $\frac{N}{10}$NaCl for 55 minutes, then tested. In five minutes the space round the acid tube was clear. In quarter of an hour there was a thick cluster round the mouth of the alkali tube. Temperature, 20° C.

13	Species B	$\frac{N}{10} Na_2CO_3$	$\frac{N}{10} HCl$ and $\frac{N}{10} KOH$	Attraction to acid and repulsion from alkali	Rectum left 24 hours in tap-water; some of contents placed in $\frac{N}{10} Na_2CO_3$ and tested in 10 minutes. Marked attraction to acid. In five minutes a cluster round acid containing all the individuals in the cell. Alkali free.
14	Species B	$\frac{N}{10} KNO_3$	$\frac{N}{10} HCl$ and $\frac{N}{10} KOH$	No reaction	Rectum left 24 hours in tap-water; some of contents placed in $\frac{N}{10} KNO_3$, and tested in 10 minutes. No marked attraction for either tube, even after half an hour.
15	Species B	$\frac{N}{10} CaCl_2$	$\frac{N}{10} HCl$ and $\frac{N}{10} KOH$	Attraction to alkali and repulsion from acid	Some of contents of same rectum used in above experiment placed in $\frac{N}{10} CaCl_2$ and tested after 10 minutes. Marked attraction to alkali; in five minutes a small cluster had formed round the mouth of the alkali tube, while the space in front of the acid tube was clear.

It was found that *Spirostomum sp.* was an ideal species for these investigations, as it was not injuriously affected by the solutions, and was very active and sensitive to the test solutions. Species A and B were also uninjured by the solutions, but did not, as a rule, re-act quite so quickly as *Spirostomum sp.* *Opalina* was very liable to injury by decinormal solutions —the action of KCl and of NaCl in this respect was capricious—sometimes decinormal solutions appeared to kill the organisms, sometimes not. Decinormal solutions of Na_2CO_3, $CaCl_2$, and $BaCl_2$, were very injurious to *Opalina*, the two latter causing almost immediate disintegration, doubtless owing to their high stimulation efficiency causing excessive lowering of the surface tension. Decinormal KOH killed all the species and caused disintegration, doubtless, again, on account of its high stimulation efficiency.

The galvanotaxis of these organisms was also tested. The ordinary stimulation trough, with parallel sides of porous clay, described by Verworn,* was employed, and non-polarisable brush electrodes were used to lead in the current. The following results were obtained:—

1. Rectum of a frog left in tap water overnight. Some of contents placed in $\frac{N}{10}$ KCl in the stimulation trough and left for a quarter of an hour. Then tested with three two-volt storage cells. *Opalina* all dead. Species B numerous, their rotatory movements became slower and tended towards the kathode. In ten minutes the anodic half of the trough was deserted, and the kathodic half well populated, especially near the kathode.

2. Some of contents of same rectum placed in $\frac{N}{10}$ $CaCl_2$ for a quarter of an hour. *Opalina* all dead. Species B numerous. Tested with three two-volt storage cells. Organisms proceeded with an irregular, wavy motion towards the anode, and in a few minutes had formed a small cluster there, which remained unaltered. Several individuals, however, remained in the kathodic half of the cell.

3. Rectum left forty-eight hours in tap water. Some of contents placed in $\frac{N}{40}$ Na_2CO_3, and left for half an hour. Tested with ten two-volt storage cells. Organisms scanty, consisting of *Opalina* and species B. Both to kathode, the attraction of species B being hampered by its rotatory movements. In half an hour a small cluster had formed at the kathode.

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* **Verworn: General Physiology: Trans. by Frederic S. Lee, page 416.**

4. Some of contents of same rectum placed in $\frac{N}{40}$KI, and left for half an hour. Tested with ten two-volt storage cells. *Opalina* and species B, both to kathode. After half an hour still at kathode, where they had formed a small cluster.

Thus the results of these experiments on galvanotaxis in different media also go to support the theory I have put forward. In addition, it may be mentioned that the results of Dale's experiments in galvanotaxis go generally to support this theory.* Thus, *Balantidium duodeni* shaken into solutions of increasing acidity collected closely at the kathode when the solution contained ·02 per cent. HCl, the current being six pint bichromate cells. The same species in pure ·6 per cent. NaCl went to anode with moderate currents, and to kathode with twelve cells. The latter result I believe to be due to the acid liberated at the anode causing the organisms to become "positive." Dale also found that *Opalina* in ·6 per cent. saline and ·01 per cent. NaOH collected at the anode, and that *Nyctotherus* did the same when left in the solution for a sufficient time (ten minutes), and other instances, in which he used only specified inorganic solutions, will be noticed on referring to Dale's paper.

4. The Structure of Striated Muscle.

The following is extracted from Schäfer's "Essentials of Histology," sixth edition, page 102 :—"The sarcostyles are subdivided at regular intervals by thin transverse disks (membranes of Krause) into successive portions, which may be termed *sarcomeres;* each sarcomere is occupied by a portion of the dark stria of the whole fibre (sarcous element). The sarcous element is really double, and in the stretched fibre separates into two at the line of Hensen. At either end of the sarcous element is a clear substance (probably fluid or semi-fluid), separating it from the membrane of Krause. This clear substance is more evident the more the fibril is extended, but diminishes to complete disappearance in the contracted muscle. The cause of the change is explained when we study more minutely the structure of the sarcous element. For each sarcous element is pervaded with longitudinal canals or pores, which are open in the direction of Krause's membrane, but closed at the middle of the sarcous element. In the contracted muscle the clear part of the muscle substance has disappeared from view, but the sarcous element is swollen and the sarcomere is thus shortened ; in the uncontracted muscle,

* H. H. Dale: Galvanotaxis and Chemotaxis of Ciliate Infusoria. Journal of Physiology, 1901, page 291.

on the other hand, the clear part occupies a considerable interval between the sarcous element and the membrane of Krause, the sarcomere being lengthened and narrowed. The sarcous element does not lie free in the middle of the sarcomere, but is attached at either end to Krause's membrane by very fine lines, which may represent fine septa, running through the clear substance: on the other hand, Krause's membrane appears to be attached laterally to a fine membrane, which limits the fibril externally." Page 105:—"Comparing the structure of the sarcomere with that of the protoplasm of an amœboid cell, we find in both a framework (spongioplasm, substance of sarcous element), which tends to stain with haematoxylin and similar re-agents, which encloses in its meshes or pores a clear, probably semi-fluid, substance (hyaloplasm, clear substance of sarcomere), which remains unstained by these re-agents. In both instances, also, the clear substance or hyaloplasm, when the tissue is subjected to stimulation, passes into the pores of the porous subtance, or spongioplasm (contraction), whilst in the absence of such stimulation it tends to pass out from the spongioplasm (formation of pseudopodia, resting condition of muscle). Thus, both the movements of cell-protoplasm and those of muscle seem brought about by similar means, although at first sight the structure of muscle is so dissimilar from that of protoplasm. We have already noticed that the movements of cilia are susceptible of a similar explanation."

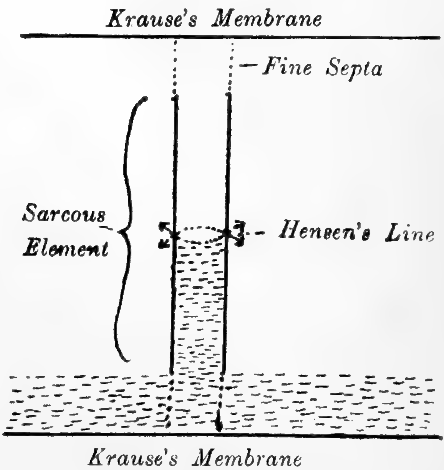

FIGURE 6.

It would thus appear that the structure of the sarcomere may be regarded as that represented in the diagram. If the walls of the sarcous element be elastic, it is obvious that the surface tension (T) of the fluid hyaloplasm would pull them in at all points along their surface of contact, while on diminution of the surface tension the sarcous element would swell in order to increase the surface of contact, and, since nothing but hyaloplasm is available to fill up the space thus created, hyaloplasm will flow *into* the sarcous element. If the surface tension is increased the operations would be reversed.

I am aware that histologists are not unanimous in adopting this theory of the structure of striated muscle, but it enables us to obtain a clear view of the influence of the surface tension of the hyaloplasm upon the contraction of muscle.

5.—The Contraction of Striated Muscle.

In order to explain the contraction of striated muscle we must assume *that there is a contact difference of potential between the spongioplasm and hyaloplasm, due to the presence of kation-proteid in the muscle.* That kation-proteid is present in striated muscle is demonstrated by the second part of Hermann's law, namely, that muscle becomes negative when dying, that is, that within the muscle there is an E.M.F. tending to produce a current *from* the dying points *to* the other points in the muscle.* If "when dying" be taken to mean "when injury of such a nature as to set up katabolism is applied" we may at once state that this is due to the liberation of kations by the decomposing ion-proteid.

Similarly, muscle becomes "negative" when excited to activity, because the excitation sets up katabolism, and kations are set free. We shall go more fully into the influence of the electric current upon the kation-proteid in the sequel; but, in passing, we may note Biedermann's statement that if the passage of a weak "polarising" current through muscle be continued, its excitability is first augmented and then diminished.† We can easily see that while the katabolic processes are being hurried up by the polarising current, any additional excitation will precipitate them the more easily because the ion-proteid is already partly decomposed, while, as the constant excitation and consequent katabolism continue the supply of kations becomes so diminished that it can no longer respond to the demands of additional excitation. That

* For an explanation of this confusion in physiological terminology, *vide* Waller: Human Physiology, 1896, page 388.

† Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 283.

such *continuous* excitation does take place during the passage of the polarising current is a conclusion definitely arrived at by Biedermann. He says:—"The electrical current sets up a process of excitation in striated, as in smooth, muscle throughout the duration of its passage."* Assuming, for the moment, what is about to be proved, namely, that the setting free of kations by the current is the *cause* of contraction, we see that the fact that maximal twitches are much higher with a constant than with an induced current† is due to the greater amount of decomposition of kation-proteid by the current which acts the longer time.

As to the nature of the kations which form the ion-proteid in the hyaloplasm of striated muscle, we can say very little. The effects of chemical re-agents on muscle show, as we shall see later, that simple metallic ions are capable of forming ion-proteids in muscle just as in unicellular organisms. Probably K and H ions play an important part—as it is well known that KH_2PO_4 is always formed when muscle becomes rigored—and, moreover, K salts predominate in the ash of muscle, Ca and Mg only being present in traces.‡

Now, it is evident that, since hyaloplasm is laden with kation-proteid, the result of its katabolism or dissociation must be the formation of an electrical double layer at the contact surface of the hyaloplasm and spongioplasm by the deposition of ions, just as in the case of the contact surface between the mercury and sulphuric acid solution in the capillary electrometer.

The action of a stimulus, such as an electric current, on muscle, is to set up katabolism at certain points in the muscle (*e.g.*, the kathode on make), and the consequence of this is, as we have seen, to cause "negativity" at such points in consequence of the kations set free. This "negativity" is transmitted, practically unaltered,§ along the muscle, and its mode of transmission will be discussed in detail in the sequel.

It remains to consider the effect of the progress of this area of high potential along the muscle. It will be, as expressed by Bernstein's "wave of excitation,"‖ to uninterrup-

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* Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 185.

† *Ibid.*, vol. i., page 176.

‡ Starling: Elements of Human Physiology, fifth edition, page 130.

§ Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 395.

‖ *Ibid.*, vol. i., page 374.

tedly raise the potential at each point in the muscle and uninterruptedly let it fall again. The effect of this will be (just as in the capillary electrometer when the potential on one side of the meniscus is raised) to diminish the surface tension at the contact surface of the spongioplasm and hyaloplasm owing to the increase in the P.D. between them.

Now, if we suppose the walls of the sarcous element to be elastic—the effect of the surface tension of the hyaloplasm will be to exert a pull inwards upon the wall—and therefore the walls are pulled in. To this pull the wall will offer a resistance owing to its elasticity. If these two forces are in equilibrium, increasing the surface tension will narrow the tube, while diminishing the surface tension will widen it. But widening this elastic tube must shorten it, just as an indiarubber tube when stretched longitudinally grows narrower, and when stretched laterally grows shorter. The sarcous element, in shortening, must exert a pull on the fine fibrils which, it is conjectured, attach them to Krause's membrane; hence, the two membranes of Krause are pulled together and the muscle contracts. Hence, since the "wave of negativity" must diminish the surface tension—*not* by deposition of ions, for in that case it would undergo excessive decrement, which it does not*—but by simply raising the P.D. between the hyaloplasm and spongioplasm it must give rise to a contraction.

6.—On the Propagation of Excitation in Nerve and Muscle.

We have seen that the hyaloplasm of striated muscle contains a kation-proteid owing to the presence and metabolism of which the surface of contact between the spongioplasmic sarcous elements and the hyaloplasm is always positively charged on the hyaloplasmic side, or, in physiological terminology, the surface of the hyaloplasm is always "negative" to that of the spongioplasm. When any breaking up of the kation-proteid takes place, kations must therefore be set free. Now, I have previously pointed out that the fundamental property of ion-proteid is that it is very unstable in the presence of ions, tending to form new ion-proteid compounds with any ions which may be present in excess; and, indeed, it is upon this property of the ion-proteid that the phenomena of contraction and irritability in living tissues depend. I may now throw this assertion into a more definite form, and state that when a certain minimal number of free ions (the number varying in different tissues) is present at any point in an excit-

* Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 395.

able tissue, the mass influence of these ions will be sufficient to displace the ions already holding the proteid molecule, and to take their place. Hence the kations set free in one section of an excitable tissue by excitation may in turn displace others in the next section of ion-proteid material, which again may set free ions in the following section, and so on, so that a wave of excitation is propagated through the tissue. Thus we conclude that the "wave of negativity" does not progress so much by diffusion as by a process of successive displacement.

The evidence for this fact will come out more clearly in the sequel, but we may allude to some of the facts supporting it now. Just as in muscle, we consider that there is present in the axis cylinder of nerve a kation-proteid which, by its katabolism under stimulation, gives rise to a wave of negativity, only, as in this case there is no elastic surface for ions to be deposited on, no contraction is evoked. Now, the excitatory state evoked in nerve by an intense stimulus is propagated more rapidly than that caused by a weaker one.* We can easily see that this must be due to the greater mass of kations set free initially; they would more easily and quickly set free other ions in each section (for it is the principle of mass action that the rate of chemical change depends upon the masses of the re-acting substances). This will be seen more easily when we come to consider the genesis of the discharge in the heart; but it is obvious that if the wave of negativity were propagated by mere diffusion, since the number of ions set free in no wise affects their velocity, the intensity of the stimulus could not affect the velocity of the excitatory wave.

Of a similar nature may possibly be the explanation of the fact that nerve cells conduct more slowly than nerve fibres.† The cross-section of a nerve cell is much greater than that of its fibre; hence at any moment the same number of ions would have very many more ion-proteid molecules to cope with than they had during their course in the fibre.

Another line of evidence supporting the theory we have put forward is the influence of various solutions of salts upon the transmission of excitation. If a portion of a conducting excitable tissue were immersed in a solution with a negative stimulation efficiency, and a wave of negativity initiated elsewhere, on passing through the immersed portion (if it travels by displacement) should either be diminished, abolished, or converted into a wave of positivity, according as little or

* Gotch: Schäfer's Textbook of Physiology, vol. ii., page 458.

† Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. ii., page 69.

much of the muscle-proteid was taken up by the anions of the solution. Of course, the wave of positivity thus produced, on issuing from the region immersed, would be converted into a wave of negativity again, owing to the anions displacing kations; but it would probably be reduced owing to some of the anions combining directly with kations. This idea receives support from the fact that nerves which have been immersed for a long time in salt solution, and are repeatedly stimulated, give a wave of positivity.* Still more suggestive is the fact that the excitatory state is often diminished when passing through a portion of nerve treated with NaCl—absolutely with a 6·1 per cent. NaI solution—though excitability is still present.† Thus the wave of negativity is, in the second instance, suppressed, as we have said it may be, though a wave may be started from the point affected by direct action of the current. The reason why the wave is so absolutely suppressed in the case of NaI is probably the high stimulation efficiency of NaI causing a great predominance of anions; as we shall see, the number of kations in a normal wave of negativity in medullated nerve is small.

It will be obvious that there is a difficulty in proving this point in nerve, because the wave of positivity in the affected region is converted into a wave of negativity directly it emerges. But our previous investigations into the contraction of muscle show that a wave of positivity cannot cause a contraction until it be converted into a wave of negativity, because a wave of positivity would only *diminish*, not *increase*, the P.D. between the hyaloplasm and spongioplasm, and, therefore, the surface tension at their contact surface would not be diminished, and no contraction would ensue; hence, a portion of a muscle which has been treated with a solution which has a sufficiently great negative stimulation efficiency ought to act as a motor nerve to the rest.

This can be very easily demonstrated in the intestine of a fly. In insects the walls of the intestine contain "striated (uninuclear) muscle cells, which by contraction set up the normal peristaltic movements of the digestive tract." ‡ The species I used for experiments was *Callophora villosa*, Desv., which is the Australian representative of the English bluebottle. If the last posterior segment of one of these flies is torn away with forceps, the end of the intestine is usually left hanging from it, and, if the operation be performed carefully, nearly half an inch of intestine can sometimes be

* Gotch: Schäfer's Textbook of Physiology, vol. ii., page 538.

† Gotch: Schäfer's Textbook of Physiology, vol. ii., page 490.

‡ Biedermann: Electro-physiology: Trans. by F. A. Welby. vol. i., page 164.

obtained. If this be placed on a slide which has been slightly wetted with a decinormal solution of NaCl, and the superfluous fluid taken up by filter paper, on examining the intestine under the miscroscope peristaltic waves of contraction are seen travelling down the intestine towards the rectum at an easily followed, uniform velocity, with moderate frequency. On now touching the intestine at about its middle point with a fine pointed camel's hair brush, which has been just wetted with a decinormal solution of $CaCl_2$, a remarkable effect is observed:—If one of the peristaltic waves starting at the end of the intestine furthest from the rectum be followed with the eye, it is observed to completely disappear on entering the region which has been treated with $CaCl_2$; but if we continue to move the eye along the intestine at the same rate as the wave of contraction was formerly moving, on reaching the other end of the affected area the wave will be seen to emerge from it as vigorous as before, and to be travelling at the same rate. Thus, *contraction* has been abolished by the $CaCl_2$, while *conduction* continues to take place at the same rate as before. The suppression of the wave of contraction in the area affected is not due to any apparent change in form in the intestine in that area, for if the $CaCl_2$ be properly applied, no apparent change in form takes place. If, however, too much $CaCl_2$ is applied—so that it is not sufficiently diluted by the NaCl present (*e.g.*, a small drop)—the intestine at that part is thrown into corrugations which represent fixed contractions; that is, the intestine at that part acquires "tone" (the cause of this will be considered later), but this does not alter the effect of the $CaCl_2$ upon incoming waves of contraction, which enter, and are suppressed, and re-appear at the other end of the affected region as before. Care must be taken in these experiments not to have the intestine too wet, otherwise it is difficult to confine the effect of the $CaCl_2$ to a given region, as the $CaCl_2$ is carried about by currents in the water. I repeated this experiment a number of times, and, when the above-mentioned precautions had been taken I never failed to get the effect described. I also obtained the same effect using a decinormal solution of $BaCl_2$ instead of $CaCl_2$. On glancing at the table of stimulation efficiencies in section 4, it will be seen that both $CaCl_2$ and $BaCl_2$ have high negative stimulation efficiencies, so that our theoretical deduction is confirmed by these experiments. The action of $CaCl_2$ and $BaCl_2$, when applied to a limited region of the intestine, may be contrasted with that of a decinormal solution of KCl when similarly applied, although no more apparent change of form is produced in the intestine by the KCl than by $CaCl_2$; yet not only is the wave of contraction suppressed in the region treated with KCl, but also the wave of excitation, inasmuch as no wave of contraction issues below the part affected—all parts of the intestine below that treated with KCl remain motionless, while those above that part are in vigorous peristalsis. This action of KCl in abolishing both contractility and excitability in the intestine of the fly is only an instance of its general effect upon contractile tissues, the cause of which will be discussed later.

7.—On the Normal Presence of Anion-Proteid in Certain Tissues, and their Sensibility.

A fact which it is important to realise is the normal presence of a certain amount of *anion-proteid* in irritable tissues. It is easy to see that this is *à priori* probable, for, since the blood and lymph contain ions of both kinds, it is to be expected that some anions would be taken up and formed into anion-proteid. But confirmatory evidence is not far to seek: the cardiac inhibitory vagus fibres, when excited, produce a *positive* variation of the muscle current; this can only be due to anions released by the nervous impulse, and since "as regards their galvanic re-action to excitation they differ in no respect from other nerve fibres,"* these anions must be displaced from anion-proteid in the muscle itself, or in the nerve endings. The "staircase" phenomenon, that is, the improvement of each of the first few contractions of a muscle by the one that precedes it, which is specially noticeable in the heart, and in the swimming bell of medusæ,† is direct evidence of the fact that the wave of negativity is not propagated by mere diffusion; for some chemical change evidently takes place wherever the wave passes, since the improvement is not confined to the point stimulated, but occurs at all points traversed by the wave of negativity.‡ I attribute the "staircase" to the presence of a small amount of unstable anion-proteid, which tends to accumulate, and is mostly removed by the first few waves of negativity, the kations of which displace the anions. We should note that the "staircase" is not always comparable with the cumulative effect of sub-minimal stimuli on many tissues, so that they eventually become capable of causing discharge and evoking contraction. In this case, no doubt, the kations accumulate, being added

* Biedermann: Electro-physiology, vol. ii., page 257.

† *Vide* Romanes: Jellyfish, Starfish, and Sea-urchins. Int. sc. ser., page 56.

‡ Romanes: Jellyfish, Starfish, and Sea-urchins. Int. sc. ser., page 57.

to by each stimulus until at last they reach the necessary minimum required to displace ions from the ion-proteid. The same principle explains idio-muscular swellings—fixed waves of contraction of small extent; these are due to the kations set free not being sufficient to cause a discharge by displacement, but sufficient to augment the P.D. between hyaloplasm and spongioplasm, and so cause local contraction —while the same principle, together with the presence of anions, explains the local extension at the anode seen in some muscles;* anions are liberated, as in ordinary electrolysis, at the anode—the P.D. between the hyaloplasm and spongioplasm is diminished, and the muscle extends; but, as kations are predominant, the anions are not strong enough to cause displacement, and so the excitation does not travel. Sometimes the P.D. is so far reduced that the muscle extends so much as to break at the anode;† such a result could not, of course, take place unless the muscle had, normally, a good deal of "tone"—that is, there is considerable room for extension and free kations are numerous.

This leads us directly to the consideration of the "*threshold number*" of a tissue—that is, the number of ions necessary to cause a discharge in a given tissue (the inverse of which is proportional to the "*sensibility*" of the tissue). If we call this number per unit cross-section β, it is evident that β must vary considerably in different tissues, and that the greater β is the slower will be conduction of excitation, for at each successive point more time must be allowed for the ions to gather. Since in non-medullated nerves the rate of conduction is much lower than in medullated nerves (8 metres per sec. in the former, 27 per sec. in the latter‡) we may state provisionally that β is greater in non-medullated nerves than in medullated. This is confirmed by the fact that non-medullated nerve re-acts better to stimuli of prolonged duration than to short induction shocks, § for more time is required by the electric current to liberate β ions in non-medullated nerves than in medullated, in which extremely short current duration is sufficient.‖ The conductivity of medullated nerve, and. indeed, of all excitable tissues, is lower-

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* Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. ii., page 236.

† *Ibid.*, vol. ii., page 239.

‡ Gotch: Schäfer's Textbook of Physiology, vol. ii., pages 455 and 482.

§ *Ibid.*, vol. ii., page 284.

‖ *Ibid.*, vol. ii., page 475: and Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. ii., pages 121 and 122.

ed by lowering the temperature.* This means that β is raised, therefore the excitability to short-duration stimuli is lowered.† Since conduction is much slower in smooth than in striated muscle, β must be greater in the former, and the minimal duration of excitation, in order to cause contraction, is therefore greater in smooth than in striated muscle. And, indeed, Biedermann states generally that the excitation of more sluggish excitable tissues depends on the duration of the stimulus.‡ The conductivity of muscle is lowered by lowering the temperature, but the height of the contractions is augmented :§ this is because of the greater value of β causing a greater P.D. on excitation. Since the rate of propagation in the heart is less than in striated skeletal muscle (1·5 metres per sec., as against 3 metres per sec.)‖ β is probably greater in heart muscle than in ordinary striated muscle.

8.—Polar Excitation in Muscle and Nerve and Electrotanus.

One of the most striking facts in the electrical stimulation of muscle is that the make contraction starts at the kathode, and the break contraction at the anode. From my theory, however, it seems to obtain a sufficiently simple explanation. On the passage of the electric current the ion-proteid undergoes decomposition, and, in accordance with the laws of electrolysis, kations collect at the kathode. As soon, however, as the kations at the kathode reach the "threshold number" they displace the kations from the adjacent section of ion-proteid material; these, in turn, displace the kations from the next section, and so the wave of negativity is propagated through the tissue. This view of the nature of the "wave of negativity" obtains further support from the fact that "the responsitivity of the kathodic points of fibres in a muscle traversed by a current increases, up to a certain limit, with the intensity of the polarising current. This limit, however, is very low . . . beyond this limit excitability diminishes, as has been shown, in proportion with the strength of the polarising current."¶ Suppose a

* Gotch: Schäfer's Textbook of Physiology, vol. ii., pages 486 and 534.

† *Ibid.*, vol. ii., page 485.

‡ Biedermann: Electro-physiology, vol. ii., page 106

§ *Ibid.*, vol. i., page 98.

‖ Burdon Sanderson: Schäfer's Textbook of Physiology, vol. ii., pages 383 and 443.

¶ Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 285.

certain amount of kation-proteid to be on the point of breaking down at points which are about to be made kathodic by the polarising current, then, if the strength of the polarising current be insufficient to decompose the whole, an additional excitation will be aided by the effect already present. If, however, the polarising current has decomposed all the ion-proteid most immediately available, irritability at kathodic points will decrease.

We now touch upon the curious fact, that during the closure of a constant current, after the make twitch, no perceptible effect is usually produced in striated muscle until the current is broken.

This depends upon two factors: the superior stimulation efficiency of rapid variation of current density (to be considered later); and, secondly, the comparative exhaustion of ion-proteid material at the kathode after make. It is obvious that such exhaustion must take place sooner or later, and we need not be surprised at its taking place immediately after the initial twitch, for, as we have seen, the duration of the current has an effect upon the height of the make twitch, inasmuch as it augments it;* that is to say, the constant current decomposes a large amount of ion-proteid material initially, to produce the make twitch.

We can account for the fact that persistent closure contraction takes place more usually, and to a greater degree, in smooth than in striated muscle, by the higher value in the former of the "threshold number"—for an excess of free kations might be liberated by the current, sufficient to cause a considerable increase in tone of the muscle, and yet insufficient to cause displacement, and so initiate a wave of negativity. Not only is variation of current density ordinarily of importance, but the comparative exhaustion of ion-proteid material after the make greatly increases the necessity for such variation in a way that will be explained shortly. Hence we cannot wonder that in such highly sensitive contractile material as striated muscle persistent closure contractions are not usually seen in a marked degree.

Biedermann† states that a wave of contraction, initiated in an extra-polar tract, cannot pass the kathode of a polarising current of certain intensity, while it can the anode. This is not due to the persistent closure contraction, because "inhibition is most pronounced when a persistent descending current in the upper half of the muscle has reduced the original persistent closure contraction to a minimum." I can account

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* Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 176.

† *Ibid.*, vol i., page 296.

for this in the following way:—The cause of the extra-polar wave of contraction is the accompanying "wave of negativity," which means that (in the first instance) when the wave of negativity approaches the kathode a number of kations are there set free. These kations will, however, be attracted by the kathode, and, moreover, there will be very little undecomposed ion-proteid from which they can displace the ions; hence, the wave of negativity will be seriously hindered, and the proteid residues at the kathode will tend to retain some of the kations. At the anode, on the contrary, undecomposed kation-proteid is abundant, and the kations are not retarded by the action of the current itself, so that the wave of negativity passes this region without hindrance.

We have seen that a certain amount of anion-proteid is present in muscle and nerve, consequently, on electrolysis taking place, anions are liberated at the anode; but, since kations are predominant, their number is not sufficient to cause displacement, and therefore a discharge; while at the kathode the proteid residues cannot take up kations, for they are immediately dissociated; but when the passage of the current ceases, the proteid residues at the kathode immediately pick up kations; hence the concentration of free kations falls at this point, and kations diffuse in from other points, including the anode; hence the mass influence of kations at the anode is diminished, the anions get the upper hand and create a discharge, which immediately, as we have seen, becomes a wave of negativity by displacement of kations. The concentration of kations at the physiological anode may, possibly, fall on break for other reasons; thus some of the proteid residue at the kathode may, when the current is broken, take up the ions from the adjacent ion-proteid; this may in turn recoup itself from the next section, and so the area of diminished kation concentration would travel to the anode.

The question immediately arises: Have we any other evidence of the liberation of anions at the anode? The answer is that we have ample in the phenomena of electrotonus.

The effect of anions at the anode would be to lower *excitability*, because, in order to obtain a sufficient excess of kations over anions to create a discharge the influence of the free anions has to be neutralised: it will be to lower *conductivity*, because the anions will tend to prevent the incoming kations from displacing ions from the ion-proteid by lowering their mass influence: and it will be to cause "positivity" in the region of the anode. These are the well-known phenomena of anelectrotonus.*

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* *Vide* Gotch: Schäfer's Textbook of Physiology, vol. ii., pages 494 and 502; and Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. ii., page 268.

The magnitude of the katelectrotonic effects will depend upon the magnitude of the threshold number (β). If only a part of the kations liberated at the kathode by a current is discharged, there will be improvement in excitability, conductivity, and "negativity" at the kathode, owing to the influence of the free kations; this will be the case when β is small, and occurs, as we should expect, in medullated nerve.* But where β is large, and the ion-proteid therefore more stable, a very large proportion of the electrolysable portion of the ion-proteid is used up in initiating the discharge, and therefore the proteid residues at the kathode, after discharge, are great in proportion to the free kations, and their delaying effect neutralises the improving effect of the kations, as is the case in non-medullated nerve, where, as we have seen, β is greater than in medullated nerve, and there is no katelectrotonus.†. If β be larger still the effect of the proteid residues is to reverse the improving effect that would otherwise be produced by the kations. This is the case in muscle, as we have seen, and in muscle β is greater than in nerve.‡ The magnitude of the anelectrotonic effect depends on the amount of anion-proteid, but since no anions are discharged until break it should, in general, be greater than the katelectrotonic effect, and this is, in fact, the case.§ In further support of our theory of katelectrotonus, we may allude to the fact that with strong currents of long duration conductivity is retarded at the kathode even in medullated nerve|| owing to the greater amount of electrolysis and the gradual diffusion of kations from the kathodic points, leaving behind the indiffusible proteid residues.

Since there is less anion-proteid than kation-proteid anelectrotonus develops more slowly than katelectrotonus, hence "currents of moderate strength but of short duration excite only on closure, *i.e.*, at the kathode."¶ Given the facts of electrotonus, Pflüger's law of contraction follows.

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* *Vide* Gotch: Schäfer's Textbook of Physiology, vol. ii., pages 494 and 502; and Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. ii., page 268.

† Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. ii., page 284.

‡ *Vide* section 8, this paper.

§ Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. ii., page 268.

|| *Ibid.*, vol. ii., page 148.

¶ Gotch: Schäfer's Textbook of Physiology, vol. ii., page 506.

9.—The Influence of Varying Current Density.

It seems probable that the reason for the importance of the steepness of increase in current density for evoking muscular contractions lies in the diffusion of the kations away from the points which form the physiological kathode. When the kations are only very slowly liberated they diffuse away from the points where they are liberated, so that they never become concentrated at any point, and their mass at any point is never appreciable in comparison with the mass of ion-proteid with which they come in contact. Hence the kations diffuse through the whole muscle without the potential having risen at any point high enough to evoke a perceptible contraction. This view is supported by Biedermann's statement that "the transmission of excitation from the seat of direct stimulation would seem, in the last resort, to be produced and conditioned by a rapid *variation* in the current."*

Persistent closure contractions, however, appear to be due to a number of kations liberated by the action of the current at the different points in the muscle forming the physiological kathode. These kations are insufficient to cause a wave of negativity from any of these points, but by raising the potential at such points they evoke a persistent contraction. If such were the case we should expect to find that persistent closure contractions were more apt to occur in muscles in which the threshold number is large; and this is the case, for "the visible manifestations of persistent excitation fall into the background, while the excitatory effects of current variation come prominently forward in proportion as the excitable protoplasm is more highly mobile,"† and we have seen that the less mobile a tissue is the greater is the threshold number (section 8). Thus we see why the discharge of the initial "wave of negativity" tends to inhibit persistent closure contraction in striated muscle.‡ Only the more stable ion-proteid compounds are left at the kathode, and these, besides being fewer in number for the current to act on, present a greater resistance to the dissociative effect of the current, so that very few ions will be liberated at any given moment, and these will diffuse into the spongioplasm before any accumulated effect is possible.

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* Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 193.

† *Ibid.*, vol. i., page 192.

‡ *Vide* remarks on polar excitation in muscle, section 9, this paper.

10.—Tetanus and Fatigue.

When a second momentary current is sent into a muscle before the contraction due to the first has subsided, the effect of the second current is added to that of the first, and a new contraction appears superimposed upon the old, starting from the degree of contraction at which the latter had arrived, and proceeding much as if that were the normal condition of the muscle; with succeeding currents the process goes on until a certain limit of contraction is reached, beyond which the muscle cannot go. If the shocks follow one another quickly enough the recording lever will trace upon a travelling surface a straight line, and the muscle is said to be in tetanus, and it will, if the shocks are kept up, continue in this condition until "fatigue" sets in, and the lever gradually sinks.

Helmholtz considered that "from the point at which the second excitation becomes effective the twitch behaves as if the contracted state of the muscle at the moment was its natural state, and the second twitch, alone, induced in it." It has been found, however, that this is not true even for the second twitch; it is lower than the first and of a shorter period,* while it is obviously not applicable to the later twitches when the limit is nearly reached. The reason for this summation is, of course, the repeated discharge of ions from the seat of stimulation—the twitches will become smaller and smaller and shorter as the ion-proteid is used up—and no increase of contraction can then take place. At this period, however, since a great mass of kations have been rapidly liberated, they cannot diffuse at once into the spongioplasm so as to diminish the difference of potential at the contact surface; so that the muscle remains for some time in tetanus, and only as the kations diffuse into the spongioplasm will the lever sink and the muscle enter into "fatigue"—finally the lever sinks quite, and the muscle is isoelectric—or, only with the usual contact difference of potential between its hyaloplasmic and spongioplasmic surfaces. An objection may be raised: Why do rapidly succeeding shocks produce reiterated contractions when a constant current fails to cause persistent contraction? There are two reasons: First, that to produce complete tetanus in striated muscle the shocks must be of extremely short duration; and we have seen that such shocks do not discharge so many ions as longer ones; that is, there is a reserve left, while the muscles in which the shocks need not be so short are just those in which persistent closure con-

* Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 115.

tractions take place. Secondly, during the intervals, however short, the proteid residues will be able to gather more kations, though fewer as time goes on, because the supplies get used up; nevertheless they will be able to do so to some extent all the time, and this corresponds to the fact that in tetanus the muscle is really vibrating, though its vibrations are imperceptible by ordinary methods.* This is further confirmed by the fact that too rapid a succession of stimuli corresponds in effect to a persistent stimulus, even in striated muscles.† Schoenlein & Richet's observations of "rhythmically interrupted tetanus" in striated muscles are doubtless due to the hyaloplasm reclaiming kations from the spongioplasm at the point of stimulation during the intervals.‡ Another reason for the rapidly decreasing height of the summated stimuli lies in the fact that the elastic re-action of the walls of the sarcous elements becomes less and less as the muscle contracts, so that each new contraction in the series starts with less force to counteract the pull of the surface tension than the previous one; hence absolute tetanus may correspond to a state of the sarcous elements in which no pull is being exerted on the wall at all. That "fatigue" is really due to the diffusion of the kations into the spongioplasm is shown by the fact that in the ureter "each wave of contraction produces a temporary depression of excitability and conductivity in the sheet of muscle, from which it only recovers during the subsequent diastole and interval (just as in the striated muscle-nets of insect intestine)."§ This also illustrates the rapidity with which the hyaloplasm recovers itself and again gathers kations; one is also reminded of the "refractory period" in the heart. It may be frequently observed that when a frog's gastrocnemius has been tetanised through its nerve for as long as several minutes, so that the lever has almost dropped to the base line again through fatigue, if the tetanising current be opened only for a moment, and then closed again, the muscle, if it is fresh, will contract in tetanus almost to the same height as before. We should, indeed, expect that striated muscle with its low β (and consequently high sensibility), and a comparatively large surface of spongioplasm to regain kations from, would have a very much shorter "refractory period" than the heart or the smooth muscle of the ureter.

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* Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 135.

† *Ibid.*, vol. i., page 131.

‡ *Ibid.*, vol. i., page 131.

§ *Ibid.*, vol. i., page 167.

11.—The Work of Muscle and the Influence of Tension.

It is well known that the work done by muscle increases, up to a certain point, with the magnitude of the load, and then decreases to zero, or even becomes negative, in contraction. The reason for the initial increase in the work done, as well as the cause of the favourable effect of moderate tension upon all contractile tissues, lies in the fact that the tension *increases the surface of contact between the hyaloplasm and spongioplasm.* It is, indeed, obvious, *à priori*, that when an elastic substance is stretched in any way its surface is increased; and this is just the case with the sarcous elements. Hence, the work which has to be done against the surface tension, along the contact surface, in order to increase that surface, is diminished; and, since the same work as before will be done by the ions set free on excitation, only against a tension that has been diminished, the *output* of work will be greater.

At the same time, the longitudinal stretching of the sarcous element (spongioplasm) will have a horizontal component tending to decrease its diameter—that is, to decrease the elastic reaction outwards, and so decrease the tendency of the sarcous element to bulge on stimulation: when this unfavourable influence exactly balances the favourable, the work will be the same as with a minimal load; between these points there must be a point of maximum work output; afterwards the work falls, and, finally, becomes zero. If, now, more loading is added, when the muscle is stimulated, what happens is that the pull of the hyaloplasm upon the wall of the sarcous element is diminished; normally the horizontal reaction would cause the walls to bulge, but now, owing to the great vertical strain, the horizontal reaction is converted into a vertical one, and *the muscle elongates when it contracts:* this is known as Weber's paradox.* It is just as if one violently compressed an indiarubber tube which was being at the same time violently pulled. On releasing the compression the tube will become more stretched, and its average bore diminished; but, if the tube were not stretched its average bore would be *increased.*

12.—The Action of Chemical Reagents upon the Contracture of Muscle.

If the "negativity" at any point in a muscle is determined by the number of free kations in the hyaloplasm at that point, we should expect to find that when a muscle is

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* Halliburton: Handbook of Physiology, fourth edition, page 135.

dipped into an electrolyte with a positive "stimulation efficiency" it would become negative at those points which are wetted, and we find this to be the case. If one end of a sartorius that is free from current is briefly immersed in highly dilute solutions of K salts, that end becomes strongly "negative" to the rest. This is simply neutralised by washing out with physiological NaCl solution.* A glance at the table of stimulation efficiencies will show that all the salts of K used in physiology have positive "stimulation efficiencies." The antagonistic action of NaCl is simply accounted for by the fact that it has a *negative* "stimulation efficiency." That the action of NaCl in abolishing the "negativity" induced by K salts is really due to the fact of its anions diffusing faster than its kations is shown by the fact that Engelmann found that a solution of NaCl, if stronger than 6 per cent., produces a weak "positivity" at points of a muscle immersed in it.† In face of the fact that nearly all potassium salts are highly positive stimuli—as shown by the table of stimulation efficiencies—it is difficult to deny that their highly poisonous effect, when applied to muscle, must be in some way connected with the high velocity of the K ion, and I think the explanation must be this: that when a muscle is dipped into too strong a solution of KCl, suppose, the kations diffuse so rapidly into the muscle-hyaloplasm and spongioplasm that little or no contraction is evoked, for the muscle is now throughly permeated with potassium ions, and ion-proteid cannot break down at any point without kations being immediately at hand to regenerate it. Even a strong current might not be able to liberate enough kations in any one section of the muscle to overcome the mass influence of those in the next; in fact, potassium salts may be said to induce a state of "persistent anabolism" in the ion-proteid. Thus it would appear that the poisonous effect of potassium salts is primarily due to loss of conductivity in the muscle, owing to an excessive rise in the threshold number, and this view is fully borne out by my experiments on the intestine of the fly. If a section of the intestine is treated, in the manner described in Section 7, with decinormal KCl solution, a block is created at the points thus treated—no contraction can pass this area, and, moreover, the peristaltic contractions travelling down the intestine *do not reappear below the affected area*, hence the excessive rise of the threshold number at the points treated with KCl renders propagation of the wave of excitation by displacement impossible.

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* Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 354.

† *Ibid.*, vol. i., page 356.

It has been shown that potassium salts produce a prolonged contraction of the gastrocnemius muscle of a frog, while calcium salts and, to a lesser extent, sodium salts, antagonise this action of potassium salts. * We can easily see that this action of potassium salts is due to the faster diffusing kation augmenting the P.D. between the hyaloplasm and spongioplasm, and hence lowering the surface tension at the contact surface, and causing prolonged contraction, while the action of the Ca salts and Na salts is simply due to the fact that in them the anion usually moves faster than the kation.

"The excitability of certain contractile substances (spermatic filaments, ciliated cells) is considerably heightened by Na_2CO_3 in dilute solutions." "If the pelvic end of an uninjured curarised sartorius dips into a ·5—1 per cent. solution of this salt, the excitability of the muscle to the closure of weak ascending currents is seen after a short time to be extraordinarily augmented, while the descending current still works quite normally, although break excitations are discharged with such low intensity of current and brief duration of closure as would not occur in normal muscle."† This improvement of contraction and excitability on treating with the Na_2CO_3 is, I believe, owing to its low *positive* stimulation efficiency slightly increasing the threshold number, while the incoming kations enable a sufficient number to cause displacement to gather more quickly at any point. In my own experiments I have observed this improvement in the sartorious, in the semi-membranosus of the frog (fig. 7), and in the intestine of the fly. If a section of the fly's intestine be touched with decinormal Na_2CO_3, the peristaltic contractions are much augmented at that part; and, if the intestine be quiescent owing to long exposure to NaCl, peristaltic contractions will start at the point painted with Na_2CO_3. The improvement, in both cases, quickly dies away, and the intestine becomes puckered at the part affected owing to increase of tone, this part now acting as if it had been painted with KCl. This is to be explained by the effect of the natrions being, at first, partly neutralised by the chloridions already present, and then as the natrions become predominant the stimulation efficiency is too great, and the ionproteids enter into persistent anabolism.

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* W. D. Zoethout: American Journal of Physiology, May, 1902: The Effects of Potassium and Calcium Ions on Striated Muscle.

† Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. i., page 221.

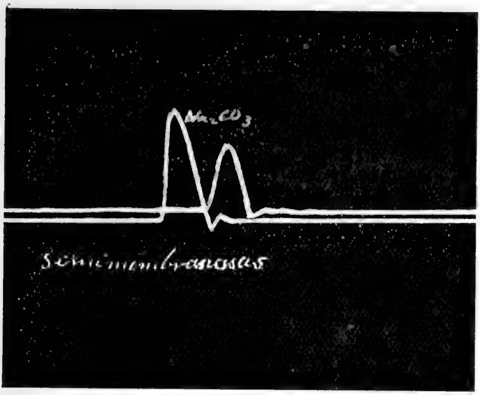

FIGURE 7.

13.—RHYTHMICITY IN MUSCLE AND THE ACTION OF INHIBITORY AND AUGMENTOR NERVES.

Direct proof that the rhythm of the heart is due to the presence of electrolytes in the circulating medium is afforded by the fact that if the proteids be removed from serum which is then circulated through the heart the rhythmic contractions will continue. If the salts are removed and the serum is circulated it is ineffective.* The solutions generally used and found effective stimuli for the heart-beat have negative stimulation efficiencies, owing to the predominance of NaCl. Let us, therefore, consider the case of an excised heart through which a solution, which has a negative stimulation efficiency, is circulated. Assuming that the walls of the heart are equally permeable to both the ions in the solution—an assumption which, however, is not strictly permissible—we see that, owing to the difference of ionic concentration on the two sides of the muscle surface, ions are continually diffusing in—but at different rates—the anions more quickly than the kations. Since the time taken for the anions entering the hyaloplasm to reach a given number—the threshold number—will be inversely proportional to the velocity with which the anions enter, we may conclude that, other things being equal, the frequency of the beat is greater the greater the velocity of the anions in the solution. Also, since the driving force which causes the ions to diffuse into the muscle is dependent upon the difference in ionic concentrations on the two sides of the muscle surface, we see that, if the solu-

* Gaskell: Schäfer's Textbook of Physiology, vol. ii., page 226.

tion is kept sufficiently dilute to ensure complete dissociation of the salts, the frequency of the beat will be greater the greater the concentration. And, obviously, the frequency will be less the greater the threshold number.

We further notice that if the ions diffusing into the muscle gathered unchecked on the muscle side of the surface, diffusion would shortly cease because of the approximation of the concentrations on both sides—the process could not be kept up. But we know that this is not the case; a periodic discharge of anions takes place which, by releasing kations, starts waves of negativity, giving rise to the contractions, or, when the heart is bathed in a solution with a positive stimulation efficiency, the periodic discharge is one of kations starting, as before, a wave of negativity. The concentration after each contraction is, therefore, on the muscle side, kept automatically constant, as far as anions are concerned; on the fluid side it is kept absolutely constant by circulation, but during the intervals between contractions the difference between the concentrations on the two sides is not constant, but continually falls off. Another fact to be considered is that the difference between the velocities of entrance of the anions and kations will diminish progressively during the intervals between contractions owing to the electrostatic repulsion, due to the excess of one kind of ion which has entered, tending to accelerate the other kind of ion and retard the ion bearing a similar charge. Finally, we have to take into account the reciprocal influence of kations and anions in altering the threshold number—kations will augment the threshold number for anions, and anions will augment the threshold number for kations. Hence the threshold number will be greater the less the difference between the velocities of the anions and kations on entering the muscle. Also, it is possible that kations of one kind may raise the threshold number for kations of another kind (when the solution contains two or more salts). Hence the threshold number, and consequently the extent of contraction, will vary considerably in different solutions.

It is obvious that a number of conditions must be satisfied in order that a solution may be able to keep a heart beating. Thus, the threshold number must be reached on the muscle side by the faster-moving ions before their velocity has been reduced to that of the slower-moving ions, by the electrostatic force which they develop on the muscle side. This involves the difference between the velocities of the anions and kations, the influence of one sort of ion in raising the threshold number for another sort, and the difference between the concentrations of the ions on the two sides of the muscle. Then, again, if the frequency of the beat is too great the beats will merge into one another, and the heart will go into tonic contraction.

Thus, the normal rhythm of the heart is due to the ions diffusing in from the blood, and the delicate adjustment of the threshold number to the nature and concentration of the salts in the blood. Almost any point in the heart is capable, in a greater or less degree, of initiating this rhythm, *e.g.*, if the auriculo-ventricular groove be ligatured or cut through, a series of rhythmical contractions is initiated; this is soon suppressed; subsequently a more permanent series is initiated.* The "rhythm of excitation" is due to the kations released by the injury due to the cut or ligature, the "rhythm of development" to kations diffusing in from capillary spaces.

A permanent rhythm, such as we see in the normal heart, could not be maintained on a nutrient fluid whose stimulation efficiency was negative, unless the excess of anions was continually removed, for otherwise the anions would gradually convert most of the kation-proteid into anion-proteid, and contraction would become impossible. The solutions, however, which are generally used as circulating media to keep up the heartbeat have negative stimulation efficiencies owing to the predominance of NaCl. We should, therefore, expect to find, if the preceding reasoning has been correct, that the rhythm of the heart would be slowed by adding a little KCl to the solution (sufficient to reduce its stimulation efficiency without making it positive), and quickened by adding $CaCl_2$ so as to increase its stimulation efficiency (since $CaCl_2$ has a greater stimulation efficiency than NaCl.). This was found to be the case by Greene.† He found that calcium salts in isotonic solutions of NaCl stimulated a cardiac strip to increased rhythm and final permanent contracture. KCl in isotonic solutions of NaCl prevented contractions and kept the ventricular strip in a state of relaxation. If the salts $CaCl_2$ and KCl were in the proportions of ·026 per cent. $CaCl_2$ to ·03 per cent. KCl, a few good contractions at a very slow and irregular rate might result. If the ratio was changed by increasing the $CaCl_2$, or by decreasing the KCl, then the contractions were increased in frequency; but if the $CaCl_2$ was diminished or KCl increased, few contractions were developed, or none at all.‡ At first sight, these results might seem to be opposed

* Gaskell: Schäfer's Textbook of Physiology, vol. ii., page 175.

† C. W. Greene: American Journal of Physiology, 1899, vol. ii., page 82.

‡ *Ibid.*, vol. ii., pages 107 and 125.

to those obtained by Zoethout in experiments on the gastrocnemius,* but, in reality, these results are due to the action of KCl and $CaCl_2$ in lowering and raising the stimulation efficiency of NaCl respectively. Pure $CaCl_2$ or KCl applied to a heart strip throws it into strong tone,† as might be expected from the high stimulation efficiency of both, since the frequency of contraction is greater the greater the difference between the ionic velocities. Hence the two sets of results are, by this theory, brought into entire harmony.

With regard to the influence of the threshold number in lowering the rate of rhythm, it is obvious that the height of contraction depends upon the magnitude of the threshold number, for the greater the potential of the wave of negativity the greater is the maximum P.D. produced between the hyaloplasm and spongioplasm; hence we should expect that the slower the rhythm the greater the height of contraction, other things being equal. This has been experimentally proved for smooth muscle by Woodworth.‡ As β grows greater in excitable tissues we find that the "refractory period" grows greater. During this period the tissue will not respond to stimuli, and it is greater in cardiac than in striated skeletal muscle.§ The reason is that, β being greater, a greater time must be allowed for the amount of ion-proteid corresponding to β to become unstable; of course, the moment at which the kations at the point of initiation are sufficient to cause a contraction will coincide with the moment at which the ion-proteid is in a certain minimal state of instability. This is the same as saying that immediately after a wave of negativity has passed a point, β is great at that point, and the amount of decomposable material small; the amount of decomposable material grows, and β diminishes until a certain point is reached at which excitation by a given stimulus is possible. Thus the *slowing* of a wave of negativity travelling too soon after a contraction is due to the greater magnitude of the threshold number.‖ Since the frequency of contraction is greater the greater the difference between the ionic velocities, any solution in which the ions move at very different rates will cause tonic contraction. Hence alkalies cause tonic contraction.¶

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* *Vide* section 12.

† C. W. Greene: American Journal of Physiology, 1899, vol. ii., page 101.

‡ R. S. Woodworth: American Journal of Physiology, 1899.

§ Gaskell: Schäfer's Textbook of Physiology, vol. ii., page 189.

‖ *Ibid.*, vol. ii., page 195.

¶ *Ibid.*, vol. ii., page 195.

In general, *inhibition* must be due to an income of anions large enough to neutralise the kations present, but not strong enough to cause a discharge in addition. If inhibition in the heart were due to the refractory period after a subminimal discharge of kations it could not last 252 seconds after stimulation of the vagus, as it may do.* We should expect the anions to cause a relaxation, and this takes place.† We should expect excitation of the inhibitory nerve, if it sets free anions in the muscle, to cause "positivity" at the points affected, and this is the case.‡ All doubt as to the action of the inhibitory fibres of the vagus being comparable to the effect of free anions at the parts affected—that is, to anelectrotonus—is removed by the fact that "a crystal of salt applied to the sinus will produce the same electrical variation as stimulation of the vagus nerve," § since in NaCl the stimulation efficiency is negative. In some animals the contractions of the ventricle are not diminished by vagus stimulation, hence there must be few or no anions at the vagus nerve-endings in the ventricles of these animals, and a most remarkable confirmation of my theory as to the nature of the "staircase"‖ and of inhibition is that "another somewhat unexpected coincidence is brought out by the comparison of ventricular muscle, whose contractions are diminished by vagus stimulation and ventricular muscle, whose contractions are not so diminished, namely, that the staircase phenomenon obtains only in the former case, and not in the latter." ¶ The effect of the anions liberated by the inhibitory nerve in the heart will be to depress the *rate* of the contractions, because a greater number of kations will have to gather at each point to overcome the mass influence of the anions. To depress the conductivity owing to the state of anelectrotonus induced, and to diminish the force of contractions owing to the diminished tonicity: all these are known effects of stimulation of the inhibitory nerve. ** The auriculo-ventricular ring always specially tends to block contractions—we may assume that

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* Gaskell: Schäfer's Textbook of Physiology, vol. ii., page 207.

† *Ibid.*, page 210.

‡ Biedermann: Electro-physiology, vol. ii., page 257.

§ Gaskell: Schäfer's Textbook of Physiology, vol. ii., page 223.

‖ *Vide* section 7, this paper.

¶ Gaskell: Schäfer's Textbook of Physiology, vol. ii., page 214.

** *Ibid.*, vol. ii., page 209.

this is due to an abundance of anions in this part—hence if we cut off the supply of kations, by ligaturing the coronary arteries, a block takes place,* because the anions have now got the upper hand.

The *augmentor* nerves increase the rate of rhythm, because kations are more abundant, and therefore at the initial points of contraction they more quickly reach the threshold number. The force of contractions increases because of increased tonicity. Conductivity increases because the inhibitory action of the anion-proteid normally present is overcome by the free kations; that is, presuming that the augmentor nerves end in spots where anion-proteid is scarce, and that the impulse therefore sets free kations; and all these are known effects of stimulating the augmentor nerve fibres.† The alteration in tone and the negative variation produced by stimulating the augmentor fibres is slight. ‡ This is to be expected, otherwise a discharge would be initiated at the nerve endings, and the refractory period would diminish conductivity. The discharge by the augmentor fibres must be less than the threshold number.

The after-effect of inhibitory nerves in improving conductivity§ is probably due to increased instability of the ion-proteid, the after-effect of the augmentors to the reverse.

The facts we have considered throw light on the whole action of antagonistic nerves in the many cases where there is a double nerve supply.

14.—Rhythmicity in Nerves.

One of the best examples of rhythmicity in nerves is that of *Ritter's opening tetanus.* "An indirectly excited muscle may, after prolonged closure of a powerful battery current, fall, on breaking the circuit, into a state of persistent tetanic excitation."‖ It specially occurs in "cooled frogs," when, as we saw in section 7, the threshold number is great, and the nervous impulse which gives rise to the tetanus is rhythmic.¶ There can be little doubt that this is a rhythmic discharge due to a collection of anions at the anode, just as a rhythmic

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* Gaskell: Schäfer's Textbook of Physiology, vol. ii., page 193.

† *Ibid.*, vol. ii., page 216.

‡ *Ibid.*, vol. ii., page 218.

§ *Ibid.*, vol. ii., page 220.

‖ Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. ii., page 117.

¶ *Ibid.*, vol. ii., page 119.

discharge is caused in the heart by the anions in a circulating fluid. The long closure of a powerful current allows plenty of time for a large number of anions to be liberated at the anode, and, what is more important, a large amount of kation-proteid to be decomposed at the kathode, so that although the excess of anions liberated at the anode may not be equal to the threshold number while the current is closed, yet, on opening, the sudden rush of kations to the former kathode causes a sudden fall in the value of the threshold number, for anions, at the anode, so that the number of free anions may now be many times the value of the threshold number. The fact that it occurs best when the threshold number is great (cooled nerves)—when the decomposition at the kathode is most marked*—favours this view. The fact that the "opening tetanus" is removed by immersion of the nerve in KNO_3 shows that it is due to anions, since it is removed by an excess of kations.

15.—The Movements of Plants.

This theory of the influence of the ion-proteid upon the surface tension of protoplasm gives a simple explanation of the movements, and especially the heliotropism, of plants. It is a well-known fact that, in the presence of chlorophyll, green plants, under the influence of light, decompose carbon dioxide, retaining the carbon and giving off the oxygen — this carbon is built up into carbo-hydrates and proteid.† Hence, it is evident that the rapidity with which the synthesis of proteid (and therefore of ion-proteid) goes on is dependent upon the supply of carbon; that is, upon the presence and intensity of illumination. Supposing a contact difference of potential, due to free ions, exists between the protoplasm of plant cells and the cell walls, it is readily seen that at the point where the assimilation of free ions into ion-proteid is going on most rapidly, this contact difference of potential will be diminished, and therefore, as we have repeatedly pointed out, the surface tension along the contact surface will be increased. This will mean decrease of surface at such points, and comparative increase of surface at other points; therefore, a cylindrical stem, in which assimilation is going on more rapidly on one side than on the other, will bend towards the *former* side.

But, we have seen that if one side of a growing plant stem is more strongly illuminated than the other, assimilation will be going on more quickly on the illuminated side; there-

* *Vide* discussion of electrotonus, this paper, section 8.

† *Vide* Vine's Physiology of Plants, 1886, pages 140-148.

fore, we should expect growing plants, with slender mobile stems, to bend *towards* the light. And such is, in fact, the case. I quote from Darwin: The Movements of Plants, page 465:—"In our various experiments we were often struck with the accuracy with which seedlings pointed to a light, although of small size. To test this, many seedlings of *Phalaris*, which had germinated in darkness in a very narrow box several feet in length, were placed in a darkened room near to and in front of a lamp bearing a small cylindrical wick. The cotyledons at the two ends and in the central part of the box would, therefore, have to bend in widely different directions in order to point to the light. After they had become rectangularly bent, a long white thread was stretched by two persons, close over and parallel, first to one and then to another cotyledon; and the thread was found in almost every case actually to intersect the small circular wick of the now extinguished lamp. The deviation from accuracy never exceeded, as far as we could judge, a degree or two."

Of course, in such cases, it may be objected that chlorophyll is not yet fully formed; but, inasmuch as chlorophyll is very quickly developed in the light, it may be supposed that the process of its formation, and the consequent accelerated synthesis of proteid, begins at once; while plenty of time was allowed for the reaction, since, in the experiment just before the one quoted, eight hours was allowed for seedlings of *Brassica* and *Phalaris* to bend "rectangularly towards the light."

In order to see how intimately the bending of plants towards the light depends upon the illumination of the chlorophyll, it is only necessary to refer to Darwin's "Movements of Plants," page 449 to page 468.

The few exceptions nearly all admit of some other explanation. Thus, Darwin shows that heliotropism may be much modified in some plants owing to their habit of climbing; in other cases apheliotropism may be induced because too intense illumination injures the chlorophyll,* and therefore reverses the effect we have described. Further, in time, the preponderating *growth* of the illuminated side will tend to reverse the effect. In the rare cases where plants containing little or no chlorophyll are heliotropic we may assume that light aids assimilation in some other way. The tendency for leaves to place themselves perpendicular to any not too strong illumination† is easily understood when we consider the influence of illumination upon the leaf stalk; illumination of its upper surface will cause a diminution of that surface—as we have

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* Darwin: The Movements of Plants, page 446.

† *Ibid.*, page 449.

seen—and this will counteract the effect of gravity tending to make the leaf hang downwards.

The importance of sudden change in illumination* is due to two factors: one the tendency of growth to counteract heliotropism if illumination is carried on for some time, and the other the tendency the ions from the unilluminated side will have to diffuse faster into the illuminated side, as the ions there are assimilated, a tendency which would slightly increase the P.D. at first lowered by the assimilation. It is evident that in normal growing plants these factors of heliotropism, growth, gravity, etc., will eventually reach a state of more or less settled equilibrium, which will determine the permanent form of woody parts.

That differences of potential, such as we have described, *do* exist in plants is well known. Thus, Biedermann† mentions that Kunkel found the veins of a leaf "positive" to the green surface (translating this physiological terminology this means that internally to the leaf there was an E.M.F. tending to promote a current *from* the green parts *to* the veins). There can be no doubt, I think, that this is due to the kations of the salts, brought up by the transpiration current, diffusing more rapidly through the walls of the vessels in the veins than the anions. The salts brought up are mainly KNO_3 and KCl, in which the kation has a greater velocity than the anion.‡ The same explanation applies to the "negativity" of the roots of a seedling towards the cotyledon, and higher parts,§ for the roots would have a large supply of kations due to diffusion from the moisture in the soil which diminishes progressively as the transpiration current mounts up the stem and the kations are assimilated.

Hermann‖ found that cross sections of the stem of a plant were "negative" to normal parts. This is doubtless due to decomposition of kation-proteid at the point of injury liberating kations.

Burdon-Sanderson finds that when the leaf of Dionea closes, the lower surface becomes "negative" to the upper.¶ This affords an explanation of its closure, since kations are liberated on the under side the surface tension on that side is

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* Darwin: The Movements of Plants, page 457.

† Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. ii., page 2.

‡ *Vide* Table of Stimulation Efficiencies, this paper, section 3.

§ Biedermann: Electro-physiology: Trans. by F. A. Welby, vol. ii., page 5.

‖ *Ibid.*, vol. ii., page 2.

¶ *Ibid.*, vol. ii., page 23.

reduced; that is, the under surface tends to increase, and the upper to decrease, hence the leaf closes.

16.—Summary.

It has been proved by Loeb and others that proteid takes up ions to form a loose compound, which they call ion-proteid.

Since these ion-proteid molecules must always be breaking down, there must be, for this reason, if not for others, a number of free ions in any protoplasmic body, and therefore, in general, a difference of potential between it and the medium in which it lives.

It is acknowledged by many physiologists* that the movements of unicellular organisms are due to changes in surface tension, while others, as Schäfer,† consider it probable that the movements of muscles may be due to the same cause. It is, indeed, obvious from the structure of amœba, cilia, muscle, etc., that, if changes in surface tension take place, movements must follow.

But since, for obvious reasons, the number of free ions in a protoplasmic body must always be changing or subject to change, it follows from known physical laws that the surface tension must also change.

We have shown that this mode of accounting for the movements of organisms enables us to explain the galvanotaxis and chemotaxis of unicellular organisms—the contraction of muscle—the electro-motive and other phenomena accompanying muscular contraction and the nervous impulse—the rhythmicity of certain muscles and nerves and the variations in their rhythm—the action of inhibitory and augmentor nerves, and the movements and electro-motive phenomena of plants.

It seems, therefore, certain that this explanation of the genesis of movement in living bodies is, in the main, true, and that it is probably capable of explaining the whole of that vast complex of facts which have been gathered together under the head of phenomena of contractility and irritability.

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* *Vide* Bütschli: Protoplasm and Microscopic Foams: Trans. by E. A. Minchin, 1894, page 289: and Verworn: General Physiology: Trans. by Frederic S. Lee, page 561.

† Schäfer: Essentials of Histology, sixth edition, page 56.

Geological Report* on the Country traversed by the South Australian Government North-West Prospecting Expedition, 1903.

By Herbert Basedow, Prospector to the Expedition.

[Read October 4, 1904.]

Plates XIII. to XX.

Contents.

The Ranges of North-Western South Australia.

Although maps represent these ranges as separate entities, they must, on geological and lithological grounds, be regarded as belonging to one and the same grand system, the intervening tracts of country which now separate the individual ranges being, for the most part, superficial deposits of comparatively recent sands and sandhills, or supra-cretaceous deposits, known as the "desert sandstone."

Rising abruptly † from the surrounding sandy country,

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* This paper, which has been slightly abridged, was the successful Tate Memorial Medal Thesis, 1904.

† Compare J. Forrest, Explorations in Australia, III., page 248:—"The whole country is level, the ranges rising abruptly out of the plains, . . ." Also the general statement by James Geikie, in Earth Sculpture, page 202: "Rising boldly above the general level, they exhibit no trace of talus or debris. . . ."

they extend in an easterly and westerly direction as huge, intrusive masses within crystalline schists and gneisses, mostly devoid of vegetation, though the intruded rocks bear "mulga," pine tree, and undergrowth of bush and grass. Fertile sandy loams, carrying mulga scrub of variable extent, surround them; while beyond this belt sandhills with "porcupine grass," "desert oak," "quondong," etc., prevail.

Their main bulk consists of plutonic masses, which form the cores of anticlinal folds of metamorphic rocks. Owing to the intense metamorphism induced not only in the intruded rocks, but also at the outskirts of the igneous intrusions themselves, it is often impossible to determine the actual plane of contact.* This factor has further been the cause of the contact rocks assuming a distinctive character by re-crystallisation of the original constituents *(Hornfelsstructur).* In this process the production of epidote has been greater than that of all other minerals, it being by far the most generally distributed near intrusions.

The following section is a diagrammatic representation of the mode of occurrence of the igneous and metamorphic series.

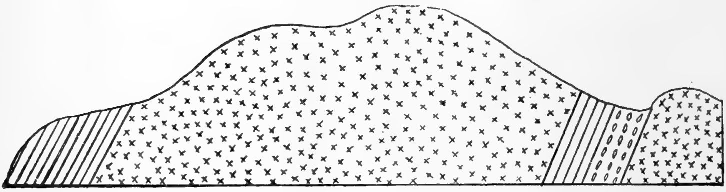

Fig. 1.—Diagrammatic Section through Portion of the Musgrave Ranges, East of Mitchell's Knob.

Owing to the absence of representatives of the Cambrian system in proximity to the ranges, the age of the igneous intrusions could not be definitely determined, but they certainly took place before the Ordovician period, as examples may be seen in the low-lying outskirts, as, for instance, Indulkana, of rocks of the Ordovician period overlying the intruded fundamentals, and not being themselves penetrated by the eruptives.

The Musgrave Ranges comprise an extensive series, ranging from acid to basic; the Mann principally acid and inter-

* Mons. Michél-Levy has described similar features in the gneisses of the Central Plateau of France. He points out that whenever it is the case that the granite is massive and intrudes rocks of acid character the plane of contact is not sharp, but the intruded and intrusive rocks are connected by a contact zone.—Bull. Soc. Géol., France, Ser. 3, tome vii. pages 852 et 853.

mediate; while in the Tomkinson Ranges members of the basic and intermediate families are typical. The intermediate group is represented throughout by numerous diorite dykes, which are usually of no great thickness, but their frequent appearance within short distances of one another is in cases marked. Their plane of contact with the intruded rock is always well defined.* The diorite intrusions have occurred later than the main granitic injections of the district. This is evident from the fact that often the diorite can be found penetrating the granite.† Yet the diorite in places does not appear to have been much subsequent in time, for magmatic intergrowths may be observed between diorite and granite rock that have been produced during a state of semi-plasticity of the latter. On the other hand, magmatic inclusions of granite rock within the diorite occur. These have been torn from the walls of the fissure, into which the diorite was injected, and embedded in the mass.

The intruded rocks, where they appear in considerable and persistent thickness *(Mächtigkeit)*, may be included generally under the headings of "gneissic quartzite" ‡ or "gneiss" proper; yet other crystalline schists are not wanting, although they are not represented to the same extent. The great variations in readings of the compass needle, produced by the magnetic minerals contained in the different granitic rocks that compose these ranges, have already been noted by various explorers.

The Musgrave Ranges.

General Remarks.—The Musgrave Ranges (Gosse, 1873) lie almost wholly in the State of South Australia, only two minor offshoots passing northward to beyond the boundary, in the localities of Opparinna and Fraser Hill. They rise from the plains as a compact chain that continues in an easterly and westerly direction for a distance of over one hundred miles. They are, however, cut in several places by valleys of denudation that are now occupied by vast deposits of sand, the upper surfaces of which form elevated plains (such as Glen Ferdinand), that permit the ranges being crossed with no great difficulty transversely to their long axis. Their breadth varies, the maximum being about thirty-five miles,

* Compare Michél-Levy, *op. cit.*, pages 845 et 872.

† See also H. Y. L. Brown, Report Journey from Warrina to Musgrave Ranges, page 2 (Adelaide: by authority, 1889); and V. Streich, Scien. Res. Elder Expl. Exp., Trans. Roy. Soc., S.A., vol. xvi., pp. 77 and 83.

‡ An altered (clastic) sandstone in which only a very faint indication of foliation has been brought about by the production of secondary minerals.

and the altitude is considerable. Mount Woodroffe, the highest peak, is estimated to be over 5,000 feet above sea level, and more than 3,000 feet above the level of the adjoining desert. Hence this chain of mountains is by far the most massive of the series seen during the expedition.

Igneous intrusions on a grand scale have produced the upheaval and form the inner mass of the several folds into which the intruded metamorphic beds have been thrown.

Mr. W. C. Gosse, in 1874, pointed out that the Musgrave Ranges "are composed chiefly of granite,"* and later Mr. H. Y. L. Brown † (1889) that they "are composed of eruptive granite and metamorphic granite rocks of various kinds, chiefly hornblendic, and seldom containing mica," comprising "ordinary granite, porphyritic granite, hornblendic granite, graphic granite, granulite, pegmatite, syenite, quartz syenite, and epidosite, gneiss, both hornblendic and micaceous, and siliceous and felspathic crystalline rocks of various kinds," and that they are intruded by diorite and dolerite. Mr. J. Carruthers stated:—‡"The Musgrave Ranges are composed principally of red granite rocks, and covered with spinifex and few scattered pines; the flats between the hills, which are principally formed by large creeks coming out of the ranges, are beautifully grassed, . . . the soils being a rich, red, sandy alluvial, and firm red loam."

Igneous Rocks.—The intrusives vary in character from highly acidic to basic, the differences, however, between the members of one and the same family being slight. The acid rocks are principally granitic, the greater bulk consisting of a rather coarse-grained porphyritic variety, with large corroded crystals of a bluish felspar (orthoclase). Ernest Giles was the first to mention§ this type of granite, and assigned to it the expressive term of "granite-conglomerate," making thereby particular reference to Mount Carnarvon, which is the eastern limit of the Musgrave Ranges. Mr. W. C. Gosse, moreover, in describing Mount Morris, wrote‖ "that this portion of the range is composed of very coarse granite. At the entrance to Jacky's Pass, on the south, this class of granite flanks the chain, but further east the southern slopes

* Parliamentary Paper, No. 48, House Assembly, page 18.

† Report on Journey from Warrina to Musgrave Ranges. By authority: 1889.

‡ Report to Surveyor General (*Adelaide Observer*, January 16, 1892).

§ Geogr. Travels in Centr. Austr., 1872-1873, Part ii., page 84.

‖ Parliamentary Paper, No. 48, House Assembly, 1874, page 16.

consist of fine-grained gneiss, the granitic outcrops being in the heart of the range. The main intrusion thus extends east of the pass towards Mount Woodroffe, thence taking a more northerly turn in direction of Mount Carnarvon; it has its greatest development east of Harries' Spring, while on the eastern borders of the range gneisses predominate. In this respect the Musgrave resemble the Mann Ranges

A subsidiary arm of the main injection of the igneous rock produces a prominence in the neighbourhood of Mitchell's Knob, the major and minor veins of the same enclosing clastic (?) gneisses. (See fig. 1.)

The ranges on the northern flanks, north of Mount Ferdinand, present a picturesque appearance, produced by grotesquely shaped, isolated, bare, granitic masses *(Sekundäre Kuppen).*

The granite, particularly that of the porphyritic variety, is characterised in the field by its strong tendency towards concentric weathering, large shells of rock exfoliating concentrically to the present contour of the rock surface. This feature is deserving of particular notice.

In the valley of the Ferdinand, west of the mount bearing a similar name, the character of the granite changes to a more even-grained, white variety, with irregular aggregates of hornblende and biotite distributed through its mass. Where this granite has been cut by diorite the contact is marked by a development of large idiomorphic crystals of hornblende. In the same locality minor veins of epidote granite, with a red orthoclase felspar, and graphic granite traverse the main granitic mass in a westerly course.

East of Lungley's Gully an intrusion of red aplite is delicately veined with crystalline epidote, and the planes of slickensiding, that cut the rock, are lined with a "*harnish*" of secondary mica and rhombohedral calcite. The rock is conspicuously jointed in two planes, the first of which strikes W., 20° N., and dips northerly 73°, the second striking N., 45° E., and dipping 23° S.E.; a third plane is less regular. Rocks belonging to the peridotite family were found in the form of pebbles among the wash of a small watercourse south of Mount Morris, but the rock was not observed *in situ*. Diorite dykes are very plentiful. The diorite rock is normal, quartzless, and moderately fine-grained. It is usually micaceous. Dolerite dykes are less numerous. They consist of a finely crystalline groundmass with porphyritic crystals of felspar and pseudomorphous (?) epidote. Dykes of a peculiar volcanic rock are rare. Fluidal structure is typical when viewed under the microscope, it being marked by ores of iron in a glassy groundmass. Corroded phenocrysts of olivine are plentiful.

Metamorphic Rocks.—The gneisses of the Musgrave Ranges, derived both from the alteration of sedimentary and igneous rocks, with few exceptions, skirt the chain on either side; they also form the intermediate flanks of folds produced by the intrusion of the eruptives. They do not extend to the same altitude as the igneous rocks, and, as is the case in the Mann Ranges, they appear more extensive on the eastern than on the western limits of the range.

A natural section along the course of Whittell's Creek presented a variety of schists within small range of country. The section showed a gradation from a compact gneiss through a series of beds, as follows:—Quartzite, quartz schist (laminated), schists of various kinds (mica, chlorite, epidote, and garnetiferous, with numerous perfect dodecahedral crystals of garnet in a dark quartzitic, schistose matrix); thence quartzite, jointed regularly in two directions at right angles. The strike varies from almost due north and south to east and west; the latter is, however, the general strike of the beds of this section. East of Mount Woodward the gneisses are in parts compact, in parts fissile. They are jointed vertically in direction north, few degrees east, and at right angles to this plane. The planes of foliation dip south. North of here it is distinctly granitic in character, and separated into more or less horizontal (lenticular) layers by planes of division; these layers thickening appreciably as the depth increases *(Bankförmige Absonderung).* At the contact with a diorite dyke it has assumed a remarkable, closely foliated character; the folia, produced by a very dark coloured biotite and stringlets of quartz running parallel with the direction of intrusion.

The gorge cut by the Opparinna Creek affords another section within the gneisses that skirt the watercourse in the form of scarped, shattered walls. They show signs of earth - movement and folding, and are replaced in parts by smaller bands of chloritic and sericite schists, often traversed by small seams of epidote at the zone of contact with diorite dykes. At Opparinna Spring the country consists of a compact, dark bluish-black gneiss, vertically jointed in directions W., 20° N., and N., 10° E. (less perfectly), and in planes dipping S. 5°. Along the last-mentioned plane the rock parts readily into layers about twelve inches thick. North of the spring the metamorphic series changes to a compact brown gneiss, weathering massive granitic, and showing a regular cubic jointing. The texture, in parts, approaches the "graphic" intergrowth of some granites, the quartz occurring as rounded and elongated inclusions *(quartz de corrosion)* in the felspar.* The optically-continuous character of the quartz and felspar can readily be detected in hand specimens by suitably reflecting the light from a freshly fractured surface. The planes of foliation of the true gneiss strike W., 20° S., and dip northerly 11°.

South of Opparinna Spring the gneissic quartzites † composing the ranges are thrown into a great overthrust fold which can be observed on the eastern face of the gorge cut by Moffat Creek, by following up the exposure of two prominent parallel layers of the rock. These, on the south, dip at a low angle of about 30°, and on the north the same bands are seen dipping in the same direction at a high angle, with an inward curve at the top. The crest of the fold has been removed by denudation; yet the outline of the original contortion of the beds, upon reconstruction, was evidently as represented in the figure. Within the fold exists a zone of extensive dioritic intrusion, while the country is severely fractured.

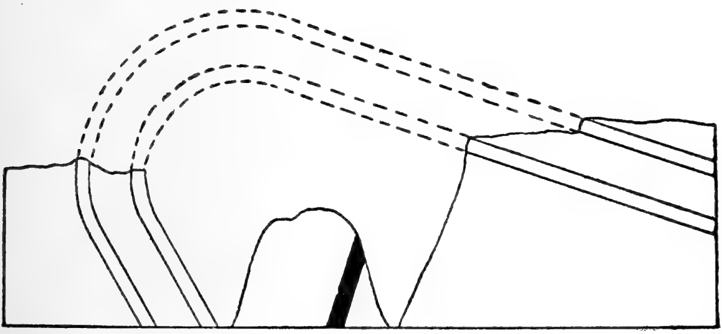

FIG. 2.—AN OVERTHRUST FOLD IN BEDS OF GNEISSIC QUARTZITE. MOFFAT CREEK, SOUTH OF OPPARINNA SPRING, MUSGRAVE RANGES.

A similar feature, though on a smaller scale, was encountered in Jacky's Pass. Beds of gneiss are in this case bent to a considerable degree; a diorite intrusion within the fold accompanied the earth-movement.

Several island-like masses of gneiss rise above the sands to the west and south-west of the group of hills termed the Kelly Hills. One of such occurs close to a native soakage

* Lacroix has described a somewhat similar type of gneiss from Southern India.—Record Geol. Survey, India, xxiv., page 157 (1891).

† No doubt equivalent to the "granitoid quartzites" of this locality mentioned by R. W. Murray. Extracts Journals of Explorations, by R. T. Maurice (by authority: 1904, page 29).

well, known to the natives as Tarrawaitarratarra, and it has been conditioned by the intrusion, within a series of schists, of pegmatite and greisen. The muscovite of the pegmatite is remarkable for its peculiar reddish-violet tint, closely resembling that of lepidolite, but failing to give the characteristic flame test of the latter. The mica, moreover, of one of the schists is similar to that of the true igneous rock, though it occurs as smaller individuals. The schist is usually a closely laminated, quartz-mica rock, often "knotted" by secondary mineral development; while at the contact with a diorite dyke on the summit of the hill a finely foliated gneiss has been produced. The planes of schistosity strike N., 12° E., and dip 40° E. The height above sea level of the exposure is 2,100 feet, and it stands 140 feet above the sand plains. The beds have suffered local displacements; planes of shear are thickly lined with a glossy layer of secondary minerals.

Outcrops some miles to the north of this exposure were presumably observed to be overlaid by conspicuous beds of quartzite. Opportunity was not afforded to determine whether these beds form part of the fundamental series or whether they are unconformable to the schists.

The hills further south are composed of rock of the compact granitic character already discussed. In parts they are of the "fluxion" type of gneiss, and they are characterised by weathering concentrically.

Outliers of the Musgrave Ranges.

The Musgrave Ranges are bordered on the south by numerous outliers of granitic rock, many of which are of considerable magnitude, and have consequently received separate names. A few of these outliers will be briefly discussed: —

Mount Caroline.—South of that portion of the Musgrave Ranges known as Lungley's Gully, about eight miles, stands a bold, isolated mount, over 1,000 feet above the level of the sands. It is known as Mount Caroline. Its mass is composed of biotite granite, with a slight tendency to foliation on the part of the mica. Large porphyritic, corroded crystals of orthoclase predominate, the quartz being subordinate to the felspar. The rock at the surface is decomposed. It is cut by a diorite dyke that can be distinguished on the western front from a distance as a black wall running up the entire height of the mount. Smaller portions of graphic and epidote granite are included within the mass.

The hill bears porcupine grass, pine and fig tree, and a light-coloured lichen covers the massive exposures of the granite.

Low outcrops of gneiss trending in a north-easterly direction lie not far to the north of Mount Caroline.

Mount Crombie.—Still further south, and about twenty miles from the above, another conspicuous outcrop of granitic rock, bearing the name of Mount Crombie, is situated. The northern outskirts only of this exposure were visited. They consist of gneiss, whose dark planes of biotite strike roughly east and west. The rock exfoliates concentrically at the surface into large shells, which subsequently break up regularly into cubical blocks in well-defined rows, corresponding to a latent system of planes of weakness brought into prominence by weathering. A diorite dyke intrudes the gneiss in direction W., 42° N.

Mount Kintore.—Mount Kintore rises from beneath the desert south of the gap that separates the Mann from the Musgrave Ranges. It is built up principally of metamorphic beds intruded by diorite dykes. The beds, comprising gneisses and quartzite, have been thrown into a series of simple folds, which is well recognisable on the northern face of the mount. Gross shattering and crumbling of the rock have accompanied the folding. The strike of the beds varies slightly, about south-east, and it is made prominent by the weathering of the rock into ridges conforming in direction with that of anticlinal axes.

At the western end of the outcrop the gneiss is replaced by a development of graphic granite; and diorite intrusions traverse the hill in several localities.

Echo Hill.—Echo Hill lies south of the eastern extremities of the Musgrave Ranges. It is one of many minor outcrops of granitic rock occurring in this neighbourhood, and is composed of gneiss neatly "lined" with biotite. Is is cut by veins of coarse pegmatite, with large felspathic constituents, while local developments of epidote are frequent. The rock is jointed in planes striking S. 40° W., and dipping 40° N.W. The height of the hill is 2,270 feet above sea level (by aneroid determination).

The Mann Ranges.

General Remarks.—The Mann Ranges, discovered and named by Gosse in 1873, lie to the west of the Musgrave, and are separated from them by a desert tract of sandhills bearing *Triodia* and *Casuarina*. They extend as a more or less compact chain in a westerly direction, with a slight trend to the north, across the border of South Australia and the Northern Territory, a distance of some eighty miles. Isolated hillocks can be traced to beyond the border line of Western Australia, culminating to the westward in a more pronounced development, known as the Mount Gosse group of hills. The trend of the Mann Ranges, if produced in an easterly direction across the intervening tract of sandhills, is in the same straight line as the axis of the Musgrave Ranges.

Both ranges consist of igneous intrusions* and altered sedimentary and igneous rocks. The western portion of the Mann Ranges, of no great width at this end, consists almost wholly of igneous exposures. In the centre the core of igneous intrusion is flanked on either side, namely, its northern and southern boundaries, by complexes of gneiss, schist, and gneissic quartzite; whereas on the eastern limits of the range, by far the widest portion, the main intrusion lies hidden beneath the metamorphic series, into which it was injected, to appear once more at the surface to the eastward, in the Musgrave Ranges.

A ground plan of the metamorphic exposures of the Mann Ranges gives roughly a U-shaped form, the flanks that skirt the middle of the ranges forming the straight arms of the U, the curved base of the letter being represented by the thicker mass of crystalline schists at the eastern end.

As a rule, the trend of the ranges coincides with the strike of the rock, except in a few instances, where irregularity of stress produced by igneous intrusion has interfered, and where a local bulging out of the mass, no doubt the result of an igneous offshoot, has produced a spur, the axis of which does not conform with the general direction of the range.

Though mineralogically not as rich as the Musgrave Ranges, the Mann Ranges are geologically of particular interest, as they exhibit many examples of rock movements and fracture that accompanied igneous intrusion.†

Igneous Rocks.—An intrusion of granite has been by far the greatest, it continuing uninterruptedly as the backbone of the whole range, to disappear under superincumbent gneisses on the east, and occurring as isolated outliers for a considerable distance to the west. The character of the rock varies, passing from a true granite (in portions porphyritic), to various metapyrigen gneisses.‡

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* Compare J. Forrest, Explorations in Australia, III., page 243:—"The Mann Ranges are composed of reddish granite." Also J. Carruthers:—"The Mann Ranges are covered with pines, bloodwood, a few scattered gums, dense spinifex, and scattered patches of coarse grass, the formation being red and grey granite."—(*Adelaide Observer*, January 16, 1892, page 9.)

† Compare the statement:—". . . hills and mountains of the Mann Ranges, some few of the Musgrave chain, and all west of the Mann Ranges have been shivered into fragments by volcanic force, . . ."—E. Giles, Geogr. Travels in Centr. Austr., 1872-1873, Part ii., page 103.

‡ The term as employed by Dr. J. W. Gregory.

The plane of contact with the primary gneisses is mostly imperceptible. A contact zone is not infrequently found gradually merging into granite on the one side, and granitic gneiss on the other. In other cases the contact has been so fractured and dislocated for a considerable distance that the junction cannot be traced.

Large "floating" masses of bedrock were noted at several localities, as, for instance, north-west of Mount Whinham and south of Mount Edwin.

The granite in general occurs as bare, rounded, dome-shaped masses,* several chains' length of rock often appearing without the least fracture in the mass, though subsequent weathering produces large exfoliating shells, which detach themselves from the body of rock (concentric weathering). This feature is more usually presented by the porphyritic varieties, while a more typical granitic aspect is brought about by the natural systematic jointing of the fine-grained, uniformly crystalline rock. Frequently the mass shows neither of these physical features, but is grossly shattered throughout by the intense stress produced during the process of solidification of the crystallizing rock magma. Such instances were found south of Mount Cockburn, and on a splendid scale south-east of Hector's Pass, where the planes of fracture have assumed regular, contorted, and curved outlines, as though produced during the last stages of solidification of the magma, the more rapidly contracting envelope of the rock having caused the enclosed mass to part along certain curves of stress by virtue of the extreme pressure from without.

Diorite dykes are very numerous, forming a fairly regular system, usually, though not invariably, trending east and west. The best noted example of excessive intrusion by this rock was observed in the hills east of Mount Whinham, on the eastern extremity of the ranges. At this locality no less than fourteen diorite dykes can be counted traversing the gneissic hills in a distance of less than a quarter-mile, and can be clearly seen continued through a similar gneissic exposure a mile or two further west.

Metamorphic Rocks.—As stated above, crystalline schists and gneisses appear more extensively developed at the eastern end of the chain. Near the north-western limit of the main

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* Giles *(op. cit.)* continues his statement:—". . . most of the higher points of all these heights are composed of frowning masses of black-looking or intensely red ironstone or granite, coated with iron. *Triodia* grows as far up the sides as it is possible to obtain any soil, but even this plant cannot exist upon solid rock, therefore all the summits of these hills are bare."

range, the metamorphosed rock, close to the intrusive, occurs as a fine-grained, compact quartzite, passing further from the contact into a garnetiferous gneiss, with large lenticular crystals of felspar (a variety of adularia, or moonstone), having a satin-like lustre, and which, even to the naked eye, can be seen to be locally surrounded by a layer of finely crushed material derived from the grinding down of the felspar itself *(Morter structure).*

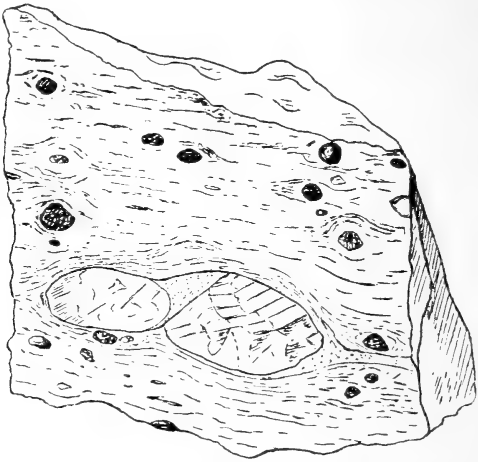

Fig. 3.—Augen Gneiss, Mount Cockburn, Mann Ranges.

In the former instance the altered rock was no doubt originally a somewhat massive, siliceous sandstone; in the latter a finely laminated rock has probably been altered by minor injection of igneous matter between the planes of lamination (injection gneiss).

South of Mount Cockburn, however, garnet-schist* and fissile gneiss occur at the zone of contact, while gneissic quartzites overlie the gneiss. It is in this locality that a natural section affords opportunity of studying the relative positions of these altered rocks. (Section on Plate xix.) A granitic intrusion appears in the form of a central axial-core,

* W. C. Gosse writes that Mount Charles is "composed of grey granite and slate." Report and Diary of Central and Western Exploring Expedition, 1873. Parliamentary Paper No. 48, House Assembly, 1874, page 12. No slate was observed in this neighbourhood, and it may be that Gosse mistook the schist or fissile gneiss for the same.

trending west, which has thrown the overlying beds into a series of simple folds: an anticlinal directly conforms with the surface of the eruptive, and consists of blue garnetiferous schist and gneiss, with "eyes" of felspar, large crystals of hornblende and fractured garnets. South of this spot the overlying beds of gneissic quartzite can be traced, occurring as two perfect sigmoidal folds, the second synclinal, with a very sharp angle, thence passing to a shallow monocline that is finally lost in the zone of crushing at the contact with a second intrusive mass. The extreme southern exposures of the range occur as outlying masses of gneissic rock, the strike of which agrees with that of the country, and the dip is southerly.

At the foot of Mount Cockburn, a low outlier of the same exposures consists of quartzitic gneiss, the foliation being imperfectly developed, and large, lenticular "augen" of felspar not infrequent. The hill shows perfect parallel planes of jointing in direction N., 15° W., dipping 75° westerly. These planes are made the more conspicuous by the resulting fissures having become filled with detritus, in which a thick growth of grass and other vegetation, standing out as dark, prominent lines from the light-coloured gneiss behind, has flourished.

To the north the augen gneiss merges on the one hand into a gneiss with *linear foliation*, and on the other into a crushed rock, with large, false "pebbles" of quartz, produced from the original rock, surrounded by well-marked, concentric "lines of flow" of crushed material. Shearing and compressive stresses have certainly contributed largely to the formation of the latter, and like forces have produced the augen gneiss, while the ultimate result of rock-crushing and shearing is the finely "lined" variety of gneiss.

Striking evidence of the extreme conditions of stress that existed during the mountain-building processes is afforded at the north-eastern end of the Mann Ranges in the form of a series of *step-faults* on a fairly large scale. The country here consists of compact gneiss, with large, bluish orthoclase and folia of biotite, intruded by diorite dykes. Ten distinct, almost vertical, scarp-faces of gneiss, rising one above the other, can be seen, each surmounted by the severed portions of one and the same diorite dyke. The igneous rock, four feet in thickness, forms the floor of each step, the vertical distances between the successive steps averaging twelve feet, and each fractured mass of the diorite dyke dipping about 10° S. The several fault planes hade 10° in a direction N. 10° E.

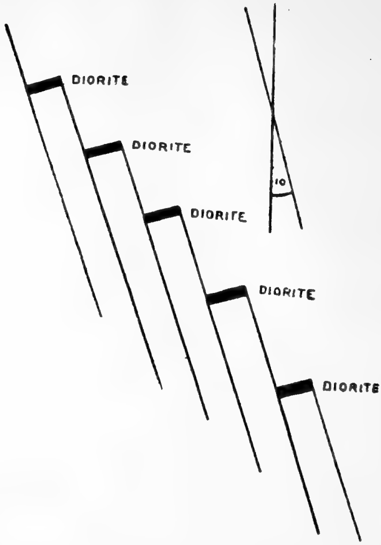

FIG. 4.—STEP-FAULTED GNEISS AND DIORITE DYKE, NORTH-EAST MANN RANGES.

An interesting phenomenon was encountered in this series of gneisses some dozen miles north-west of the western extremity of the main range, where low outcrops skirt the eastern limit of a large depression or "salt pan," the saline deposits of which rest directly upon a bed of similar gneissic rock. These outcrops have weathered by a process of *æolian erosion* into mushroom-shaped masses *(Pilzfelsen)*, with smooth central columns, narrow at the base, and gradually widening upwards to support a flat, tabular mass at the top. The stalk is abraded by deflation, the wind hurling the coarse grains of sand, which do not rise to beyond a few feet above the level of the ground, incessantly against the base of the column. (Plate xiii., fig. 2.)

Streich has reported* mushroom-like forms of sand to occur in the wind-drifted sands of the Great Victoria Desert. He states that the sand is generally loose, though somewhat consolidated by means of a clay cement, but only on the surface. When the uppermost crust has been broken through, the wind gradually blows away the underlying loose sand, leaving the upper layer unsupported around the

* Scient. Res. Elder Expl. Exped., 1891-2, Geology. Trans. Roy Soc. S.A., vol. xvi., page 88.

border. The phenomenon is really resistance to transportation of the consolidated crust by wind rather than abrasion or erosion of the underlying loose sand by æolian agency.

A further factor that plays an important part in the weathering of rocks in the desert was noted in the outcrops of garnetiferous gneiss immediately west of the shores of Lake Wilson. This form of weathering, the *Seele der Verwitterung* of Schweinfurth, consists of the flaking off of the rock as a result of crystallisation of salt within minute fissures in the mass. Portions of the outcrops, that have been previously locally hardened by cementation (concretionary), have resisted this weathering to some extent, and consequently those portions project from the surface of the decomposing gneiss as irregular, partly serrated, ridges, the direction of which is usually consistent with that of an original constant geological feature of the rock.

Veins, etc.—Comparatively few true fissure veins or lodes were noticed in the Mann Ranges. At the salt pan just mentioned an exposure of a "quartz reef" occurs in combination with a coarse pegmatite (*i.e.*, secondary quartz, in the intrusive). The quartz of the "reef" is very coarsely crystalline, the faces of the prisms exhibiting oscillatory combination to a marked degree. The felspar of the pegmatite occurs as large pink idiomorphic crystals of orthoclase. The lode is non-metalliferous.

A common method of formation of so-called "quartz blows" in the ranges is nothing more than metamorphism by igneous intrusion into the bedrock, the ultimate product consisting of a highly altered quartz schist. The best example of this phenomenon was met with south-east of Mount Edwin. The quartzose outcrop there consists of three parallel ridges of metamorphic quartz schist and granular quartz, the planes of schistosity of the former being visible either as thin layers of secondary mica or the direct products of decomposition of the same. The outcrop trends W. 40° S., and is jointed in directions: (a) N.E., dipping 70° S.E., the rock being finely laminated in this direction, and the planes of lamination a fraction of an inch in thickness; (b) N.W., in well-defined, parallel planes, few inches apart; (c) W. 10° N., and N. 20° W., in less perfect partings. This quartzitic exposure is, beyond doubt, a true product of contact metamorphism, and the difference between its strike and that of the country is explained by parallel outcrops of garnetiferous diorite dykes between the separate ridges of the formation; for these have been the cause of the metamorphism of the original schistose beds lying directly in contact with them.

Owl and Bat Guano.—In the Mann, Musgrave, and Ayers Ranges caves were found containing a considerable floor deposit of so-called guano, the droppings of owls and bats. These caverns have been produced in the granitic rock masses by the denudation and subsequent removal of included softer portions or by the more rapid weathering of the material along planes of parting in the rock. In the former case they were usually observed opening out on to the bare, more or less vertical, joint faces. Owls (principally *Strix delicatula)* appear to be frequent inhabitants of such caves at the present time. Similar deposits were discovered in the Fraser Range by the Elder Expedition.*

The "guano" consists of a faintly yellowish to dirty white, compact to flaky, or lamellar mass, with a peculiar, penetrating odour resembling that characteristic of the excrement of flesh-eating birds. The bottom and oldest layers of the deposit have assumed, not invariably, a more or less elastic character when in mass, making it somewhat difficult to detach in small pieces with a hammer. It breaks away as distinct layers or slabs.

In April, 1902, Mr. H. Y. L. Brown reported † on cave deposits occurring in quartzite near Yunta. The "guano" from this locality is almost identical with that from the ranges of Central Australia. I have had opportunity of comparing hand specimens collected by Mr. Brown with those I gathered in the Mann and Ayers Ranges. An analysis of guano from the Yunta caves made by Mr. Goyder proved the presence of phosphoric acid and nitrogen in different samples in the following proportions:—Phosphoric acid (P_2O_5) : (a) ·55; (b) 6·00; (c) 2·57 per cent.; and nitrogen: (a) 1·68; (b) 23·44; (c) ·6 per cent.‡ It is evident from the above estimations that some of our cave deposits are equal to high-class manures, though it may hardly be expected that they will ever become of commercial value. On account of their limited extent, to say nothing of the troublesome journey to the above ranges.

Analyses of cave deposits have also been published from Victoria and New South Wales.§

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* V. Streich: Trans. Roy. Soc. S.A., vol. xvi., page 99.

† Report of Government Geologist to Minister of Mines, April, 1902.

‡ See Macivor, On Australian Bat Guano, etc., *Chem. News*, May 13, 1887, page 3.

§ Notes and Analyses of Some N S.W. Phosph. Minerals and Phosph. Deposits, by J. C. H. Mingaye, Aus. Asso. Adv. Sc., vol. vii., 1893, page 332.

Mount Gosse, W.A.

Mount Gosse is situated in Western Australia, about two miles from the boundary of that State and South Australia, and ten miles north of the projected border line between the Northern Territory and South Australia. It is composed of an intrusion of granite within schistose to granitic gneiss, the foliation of which strikes west, slightly north. The rock shows cubical jointing, and the gneissic rocks are overlaid by a compact blue quartzite* possessing a perfect conchoidal fracture, the whole formation being traversed by the never-failing diorite.

A prominent hill, situated seven miles east of north of Mount Gosse, and almost on the border line, stands 2,250 feet above sea level, and 325 feet above the desert, which bears *Xanthorrhœa* and *Triodia*. It has been determined by an intrusion of granite, with porphyritic blue felspars, the trend of the intrusion being slightly north of west.

The injection lies within a linearly foliated gneiss, showing closely set veinlets of quartz. In portions the gneiss is schistose, or slightly fissile, and passes to a fine-grained, felsitoid quartzite. Minor veins of graphic granite, with a white (decomposed) felspar matrix, and epidote, are also met with.

Tomkinson Ranges.

General Remarks.—These ranges occupy the north-western corner of the State of South Australia proper, and extend westward to beyond the border into Western Australia (Mount Hinckley). They were named by Gosse in 1873. Generally speaking, their dominant features are similar to those of the Musgrave and Mann Ranges, namely, igneous intrusions within crystalline gneisses. In the case of the Tomkinson Ranges, however, the intrusive rock consists largely of gabbro, accompanied by diorite dykes. Moreover, the ranges are not as persistent and compact as those already described.

The higher intrusive bosses bear scanty vegetation, as porcupine grass,† mallee, and pine, while the lower spurs of gneiss are covered with mulga and kangaroo grass. The intervening gullies and flats were thickly clothed with grass and herbs.

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* "The formation at Mount Gosse is a quartzite, with frequent diorite veins and dykes, . . ." W. R. Murray, Extracts from Journals of Explorations, by R. T. Maurice (by Authority: 1904), page 17.

† See also E. Giles, Geogr. Travels in Centr. Austr., 1872-1874, II., page 103; and J. Carruthers:—"These hills are covered with spinifex, . . ."—Report to Surveyor-General (*Adelaide Observer*, January 16, 1892).

The Mount Davis chain includes, among others, a large intrusion of granular olivine-gabbro, * varying in colour from dirty green, through various shades of green, to faint blue. In the last case the predominance of plagioclase felspar and the presence of only a small amount of olivine have produced the bluish tint. The intrusion trends east and west as a massive, rugged chain, flanked by less conspicuous diorite dykes.

The latter, though individually smaller, are very numerous. Their direction of intrusion possesses no regularity, often cutting one another at various angles. Upon one hill, about three miles south-east of Mount Davis, two conspicuous diorite dykes can be traced up the hill slope. These dykes gradually converge towards the summit of the hill, where they ultimately cross one another at an angle of about 30°, each continuing its own course after the point of crossing. The direction of intrusion of the diorite appears more constant (east and west) on the northern side of the ranges than is the case of the more numerous examples on the south.

Very often smaller dykes can be traced in a direction nearly at right angles to the larger, from which latter they have been injected into minor fissures of the rock. The trend of these smaller dykes, in several cases, was noticed to correspond with that of the planes of foliation of the intruded gneiss, and their outcrops can be traced down to the adjacent sandy flats, from which they stand out, by their superior weathering, as marked, low, parallel walls. † As a general rule the diorite rock of the Tomkinson Ranges is of one type only: a finely crystalline, black-looking (hornblendic) variety.

A few miles south of Mount Davis a slight exposure of graphic granite occurs. The quartz that produces the hieroglyphic markings on the surface of the rock is colourless and embedded in a red orthoclase felspar matrix. The whole rock is traversed by veinlets of crystalline epidote.

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* J. Carruthers, *op. cit.*: "The Tomkinson Ranges . . . are composed of grey and red granite, with large outcrops or dykes of basalt." No basalt was found in the neighbourhood of the Tomkinson Ranges, and it is possible that the gabbro was mistaken for basalt by Carruthers. W. C. Gosse, Report and Diary of Central and Western Exploring Expedition, 1873, Parliamentary Paper No. 48, House Assembly (1874), page 13, writes:— "Mount Davis must be at least 1,500 ft. high. This portion of the range is composed chiefly of grey granite." W. R. Murray, Extracts Journals of Explorations by R. T. Maurice (by authority: 1904, page 17).

† Which Mr. Streich compares with the "ruined walls of houses." Scient. Res. Elder Expl. Exp., Trans. Roy. Soc., S.A., vol. xvi., page 93.

Metamorphic Rocks.—The gneisses occur as broken spurs and ridges, extending far outward into the sandy plains. On the north their character is granitoid and foliated, the planes of foliation striking north-easterly. The rock is characterised by bands of quartz and the presence of secondary minerals in more or less distinct layers.

North of Mount Davis outcrops of hypersthene-bearing granulite, which trend slightly east of north, present splendid examples of spherulitic weathering *(Kugelige Absonderung).* This rock is compact and granular, with little or no evidence of foliation on freshly fractured surfaces, though it is apparent on weathered faces. The rock has a peculiar olive-green waxy appearance.*

The most westerly exposure of the Gosse's Pile Spur† consists of gneiss, which is normal, though quartzitic, the quartz occurring in the form of elongated lenticles, and the mica as small flakes in regular layers of no great thickness. The rock is thickly studded with red garnets *(Almandine).* This class of gneiss predominates in the Tomkinson Ranges, it being also met with south of the main range.

Veins, etc.—Non-metalliferous quartz veins of a bluish tint and a shattered glassy character are fairly plentiful. They are usually seen in direct association with diorite dykes.

The Murru Yilyah Outcrop.—This outcrop, which was stated to be auriferous, skirts the northern foot of the Mount Davis chain for some miles in a westerly direction (W. 20° N.), with a prominent escarpment facing the north. The deposit consists of a fresh-looking, highly-siliceous rock, varying from an impure siliceous ironstone through chalcedonic and semi-opaline varieties of quartz, the chalcedony often occurring, encrusting, drusy or slightly stalactitic, or pervading the rock as irregular planes of infiltration. The silica has been tinted by mineral salts in solution, the colour ranging from a rich brick-red through pale yellow to a bright green (chromium). Small, irregular cavities exist in the rock, which are either coated with a drusy form of quartz or filled with haematite, compact to cellular. The rock breaks with a conchoidal to sub-conchoidal fracture, and small fragments, the result of weathering, cover the adjacent slopes and

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* Mr. G. W. Card, of the Geological Survey of New South Wales, who examined a section of this rock for me, writes that the hypersthene is not very abundant, and is of a deep colour. Apatite is present in noticeable amount. The bulk of the rock consists of granular quartz and felspar. Granulitisation and recrystallisation are not complete in the case of the felspar, residual portions of which may still be seen.

† Compare "Gosse's Pile Hill is of grey granite, with diorite, . . ." W. R. Murray, *op. cit.*, page 17.

flats. A pseudo-brecciated appearance within the rock is produced by simultaneous precipitations of compounds of iron and chromium and chalcedony. Surface cappings of travertine and small deposits of magnesite rest upon the outcrop in places, and more frequently upon the diorite dykes in proximity to it. The deposit is of no great thickness, and can be seen on the west directly overlying diorite. Its origin is doubtful, as it can hardly be referred to the "desert sandstone," though in some respects it is not dissimilar to it. The formation has been proved to be non-auriferous.

Everard Ranges.

General Remarks.—The Everard Ranges lie to the south of the Tomkinson, and south-west of the Musgrave Ranges. They are the most southerly of the series of elevations in Central Australia, the other members of which have already been described. They were discovered in 1873 by Ernest Giles, and subsequently (1891) visited by the Elder Expedition. Mr. V. Streich, the geologist to that expedition, points out* that the Everard and Birksgate Ranges consist almost entirely of eruptive granite, although representatives of a schistose series overlying the granite were observed, usually as outliers of the main range. Mr. Carruthers also pointed out that they "are chiefly composed of red granite."† Only the eastern limits of the range were visited by the North-West Expedition, although the main granitic chain, with Mount Illbillie as a prominent feature, was sighted in the distance, and therefore the following notes relate to that portion of the range only.

Igneous Rocks.—True granitic intrusions, often with large porphyritic felspars, have penetrated granitic gneiss. The granite at the borders of the intrusions has assumed a gneissic character, the apparent planes of foliation having a waved and plicated outline. These planes have, beyond doubt, been produced by movement of the rock magma after partial crystallisation of the constituent minerals. Veins of epidote and epidote granite, in which epidote replaces mica, are general, while interrupted veins of coarse acid secretions are not infrequent.

The intrusion of the granite has taken place in a direction a few degrees south of west, and the weathering of the softer portions of the rock has left huge, bare massifs, upon

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* Scient. Res. Elder Expl. Exped., Trans. Roy. Soc., S.A., vol. xvi., page 83.

† Rep. to Surveyor-General (*Adelaide Observer*, January 16, 1892).

the surface of which lie boulder-shaped tors that often rest in perilous positions.

Diorite and pegmatite dykes occur in fair number, the former more frequently than the latter.

Metamorphic Rocks.—The gneiss occurring in this locality is, without exception, granitic and largely "metapyrigen." The best exposures that came under notice are those occurring south-east of Artootinna soakage well. At this spot the planes of foliation, greatly contorted and folded, strike easterly, and the rock is vertically jointed in direction north and south. The foliation is made conspicuous by planes of dark-coloured biotite, the mica in the original intrusive mass being in parts poorly developed or absent.

Veins, etc.—Veins of barren quartz within the bedrock are not wanting. To the east of the ranges, further, small pegmatitic veins exist within the gneiss, containing irregular secretions of magnetite.

Ayers Ranges.

General Remarks.—The group of hills, situated for the most part in the southern limits of the Northern Territory and partly in South Australia proper, and generally known as Ayers Ranges, is hardly deserving of such a geographical term. In appearance the hills are similar, though smaller and more disconnected than the previously mentioned groups of elevation. Mr. Ernest Giles, describing these "ranges," which he discovered in 1872, from the summit of Mount Sir Henry, stated* that "the mount and all others connected with it rose simply like islands out of a vast ocean of scrub," and that the mount "consisted of enormous blocks and boulders of red stone, so riven and fissured that no water could lodge for an instant upon it."

The hills are of fair altitude; yet they appear comparatively low. This is because the red sands from which they rise cover their flanks to a considerable height. The highest point, Mount Cavenagh,† stands 2,200 feet above sea level, but only 300 feet above the adjoining sands. They may be divided into three groups: firstly, that comprising Mounts Cavenagh, Barrow, and Reynolds, all of which are portions of the same outcrop and in proximity to one another; secondly, Mount Sir Henry, situated about three miles south of the former; and lastly, a prominent southern ridge that extends into South Australia proper. All these prominences have been determined by igneous intrusions, the first two sets consisting of granite, the last of an extensive belt of diorite dykes.

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* Geogr. Travels in Centr. Austr., 1872-1874, I., page 78.

† Mount Cavenagh of Giles was re-named Mount Burton by Carruthers' party.

Lying between these masses, disconnected, rounded hills of metamorphic rock appear, rising, as in previous instances, from a vast expanse of sand.

Igneous Rocks.--The granite is somewhat coarsely crystalline, normal to slightly porphyritic, the felspar often occurring as porphyritic individuals. Magnetic ores of iron are plentifully developed. The rock is superficially rotten. The mass shows typical granitic features, with a regular, vertical system of jointing, which sometimes, by weathering, have formed large caves, notably north-west of Mount Cavenagh. The intrusion appears to have occurred in a direction north of west, and the Mount Cavenagh outcrop is divided by a series of parallel gullies running in a northerly direction. Outcrops of identical rock were found intermediate in position between Mount Sir Henry and Mount Carnarvon, thus geologically connecting the Musgrave and Ayers Ranges. About fifteen miles south of Mount Cavanagh a different type of granite is found adjacent to a belt of dioritic intrusion. It is a highly felspathic graphic granite, the felspar being a light red orthoclase, and in parts is pegmatitic. Further east it has suffered considerable metamorphism, and is veined by saussuritic rock and a coarsely crystalline, felspathic, acid modification.

Diorite intrusions are exceedingly plentiful. The southern extremity of the ranges is a pronounced ridge, rising about 200 feet above the plain, about a mile wide, and extending for several miles east and west. It is composed almost entirely of diorite intrusions, with the exception of a few "floating" masses of highly altered rock in the same. The dykes trend within a degree or two of due west, and are either regularly jointed into quadrangular blocks or weather into rounded masses resembling granitic tors. Between this prominent ridge and Mount Sir Henry a marked series of parallel diorite dykes, usually of no great thickness, continues for nearly the whole distance, a dyke being met with at every few chains. Their direction is east and west, with very few exceptions. A few low exposures of the bedrock were met with, consisting of various modifications of altered granite.

Metamorphic Rocks.—The gneiss has its greatest development in the east of the ranges, occurring as more or less isolated bare hillocks. It is linearly foliated, the planes of foliation striking N. 10° E., and dipping W. at Kurrekapinnya soakage. This fact seems extraordinary, as in all other cases noted the foliation of the gneiss coincided in direction with the trend of the intrusion, and this evidence, in conjunction with other physical features, has suggested a change in the direction of intrusion of the granite. The rock is jointed in well-defined planes, striking W. 25° N., with a northerly dip, and, less conspicuously, in planes striking N. 3° E., with a dip of 75° W. Secondary minerals line the walls of these joints, along which, moreover, slight faults and hitches have occurred.

The Indulkana Outcrop.

About twelve miles east of Indulkana Spring, adjacent to Chambers's old wagon track, a small exposure of bedrock exists, and, whilst not many square miles in extent, indications are not wanting that the rock may be found at no great depth over a much wider area. The exposure is 1,300 feet above sea level, and is surrounded on all sides by a capping of "desert sandstone" barely exceeding 30 feet in thickness.

Igneous Rocks.—The intrusive rocks are of the acid and intermediate families. Diorite dykes predominate, though it is often difficult to determine the exact planes of contact with the intruded schists on account of the severe shattering of the rock. At least four major diorite intrusions have occurred in direction east and west, with slight variations, due possibly to subsequent earth movement. The largest measures one hundred yards in breadth. In places where the contact with the schist is visible the latter rock appears baked and highly schistose, with upturned planes of schistosity. The diorite is for the most part fine-textured, quartzless, and micaceous; on the surface the rock is usually "honeycombed" by unequal weathering of the constituent minerals, the liberated iron oxides coating the surface with a "rust."

Intrusions of graphic granite, pegmatite, and greisen have occurred previous to that of the diorite. This is evident from the fact that the diorite dykes are often found cutting the pegmatite, the latter having thereby frequently suffered lateral displacement. The mineralogical character of these acid rocks varies considerably. Their common feature is coarse crystallisation of the constituents. In some dykes quartz predominates, in others it is subordinate to felspar, while mica occurs as irregular aggregates in the greisen and occasionally as an accessory in the pegmatite—in the latter case usually in a state of partial decomposition. On the western limits of the exposure igneous intrusion is marked by dykes of graphic granite and schorlaceous greisen, the latter including large, perfect crystals of black tourmaline and a light-coloured microline. The general direction of intrusion is east and west, although dykes may be found running at right angles to this. True granite is feebly represented by a coarsely crystalline rock, with pink crystals of orthoclase, rather subordinate quartz of a bluish sub-opaline character and a greenish biotite.

Metamorphic Rocks.—In traversing the outcrop from south to north a gradual alteration in the structure of the bedrock will be noticed, the rock grading from a quartz mica schist on the south, through a highly micaceous black biotite schist, to a finely foliated quartzitic gneiss, to a typical augen gneiss on the north. The strike of the beds varies (in zones of extreme pressure considerably), though the general direction appears slightly south of west. The dip is doubtful, possibly northerly. The augen gneiss, compact and granitic, contains lenticular veinlets of quartz, which are often considerably distended as a result of lateral pressure during a state of semi-plasticity, and in addition are frequently found turned upon themselves or complex-folded. The schist can be distinguished from the gneiss in the field even at a distance by contrasting its serrated lines of outcrop with the rounded, massive, boulder-like outcrops of the gneiss. On the north-east the rock consists of a rotten biotite schist, in which planes of mica have become so aggregated that the rock appears to be almost entirely built up of the pure mineral biotite. Even in hand specimens the curved and crinkled lamellæ of the mica indicate how great a stress the beds have been subjected to. The planes of schistosity of the rock strike from 10° to 20° south of east, and dip N. 32°. The beds are further jointed in directions E. 10° S., with a dip of 60° S., N. and S., with a dip of 85° W., and irregularly by a poor vertical plane. To the south this rock becomes less persistent, and has yielded more to weathering. A small development of chlorite schist occurs in contact with the augen gneiss, and a local production of hornblende epidote schist has taken place at the contact with certain diorite dykes. Skirting the north-western limits of the outcrop a finely crystalline gneiss seems to point to a zone of crushing of an igneous rock. (See Appendix. Pages 94-5.) Outcrops of quartz schist, mica schist, and gneiss extend more or less continuously westwards to Indulkana soakage well, at which spot the gneiss contains coarse vein-segregations of felspar with a development of tourmaline and titaniferous iron ore. Repeated searching for tin ore proved fruitless.

Some miles south of the main outcrop low surface exposures of ferruginous clay slates and mud stones appear, the sharp, serrated edges of the same standing out conspicuously. In some parts the rock comes near to a phyllite, and is traversed by very many small quartz veins.

Veins, etc.—The so-called "quartz reefs" of the locality are of two kinds, namely, those forming portions of a true igneous (pegmatitic) dyke, and those formed subsequently by deposition from solution in fissures of the rock. The latter have a remarkably fresh, compact, crystalline appearance, and in no case do they extend downward to any depth, but pinch out in less than a dozen feet; they are the fillings of wedge-shaped fissures within the diorite dykes. A typical instance of a "reef" occurs one mile east of Krupp Hill. It measures four feet in width at the surface, but its walls rapidly converge to a point in depth. The fissure walls strike E. 8° S., the northern wall dipping 60° S., the southern 80° S. The quartz is either milky or glassy. The formation may be termed a "dead lode,"* although pyrites is disseminated through the vein, and in one instance a trace of grey copper ore was discovered. The pyrites crystals that impregnate the mass are decomposed near the surface, leaving small cavities containing sulphur and a little limonite, the remaining products of decomposition having stained the numerous cracks and crevices in the quartz. Slight quantities of secondary minerals (chlorite) occur locally, and the walls of small cavities are coated with drusy quartz.

Few miles west of Indulkana soakage a lode of siliceous ironstone† stands out conspicuously from a fissure in the crystalline schist. It is possible that this lode overlies a diorite dyke.

Cambrian.

No representatives of the Cambrian system were discovered in the vicinity of the north-western ranges, none of the contact rocks having disclosed any trace of organic remains in any shape or form. However, limestones that must without hesitation be correlated with the Cambrian strata of the Flinders Range occur at the head of Lake Torrens. The outcrop occupies but a small area at the surface, being about three miles in length, in direction east and west, by two miles north and south. The beds are massive, though they extend to no great vertical height above the general level of the country; they stand as large, separated blocks resting upon a more compact body of rock below. The beds seem to strike westerly, although considerable variation (up to N. 25° W., and more) were observed. On the southern limits of the exposure they have the form of a slight syncline, the dips of the strata on either side of the axis of folding being low (12° and 25° respectively). They are jointed vertically in two directions at right angles to one another. The rock mass, as a

* One sample of this rock, that was subsequently assayed, returned a mere trace of gold (accidental?).

† Mr. H. Y. L. Brown has noted a "lode outcrop of ferruginous quartzite and iron oxide" to occur in this locality, and is probably the same as that referred to.

whole, shows no signs of bedding, but the impurer portions (siliceous) exhibit faintly planes of deposition and current bedding that are rendered more apparent on partial denudation of the rock. The character of the rock varies from a bluish, sub-crystalline limestone to a granular marble, to be in parts replaced (in the upper layers) by coloured siliceous and dolomitic limestones. The crystalline limestone contains accessory minerals, as small, perfect crystals of fluorite and aggregates of ankerite, while carbonates of copper occur as locally concentrated fissure fillings and pockets of inconsiderable magnitude or quality. Chert nodules that have possibly been derived from solution of contained radiolarian tests, or enclose the spicules of Cambrian sponges,* weather from the surface of the limestone, by virtue of their superior hardness. They are flattish-ovoid in shape, and are bounded by regularly curved, smooth surfaces.

Ordovician.

Exposures of beds of the Ordovician period were met with in districts widely separated from one another, namely, at Indulkana, Mount Conner, and the Mount Kingston outcrop.

Indulkana.—Mr. H. Y. L. Brown visited this outcrop in 1889, and reported † similar rocks to extend in a direction southward to Arcoollina Well, and for a long distance westwards. Mr. V. Streich passed the same outcrops two years later, ‡ and traced the western boundary of the same formation to Townsend Ridge, over one hundred miles beyond the border line of Western Australia.

On approaching the Mount Chandler range from the north, it has the appearance of a tableland, with its surface sloping slightly westward. This is not, strictly speaking, the case, for, on entering the range, it is found to consist of a series of parallel ridges trending from east to west. The whole formation at this locality appears in the form of a shallow, synclinal trough, the axis of which pitches east and west. The strike of the beds is E. 5° S. The rock is composed principally of a

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* Since writing this paper Mr. R. Etheridge, jun., of Sydney, has kindly examined a section of one of these nodules for me. He writes that, "the micro-section of the nodule appears to consist of calcite and chalcedony, with perhaps a third undetermined mineral. I cannot distinguish any trace of organic structure."

† H. Y. L. Brown: Report on Journey from Warrina to Musgrave Ranges (by authority: Adelaide, 1889).

‡ V. Streich: Scien. Res. Elder Expl. Exped., 1891-2, Geology. Trans. Roy. Soc., S.A., vol. xvi., page 80.

hard, compact, fine-grained quartzite, merging in parts to a more friable sandstone and grit, portions being ferruginous. A prominent parting of the rock coincides with the original planes of bedding, while further two joints, not very persistent, occur: one in direction N. 20° E., dipping 65° easterly, and another at right angles to this. Planes of shear are highly polished by slickensiding, and in parts the rock has been severely fractured. Drift bedding is much in evidence, and makes the determination of strike somewhat difficult at the eastern limit of the outcrop. The rock has a tendency to cavernous weathering, one of the largest caves having been occupied as a store by the Government surveyors.

The quartzite overlies unconformably schists and clay slates, the planes of schistosity and cleavage of which stand at a high angle. The direct junction is for the most part hidden by the "waste" of rock that has accumulated at the foot of the escarpment, but in a small watercourse on the east the direct contact can be observed for a limited distance, the quartzite resting upon decomposed clay slate.

Although the underlying pre-Cambrian beds are extensively intruded by diorite, pegmatite, and other dykes, no such intrusion was observed to penetrate the overlying quartzite.* The same is true with regard to large quartz reefs occurring in the immediate neighbourhood. From Mount Chandler the quartzite extends eastward as low, disconnected ridges, and was subsequently found at Camp 7 (Krupp Hill) overlying pre-Cambrian schists, but not overlain by desert sandstone, which, however, directly overlies low outcrops of pre-Cambrian rocks in the vicinity. This fact would indicate a fair altitude of the quartzite during late Cretaceous times.

At Ewintinna soakage outcrops of the same formation take a northerly curve, the beds locally striking N. 25° E. The rock at this spot is, similarly, a quartzite, slightly banded and sub-fissile, and in parts traversed by numerous wavy veinlets of secondary quartz. The rock is parted by a prominent strike-joint, dipping about 75° westerly, and another plane dipping 85° in the direction N. 25° W. A few miles south of this soakage the quartzite was found to have its strike identical with that of the Mount Chandler outcrop.

Mount Conner.—This monolith, rising to a height of 2,600 feet above sea level, and about 800 feet above the level

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* Compare the statement:—". . . the granite and other dykes and quartz reefs do not extend into these rocks." H. Y. L. Brown, Report of Geological Examination of Country in Neighbourhood of Alice Springs (by Authority: Adelaide, 1890).

of the desert in which it stands, forms one of a remarkable series of three conspicuous landmarks situated north of the Musgrave Ranges; the other two being known as Ayers Rock and Mount Olga. Mount Conner, rising abruptly from the surrounding desert, is a huge, table-topped outlier of a once continuous extensive geological formation. The base of the mount has a circumference of about six miles, while the plateau itself is roughly two miles long by three-quarters broad. It is surrounded on all sides by a talus, having an angle of repose of from 30 to 35 degrees; above the talus an abrupt escarpment rises to the edge of the plateau, a vertical distance of about 250 to 300 feet. With the exception of one or two pine trees the escarpment is practically destitute of vegetation.

The rock is a close-grained, compact, siliceous quartzite. The beds show a pronounced horizontal parting, corresponding with the original planes of bedding, and the rock is in portions sub-fissile and fractured, the cracks and crevices affording shelter for numerous hawks and owls.

The topmost layers of the rock are composed of a glossy, white, hard quartzite, while the lower portions assume a softer, arenaceous character, and are stained red by precipitated products of decomposition. In places the quartzite contains irregular bands of well-rounded pebbles of altered sedimentary rock (banded and black quartzite), producing locally a conglomerate. Peculiar false-bedding-like markings are found, not infrequently surrounding these conglomeritic portions, and the quartzite contains segmented ferruginous segregations, which are not altogether unlike organic remains. The strike of the rock varies from west up to 30° north of west, the beds forming a shallow synclinal fold. Portions of the quartzite are shattered into small blocks, fairly regularly bounded by conchoidal surfaces, huge masses being in cases thus reduced to fragments, lying loosely together in a state of unstable equilibrium. This phenomenon is a direct result of insolation. (Plate xiv., fig. 2.) Mount Conner is surrounded by low, rugged outcrops and ridges of fissile quartzite, "covered with dense mulga" and "marked by a low cliff."* The quartzite is banded, and weathers into large flat slabs. The strike varies.

THE MOUNT KINGSTON OUTCROP.—Mount Kingston is situated west of Mount Watt, the portion of a southern Ordovician outcrop that was examined by Messrs. Tate and

* W. H. Tietkens: Journ. Cent. Austr. Expl. Exped., 1889, page 59.

Watt on the Horn Expedition. These authors report* that Mount Watt is composed of a hard, dense quartzite, much fissured, and with few ferruginous bands. Fossils were obtained in the form of casts in large numbers in the quartzite.

The exposure† examined by us is situated about six miles south-west of Mount Kingston, and appears in the form of three or four well-defined parallel ridges trending north-easterly. The rock is a compact, fine-grained quartzite, in parts highly ferruginous. In certain zones the rock is fissile, breaking into fairly large slabs from a fraction of an inch to several inches in thickness. The strike is E. 36° N., and dip 60° north-westerly. The beds are jointed in directions N.W., dipping 60° N.E., and N. 10° W., dipping easterly at a low angle. A ferruginous coating is found covering slickensided surfaces, and bands of highly ferruginous rock occur within the rock. A concretionary structure and dendritic precipitations of iron oxide are common.

The outcrop appears in the midst of the desert sandstone tablelands, the broken outliers of which surround the quartzite on almost every side. Its physical features are, however, quite distinct from those of the table-top formation, although hand specimens of the two formations may be not altogether dissimilar.

The height of the exposure above sea level, by aneroid determination, is about 1,950 feet, and about 260 feet above the level of the sand.

Mount Olga and Ayers Rock.—No doubt exists in my mind that Mount Olga and Ayers Rock are isolated remnants of the Ordovician system, the former consisting of a conglomerate,‡ the latter of a coarse metamorphic grit. These features suggest that Mount Olga was probably situated close to the old Ordovician land surface, Mount Conner being distant, and Ayers Rock in a position intermediate between the two.

The geologists of the Horn Expedition § have already hinted at the possible Ordovician age of Mount Olga and Ayers Rock, while Mr. Brown, judging from specimens col-

* Tate and Watt: Rep. Horn Exped. Centr. Austr., General Geology, page 59.

† Mr. Wells has erected a small pile of stones on the highest point of this exposure.

‡ Compare W. C. Gosse, Parliamentary Paper No. 48, House Assembly, 1874, page 11:—"This range is formed of a number of round-topped masses of solid conglomerate rock (known as pudding stone), but with stony, spinifex slopes, from 100 to 300 feet rising to their foot. Each hill is a separate rock."

§ Tate and Watt: *op. cit.*, page 59.

lected by Mr. Tietkens, was inclined to consider Mount Conner younger than the other two members.*

Desert Sandstone.

The term Desert Sandstone, which was originally used by Daintree for a highly siliceous deposit that is often found overlying the fossiliferous Cretaceous of Australia, is, to a certain extent, misleading, as the formation is only to a limited extent a true sandstone. Mr. H. Y. L. Brown employed the term Super-Cretaceous, and later Professor Tate and Mr. Watt Supra-Cretaceous, for the same formation. Messrs. Jack and Etheridge regard the desert sandstone as Upper Cretaceous.

No conclusive evidence concerning the exact relationship was found, but I observed that the desert sandstone in many places, particularly at Indulkana, unconformably overlies intruded primary schists. This fact, if the formation is to be correlated with the cretaceous, would demand, as Professor Tate suggested, that the desert sandstone overlaps the latter

Beds of this formation occur along the track from Oodnadatta westward to Indulkana. Such trigonometrically-surveyed heights as Mount Mystery, Mount Alberga, and De Rose Hill are prominent members of the series. From Indulkana, the north-western limit of the formation in South Australia runs east of north in a direction west of Crown Point; beyond this line the primary and intrusive rocks of the Musgrave, Mann, Tomkinson, and Everard Ranges, no doubt, were high land surfaces during the deposition of the desert sandstone formation. Slight surface exposures only of the so-called sandstone were observed, immediately south of the Mann Ranges at Hector's Pass, in the form of a low bank of rather decomposed, friable, silicified quartzite and white, semi-opaline quartz a mile or two east of the pass. A similar semi-opaline rock was found a few miles south-east of Giles West Camp (Musgrave Ranges), and south of Ayers Ranges, in the Northern Territory. Indications of the formation exist, as rock fragments, strewn on the surface, north of the Mann Ranges.

To the south, the whole of the elevated country lying between Oodnadatta and Lake Torrens that was traversed by the Expedition, consists of desert sandstone, with the exception of comparatively few exposures of palæozoic rocks, as in the neighbourhood of Mount Woods and at the head of Lake Torrens.

The formation, as a whole, occurs either as isolated table-topped hills or as groups and ranges of the same. The

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* W. H. Tietkens: Journ. Centr. Austr. Expl. Exped.: Section by H. Y. L. Brown.

hills are almost invariably capped by an exceedingly hard, silicified layer of rock, the base being of a more friable and softer character.*

At Indulkana the top layer is composed of a compact, chalcedonic grit, with irregular, sub-angular fragments of colourless and blackish quartz scattered through the mass, with a secondary interstitial cement of a form of quartz. Though the rock may be a coarse grit, the surfaces of fracture, which are in parts sub-conchoidal, are remarkably smooth; the compactness of the rock causing the planes of fracture to pass through the included particles. Professor Tate described the desert sandstone as being composed of "sharp grains of glassy quartz, varying much in size, cemented by opaque, white siliceous matter, and more or less stained red by oxide of iron." This description would apply equally well to the Indulkana outcrops. In places the formation becomes very fine-grained, showing a laminated character or a distinct fissility, and a fairly regular system of vertical jointing, in a north-easterly direction.

A second variety of desert sandstone has been produced by an opalisation of the mass. Examples of this character were seen at Hector's Pass (Mann Ranges), south-east of Giles West Camp (Musgrave Ranges), and south of Ayers Ranges (Northern Territory). The rock is an impure form of common opal; in colour white to bluish-white; containing cellular cavities and small black inclusions of carbonaceous matter. It breaks with a true conchoidal fracture. Surface outcrops only were found of this variety.

At North Creek the formation consists of a very fine-grained, splintery, chalcedonic quartzite, the individual grains being hardly distinguishable with the naked eye. The rock is traversed by small veinlets of oxide of iron, subsequently precipitated. The colour varies considerably: white, yellow, reddish, blue, and purple. The rock is brittle and rings when subjected to the blows of the hammer.

At Yarrabollinna Waterhole the character of the rock again changes entirely. Large, bluff-shaped masses are composed of an excessively fine-grained form of silica, so fine that it shows no sign of a gritty feel when rubbed between the fingers, resembling somewhat the touch produced with kaolin, which mineral is present in small measure only. The pure forms are snow-white, others are variously tinted. Within this deposit nodular masses of a cherty form of silica occur, which are bounded by an outer concentric growth of white chert. (See Plate xv., fig. 1.)

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* See Tate and Watt: Rep. Horn Exped. Cent. Aus. Phys. Geog., page 8; General Geology, page 68.

In the same bed are found nodules of barytes, with a radiating, concretionary structure. They are more or less spheroidal in shape, being flat or concavely indented in the plane of the longer axis. Others are flatter, broadly discoidal. Their dimensions vary considerably, the largest being about four inches in diameter. The smaller forms have a tendency to slit horizontally in two.*

A more argillaceous variety of desert sandstone, spangled with tiny flakes of mica, was observed south of Stuart's Creek Cattle Station. This outcrop weathers more like a shale than the sandstone generally.

Fossilised wood was found in the desert sandstone at a few localities, notably west of William Creek, in the neighbourhood of Beltabeltana Waterhole, where it is plentiful. Other fossils were not observed in this formation.

The most picturesque and rugged range of disconnected masses of the desert sandstone formation came under notice in the locality known as the Serrated Range. This range is composed of peaks, bluffs, pillars, and tables, often of a very quaint appearance, and tinted in various shades of colour. The formation may with justice be called the Mauvaises Terres of Australia, as have been termed the Cretaceous desert formations of North America.

Owing to the porcelainised, brittle character of the rock, particularly of the overlying hard band, it gives way readily and suddenly when subjected to irregular strain. It is on this account that the sandstone, wherever met with, has been more or less broken up into fragments, often terminated by conchoidal faces; the phenomenon being the result of subjection to extremes of temperature within a short period of time (insolation). These fragments are subsequently scattered over the plains between the table-hills by the floods which occur at rare intervals, and are known as gibbers (less frequently shingle or gravel). The gibbers form

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* I have recently had opportunity of seeing identical concretions in the Sydney University Museum, which were collected by Mr. E. F. Pittman from the opal-bearing strata at White Cliffs. Through the courtesy of the Mines Department of New South Wales I have been permitted to annex the following analysis by Mr. J. C. H. Mingaye:—

Analysis of a Nodule of Barytes obtained from Opal-bearing Strata at White Cliffs.

04·1666

Barium sulphate	95·35
Ferric oxide and alumina	·50
Silica	2·60
Water	·72
Lime, magnesia, and undetermined	·83
	100·00

stony plains, and have already been referred to by Sturt as the stony desert. Owing to the extensive denudation of the desert sandstone the gibbers cover a considerable area of Central Australia. The lateral transportation of the stones by water action cannot be considerable, owing to the level contour of the intervening plains; in fact, they are deposited, on the removal of the softer, underlying portions more or less vertically below their original position *in situ*. On the slopes of many of the hills in process of disappearance the stony "wash" has accumulated in rounded terraces or steps, transported by torrential floods.

The reflection of light from the smooth surfaces of these stones, when travelling towards the sun, is irritating to the eye. The glaze has been described by Mr. Brown as being "probably due to the action of siliceous water," and the effect is in small measure increased by a slight, glossy surface coating of precipitated iron oxide. The superficial polish has also been assisted, as has been suggested, by the action of wind-driven sand.

The gibbers consist mainly of different varieties of quartz —forms of agate, jasper, chalcedony, and semi-opal—while in association with them occur concretionary forms of limonite, often assuming grotesque shapes. Gypsiferous clays were met with throughout the area covered by this formation, and, in them, large slabs of transparent gypsum that have been produced by crystalline intergrowth. In addition to these, various nodules, that occur in the softer portions of the rock and resist the denudation to a greater extent, are found.

Obsidian Bombs (Volcanic).—These are widely distributed over the desert sandstone area, and have been the cause of much discussion, without any satisfactory deductions as to their origin. The phenomenon, which points to a former surface deposition, somewhere, of volcanic *ejectamenta* has given rise to various theories, such as meteoric, glacial, and of volcanic action *in situ*. Comparatively few examples were found during the Expedition, though single specimens were collected near to the Mann, Musgrave, and Ayers Ranges. I have, however, received a number of specimens from Mr. McNamara, from the neighbourhood of the Peake. Their universal distribution has, no doubt, been assisted by the agency of the native and the emu (in the form of "gizzard stones"). The natives call obsidian bombs *Pandölla* and *Kaleya korru*, the latter meaning "emu eye." They are collected by the medicine men of the tribes, and applied in the healing of sickness.

Recent Deposits.

Sand.—With the exception of the various outcrops of rock previously discussed, sandy deposits cover all the adjacent country to the north-western ranges of South Australia, and extend for many hundreds of miles north, south, and west, the tablelands on the east checking the accumulation to a slight degree in that direction.

The height above sea level of these deposits is considerable, the sand ascending to an altitude of 1,900 feet in the Ayers Ranges, and to 2,200 feet in the locality north of Opparinna Spring. It is on this account that all the larger valleys cutting the ranges have become filled up with elevated deposits, from which large, gum-lined creek beds emerge, to be subsequently "lost" in the sands adjoining the ranges. This drifting cover is embarrassing to the prospector, as the higher portions of the ranges alone can be examined, the more favourable contact-rocks being for the greater part hidden underneath the great depth of sand.

The material of the deposits consists of a moderately fine-grained, incoherent sand, the grains being usually superficially coated red by oxide of iron. In proximity to the ranges these sands are more loamy, and have been bound together by vegetation. There, also, they contain other constituents derived from the decomposition of the primary rocks, such as cleaved fragments of felspar and hornblende, flakes of mica, small nodules of limonite (iron-shot), and occasional patches of garnets. Beyond the belt influenced by the ranges, the sand is loose, incoherent, and subject to a continual drift. In these regions the sand accumulates in the form of more or less parallel undulations or sandhills, mostly incoherent throughout, but occasionally very slightly cemented superficially. The direction in which these sandhills trend, being at right angles to prevalent winds, is east and west, south of the Musgrave Ranges, although the more usual direction observed further south, in the basin of Lake Torrens, is south-west. Frequently two such parallel undulations unite to form one,* thence continuing as one in the same direction. Nuclei which had in the first place started the formation of sandhills were observed north of Mount Crombie, in the shape of low outcrops of granite, while a few miles south of Stuart's Creek a prominent "sandhill" consists of a former tablehill of desert sandstone, almost completely covered with drift sand, few exposures only of the rock being visible, and limited to one side of the hill. The source of this vast amount of sand must be attributed to the æolian waste of the desert sandstone formation.†

* Streich states that the "sand dunes" of the Great Victoria Desert are "very seldom found confluent."—Trans. Roy. Soc., S.A., vol. xvi., page 89.

† Compare E. F. Pittman: On the Cretaceous Formation in the North-Western Portion of New South Wales. Rec. Geol. Surv. N.S.W., vol. iv., Part iv., page 146.

The wonderful capacity for binding the sand displayed by the porcupine grass (*Triodia spp.*) can be favourably compared with that of *Spinifex hirsutus* on the dunes of our sea shores.

Travertine.—Travertine was only found as small, local, surface coverings, most frequently along the banks of creek beds, where it is regarded as a valuable guide to subterranean water. Examples occur along the course of Opparinna Creek and certain creek beds in the Tomkinson Ranges.

Travertine was further noted in many instances to overlie diorite dykes, a breccia having often resulted from the cementation of originally loose rubble derived from the dykes (Opparinna). The travertine occurring at the foot of Mount Davis, in the Tomkinson Ranges, deserves notice on account of its extreme compactness and hardness, it being almost resistant to the blade of a knife. At Stuart's Creek a small deposit of banded travertine has been produced by the precipitation of successive layers differently coloured by varying magnesian and carbonaceous contents.

A thick incrustation of calc-tufa was discovered in the Musgrave Ranges. To the west of Opparinna Spring a series of rock waterholes is to be found along the bed of a rugged gorge enclosed by steep walls of gneiss. One of such holes is situated at the base of a waterfall that has been produced by the intermittent flow of a creek over a locally hardened band of blue garnetiferous gneiss, the softer rock below having become undermined. This deposit of earthy, calcareous sinter, with a fair percentage of included organic matter, occurs as regular stalactitic and mammillated masses, hanging from the under side of the indurated ledge or bank of gneiss. The formation produces an imposing aspect.

APPENDIX.

Petrological Notes on Rocks Collected on the Expedition.

Granite.

Locality.—Mann Ranges, outcrop fourteen miles west of Mount Samuel.

Macroscopically.—Granitic, porphyritic; the felspar occurring as large (up to 2·7 cm.), more or less lenticular, porphyritic crystals, rounded by the chemical (?) corrosion of the rock magma. Felspar dark grey, fresh, in places not unlike the greasy-looking elaeolites of syenites.

Quartz in smaller, blackish, segregations throughout the mass. Mica black, not infrequently as lenticular aggregates having their long axes indistinctly parallel, and surrounded by a border of pink secondary mineral. The rock has suffered from the effects of mountain building forces.

Microscopically.—Rock with a holocrystalline groundmass, in which the larger crystals of felspar are embedded.

In parts the quartz (appearing normal in plain light) when viewed in plane polarised light, proves to be microscopically separated into numerous contiguous particles; micrographic intergrowths with the felspar common; generally speaking it is allotriomorphic, crowded with inclusions, and its fissures stained by oxide of iron, subsequently precipitated.

The potash felspar is clouded and crowded with minute inclusions, which are frequently arranged in parallel bands, and some, on decomposition, locally stain the enclosing mineral. The felspar crystals are corroded and surrounded by a border of secondary mineral fibres, radially arranged; the cleavage cracks are filled with secondary mineral, polarising with high colours. "Strain shadows" traverse the quartz and felspar crystals on rotating the stage with crossed nicols.

The mica, a rather decomposed dark green biotite in irregular aggregates of crystals, is almost invariably surrounded by a broad band of closely set, pink garnets, which are minute (averaging ·005 millimetres in diameter). The individual grains appear rather to have been separately developed than to be crushed parts of larger garnets. Optical anomalies are general among them.

Magnetite is scarce; the rock also contains patches of an earthy form of iron oxide. Epidote as a scantily developed accessory (secondary), in small though conspicuous (on account of the high refractive index) aggregates with no definite geometrical boundaries.

Granite.

Locality.—Mount Sir Henry, Ayers Ranges.

Macroscopically.—A moderately coarse-textured, holocrystalline rock, considerably decomposed; the quartz and felspar appear brown from iron pigment; the black-looking mica in fairly large, irregular aggregates.

Microscopically.—Texture typically hypidiomorphic granular, the rock being composed essentially of quartz, felspar species, and biotite. The normal order of crystallisation from the rock magma has generally prevailed, although the mica occurs in parts interstitial to the felspar. A micrographic intergrowth between quartz and felspar on a very minute scale is apparent, and the former contains numerous unindividualised inclusions in parallel bands.

Felspar is of two species: orthoclase and a delicately twinned plagioclase. Decomposition has acted to a considerable extent upon many of the constituents; the felspar, being clouded when viewed by plain transmitted light, becomes brilliantly tinted in the dull portions under crossed nicols on account of the strong double refraction of the products of decomposition (kaolin). Orthoclase is somewhat subordinate to plagioclase; the cleavage cracks and borders of both are lined with oxide of iron.

The mica, a green biotite, occurs principally as aggregates of flakes, partially decayed; the whole rock section, moreover, is speckled with minute particles of biotite.

Magnetite is fairly plentiful, usually surrounded by a layer of secondary mineral.

Apatite is present as stout, prismatic individuals, with prominent cross fracture.

Hornblendic Granite.

Plate xviii., fig. 2.

Locality.—Glen Ferdinand, Musgrave Ranges.

Macroscopically.—Rock granitic, normal; composed of white felspar, colourless quartz, dark mica, and hornblende, as largish, cystalline secretions.

Microscopically.—Texture hypidiomorphic granular; the quartz and felspar uniformly distributed over the sections; the mica and hornblende not so. A fine mosaic of microcline and quartz is chaıacteristic.

The felspar is represented both by orthoclase and microcline, the former being occasionally crowded with numerous very slender, crystalline needles of zircon.

Mica (strongly pleochroic, brownish biotite), as irregular, curved, and twisted lamellæ, partially or wholly altered to a dark-green chlorite, more or less fibrous, and with a weak double refraction. Pink, fractured garnets of fair size are rather plentiful, usually, though not necessarily, in proximity to the mica and the altered chlorite.

Magnetite is present as irregular particles.

Granite.

Locality.—Everard Ranges.

Macroscopically.—A coarsely crystalline, normal granite with prominent pink felspar (orthoclase) and dark-coloured mica. The rock is deeply "honeycombed" on its surface, this being a result of the ready decomposition and removal of the felspar.

Microscopically.—Rock typically hypidiomorphic granular, consisting of clear quartz, a clouded orthoclase, and a strongly pleochroic biotite. Micrographic intergrowths between quartz and felspar are common. Magnetite scarce.

Epidote Rock (Altered Granite).

Plate xvii., fig. 4.

Locality.—Musgrave Ranges, Titania Spring.

Macroscopically.—A granular rock, composed of clear quartz and white, clouded felspar, traversed by veinlets of epidote, the small columns that build up the bulk of the epidote standing with their long axes at right angles to the bounding lines of the veins in the section.

Microscopically.—The texture of this rock, though no doubt originally holocrystalline, has been obscured by the secondary secretion of epidote; the rock has, moreover, suffered considerably from crushing.

The felspar is orthoclase, though little of its primary characteristics remains, it having yielded to metamorphism by transformation into epidote. Intermediate stages of this conversion are general.

The epidote, which is light greenish-yellow in colour, covers fully three quarter parts of the section, as aggregates of irregular, elongated, and columnar individuals. The strong relief produced by the total reflection at the border of the epidote is characteristic, and the cleavage is conspicuous in the larger individuals only.

An imperfect "cross-hatched" appearance is here and there visible on the faces of the felspar under crossed nicols. This is an extreme case of "strain shadowing" as a result of pressure.

Hematite (micaceous) is present as dark reddish-brown (by transmitted light), hexagonal plates, presenting a slight metallic lustre by reflected light. The perfect forms range up to ·27 mm. in diameter, and the adjoining minerals are invariably stained red by iron pigment for some distance around.

Gneiss.

Plate xviii, fig. 1.

Locality.—Indulkana, Krupp Hill West.

Macroscopically.—A fine-textured gneiss, consisting essentially of quartz (colourless), felspar, and biotite, the last-named being arranged in a more or less parallel manner without the production of distinct, continuous planes of foliation *(Quincuncial structure).* It is traversed by shattered veinlets of quartz. A green accessory mineral (epidote) is developed as irregular particles and patches throughout the rock, imparting a faint yellowish-green tint to the rock mass.

Microscopically.—Texture finely crystalline, granulitic, with faint parallelism in the arrangement of the constituent minerals. In parts a feeble *centric structure* is discernible.

The sections appear fresh, though a fine groundmass is here and there noticeable, connecting the individual minerals: this is the result of crushing.

The quartz occurs as small grains, with irregular or rounded boundaries, with numerous fluid pores arranged in parallel bands or scattered.

Felspar predominates: microcline crowded with inclusions (unindividualised) more or less grouped: a very small amount of plagioclase is present. "Strain shadows" are much in evidence.

Mica occurs as a dark, brownish-green biotite, with prism axes roughly parallel: some flakes have undergone partial decomposition peripherally, with the production of a green, fibrous mineral.

Magnetite, as opaque particles, with no definite boundary, rarely idiomorphic, elongate, frequently enclosed by biotite.

Zircon is fairly well represented as inclusions in the microline appearing with the rather rare elongated prismatic habit. The prisms polarise with red and green interference colours under crossed nicols; they are not surrounded by a pleochroic halo.

Epidote produced at the expense of the felspar, as colourless or faintly yellowish individuals, without definite form. Some of the felspar individuals can be observed to be partially converted into epidote, the latter appearing (with crossed nicols) as very numerous brilliantly coloured specks, almost entirely obliterating the characteristics of the felspar.

The gneiss in many respects resembles a granulite, though garnets, usually characteristic of granulites, are entirely absent.

The rock seems beyond doubt a "metapyrigen gneiss."

Gneiss.

Plate xvi., fig. 2.

Locality.—Mann Ranges, south-west of Mount Samuel.

Macroscopically.—A compact granitic rock, with a tendency to foliation, the mica in elongated patches, whose major axes point in one direction; advanced in decomposition superficially.

Microscopically.—Texture granular with a quartz-orthoclase mosaic, and larger felspars embedded in a crushed groundmass.

Quartz clear, with gaseous and liquid inclusions, arranged more or less distinctly in streaks; also few individualised inclusions of elongate-rounded form, the largest measuring ·03 mm., with a high refractive index and double refraction (zircon).

Felspars essentially orthoclase and microcline; plagioclase very subordinate, irregular, and finely twinned; crystal outlines generally corroded, and the mineral clouded by partial decomposition; the cleavage cracks tinted by subsequently deposited iron ores. Twinning after the Karlsbad law is observed in the orthoclase. Microline subordinate. A micrographic (granophyric) intergrowth between quartz and felspar on a small scale is visible in parts of the section.

Biotite strongly pleochroic, from light greenish-brown to almost black.

Magnetite as small, angular individuals.

Garnet Gneiss.

Plate xvii., fig. 2.

Locality.—Mount Davis (two miles north), Tomkinson Ranges.

Macroscopically.—A fine-grained quarzitic gneiss, with a rich, red-garnet development; foliated, the biotite in regular planes, the quartz and felspar foliations often wedging out. Portions of the rock appear very quartzose, compact, with largish fragments of smoky quartz.

Microscopically.—A quartz orthoclase mosaic. The foliated character, though clearly visible in hand specimens, is not apparent under the microscope.

The quartz contains minute liquid inclusions, and aggregates of black particles disseminated through its mass, which appear to be carbonaceous, the former not infrequently grouped centrally. A fair amount of isotropic mineral is also present

Felspar: large clouded crystals of orthoclase and smaller subordinate plagioclase.

Biotite strongly pleochroic, in shades of brown to almost black, when the rays vibrate parallel to the cleavage; elongated or irregular, and is in parts decomposed, the resulting iron oxides staining the adjoining minerals reddish-brown; often enclosing magnetite and felspar.

Magentite as fine dust and larger individuals, sometimes filling fissures between the felspar.

Shattered crystals of red garnet, the largest of which are a millimetre in diameter, are plentiful. They behave completely isotropically under crossed nicols, though the quartz and felspar exhibit undulose extinction rather markedly.

This rock appears to be a "clastic gneiss."

Contact Gneiss.

Locality.—Opparinna, Musgrave Ranges.

Macroscopically.—A closely foliated, fine-grained gneiss, with prominent dark planes of mica *(linear foliation)*, and narrow lenticles of quartz and felspar. The rock occurs in direct contact with a diorite dyke, and its planes of foliation have the same strike as the walls of the dyke.

Microscopically.—The distinct gneissic foliation remains prominent even under a high power objective; the mica in regular parallel stringlets. The fine state of crushing of the rock appears to be an ultimate stage of metamorphism.

The quartz occurs as excessively crushed particles that display marked "shadowy extinction" when viewed under crossed nicols. It is comparatively fresh-looking, and free from interpositions except the minutest.

The felspar, orthoclase, as small, irregular individuals, showing shearage on a microscopic scale, with few individualised inclusions.

Microperthite is developed to a limited extent, and displays a very delicate lamination under crossed nicols.

The biotite is clear, strongly pleochroic, and appears in the form of elongated flakes.

Schistose Quartz Rock (so-called "Quartz Blow").

Locality.—Mann Ranges, south-east of Mount Edwin.

Macroscopically.—A fine-grained, white quartzose rock, schistose, with well-defined planes of brown secondary mica, in parts decomposed and brown.

Microscopically.—Essentially composed of closely aggregated, allotriomorphic grains of quartz, the boundaries of which are usually sharp, and the grains in direct contact with one another. A fair amount of amorphous silica is present. The quartz is fresh, but contains numerous unindividualised fluid inclusions, with stationary and mobile gas bubbles, usually arranged in fairly broad parallel bands, crossing in a continuous line several adjacent grains. It, therefore, appears that the inclusions are to a certain extent not original, but have subsequently been produced by the metamorphism of the rock by igneous intrusion. Individualised inclusions occur in the form of elongated prisms of colourless apatite, with indistinct, rounded prism-terminals and transverse fracturing.

The decomposed mica flakes do not exhibit any striking tendency to parallel orientation. Dark strain shadows crossing the quartz on rotation of stage between crossed nicols give ample evidence of stress to which the rock has been subjected.

Olivine Gabbro.

Plate xvii., fig. 1.

Locality.—Mount Davies, Tomkinson Ranges.

Macroscopically.—Dark green, coarse-grained, heavy rock, apparently composed essentially of a pyroxene. Fracture very rough.

Microscopically.—Texture hypidiomorphic to allotriomorphic granular, of medium-sized grain; composed principally of diallage, olivine, and plagioclase. The diallage varies in colour from very faint green to colourless, and shows the basal striation to perfection. Well-defined, irregular cross-partings are prominent. Alteration to serpentine is seen in different stages of progress.

Olivine greenish to colourless, darkened by granular iron ores by decomposition. Crystal boundary rounded, and the cleavage (010) is distinct in a few examples. The crystals of olivine are altered to serpentine, sometimes completely, with deposition of a ferruginous "dust."

The plagioclase (labradorite) is scanty, and occurs chiefly in aggregates. The albite twin lamellæ frequently "wedge out." Undulatory extinction, produced by pressure, common. The scarcity of this mineral gives a decided basic character.

Ores of chromium were not observed in the rocks examined, although the Murru Yilyah outcrop, adjoining the gabbro, contains a secondary siliceous infiltration which is stained by chromium.

Diorite.

Plate xvii., fig. 3.

Locality.—Indulkana.

Macroscopically—Heavy, compact, dark-coloured, finely crystalline rock, coated on the surface with a rusty brown product of weathering.

Microscopically.—Fine-textured, holocrystalline rock. In the sections examined quartz is absent.

A slight amount of orthoclase occurs as irregularly bounded individuals, often squeezed in between idiomorphic crystals of plagioclase. The plagioclase felspar is twinned according to the Albite and Karlsbad laws, the former being often accompanied by Pericline. From determinations on sections from the zone at right angles to (010) the felspar appears a slightly basic Andesine. Zoning comparatively scarce. The felspar is clouded (more so along the central portions) by kaolin and possibly calcite.

Hornblende light brown, enlarged in certain directions by an outgrowth of secondary, often fibrous, green mineral (hornblende); crystals not infrequently twinned, decomposing with a large deposition of red oxide of iron. Mica scarce as well-defined flakes of strongly pleochroic brown biotite.

Magnetite plentiful, arranged in groups, the individual constituents of which have a strong tendency to parallel arrangement, as though conforming with some pre-existent crystal constant. Hornblende has, no doubt, yielded to its formation.

The absence of quartz, feeble development of orthoclase, and the brown tint of the hornblende indicate a basic type of diorite.

Dolerite.

Locality.—Mount Olga.

Macroscopically.—Slate-coloured, uniformly crystalline rock of fine grain. The minute needles of felspar are dimly recognisable, and here and there larger secretions of a green mineral are apparent (olivine). The rock decomposes to a richly coloured ochreous powder.

Microscopically.—Holocrystalline; of fine texture. The lath-shaped felspars, on an average about ·2 mm. in length, are clouded; on that account they exhibit twin lamination and cleavage cracks very imperfectly, and are variously tinted in polarised light. The arrangement of the laths produces a poor *fluxion structure.*

The augite in the sections examined has been almost completely altered to a scaly, green, chloritic mineral, possessing a very faint double refraction.

Between the felspars a subsequent crystalline segregation has taken place radially to small granules of magnetite. These aggregates show the characteristic black cross under crossed nicols, having its arms parallel to the cross wires of the microscope.

Olivine as greenish, irregularly bounded individuals.

Magnetite is distributed generally through the mass as small granules and cubes; or it darkens the constituent minerals in the form of a very fine dust.

A secondary serpentinous, fibrous mineral present is probably another product of the decomposition of the augite.

Ordovician Quartzite.

Locality.—Mount Chandler.

Macroscopically.—A highly compact, fine-grained, white, siliceous quartzite, breaking with a splintery fracture.

Microscopically.—Consists of closely set, rolled grains of clear quartz, so compacted by pressure as to have left but little space for interstitial cement, which is also of silica. The interstices are slightly stained by iron salts. The average dimensions of the quartz grains of this particular specimen are ·5 mm., although elsewhere the rock passes into a coarse grit and conglomerate. The quartz is either perfectly clear or encloses interpositions, either central, scattered, or arranged in bands. They are mainly unindividualised. Undulose extinction is apparent under crossed nicols.

Felspar is very subordinate, or practically absent.

The orginal planes of bedding are indistinctly discernible by a general tendency of the longer axes of the separate grains to arrange themselves in parallel lines.

No trace of any organism has been preserved in the sections observed, but a similar rock at Mount Watt is highly fossiliferous.

Metamorphic Grit (Ordovician).

Locality.—Ayers Rock, Northern Territory.

Macroscopically.—A dark, metamorphic grit,* which on casual observation may be, and has been, mistaken for an eruptive rock, the large felspars showing up conspicuously from the mass with their surfaces of cleavage. The quartz grains are clearly recognised as derivative *("clastic")*. A black mica, ores of iron, and other foreign minerals are among the grains. The rock may be termed a *greywacke (Grauwacke)* or *arkose.* The aggregation of waterworn grains of quartz and felspar (one single grain of the rock, moreover, often consisting partly of quartz and partly of felspar, still in juxtaposition as orginally in an igneous rock) suggests the disintegration of granite.

Microscopically.—The rock† is compact and composed essentially of quartz and felspar *(allothigenous)*, with additional fragments and flakes of ores of iron and mica *(authigenous)*.

The quartz occurs as more or less irregularly rounded and rolled grains, containing numerous gaseous inclusions in bands and streaks, or scattered. Some of the grains, moreover, exhibit a microscopic intergrowth between quartz and felspar.

The felspar is of several species. A typical microcline predominates, and is often traversed by narrow parallel streaks of strongly doubly refracting altered mineral (kaolin). Micrographic intergrowths of this felspar, with quartz, appear to be prominent, although the effect is masked. "Strain shadows" under crossed nicols.

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* "The rock is a very indurated, and, to some extent, altered, arkose sandstone, decidedly gritty in parts."—Tate and Watt: Rep. Horn Exped. Centr. Austr., Phys. Geog., page 8.

† A description of a similar rock, by Messrs. Smeeth and Watt, has appeared in the report of the Horn Expedition, Petrology. "Arkose"; No. 213, page 83.

Orthoclase is clouded and strongly illuminated under crossed nicols as a result of its alteration.

Plagioclase is subordinately represented, the fragments being comparatively small. A dark mica (biotite), in aggregates of curved flakes, is plentiful. It is very probably secondary,* and occurs interstitially. Its decomposition has produced hematite. Few tiny flakes, apparently white mica, are also present.

Ores of iron are plentiful. Ilmenite occurs as asymmetrical masses, opaque, and (by incident light) shows the imperfect system of striation and characteristic brownish tinge. Moreover, this form is replaced in parts by a semi-transparent variety, "with a clove-brown colour,"† suggestive of micaceous titanic iron. Magnetite is also represented as irregular patches.

With regard to the constituents of this rock being essentially of grains of quartz, orthoclase, and microcline, it is interesting to note that Dr. C. Chewings has described‡ a granite from Mount Olga (a sister outcrop to Ayers Rock), which is composed almost essentially of quartz, orthoclase, and microcline. The constituent grains of the rock from Ayers Rock, therefore, have in all probability been derived from the same granite as the specimen from Mount Olga. Mount Olga consists for the most part of a metamorphic conglomerate.

EXPLANATIONS OF PLATES.

Plate XIII.

F)fi. 1.—Mount Conner; an outlier of Ordovician quartzite, surrounded by saltbush flats.

Fig. 2.—Æolian erosion; mushroom-shaped outcrops of gneiss in the desert north-west of the Mann Ranges.

Plate XIV.

Fig. 1.—Intrusion of porphyritic granite within hornblendic garnetiferous schist, south of Mount Cockburn, Mann Ranges.

Fig. 2.—Ordovician quartzite, shattered by insolation, Mount Conner.

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* Compare Tate and Watt: *op. cit.*, page 8—"Although once a sedimentary rock, it has been to some extent altered by metamorphic agencies, a small amount of mica, perhaps of secondary origin, having been formed."

† Rosenbusch: Microsc. Phys. of Rockmaking Minerals (Iddings), 1900, page 167.

‡ Chas. Chewings: Beiträge zur Kenntnis der Geologie Süd- und Central Australiens, Heidelberg, 1894—"Ein Granit von Mount Olga (Central-Australien) besteht fast ganz aus Quarz, Orthoklas, und Mikroklin."

Plate XV.

Fig. 1.—Range of desert sandstone at Yarrabollinna Waterhole. The bluff consists of excessively fine-grained arenaceous material, with nodules of chert and barytes.

Fig. 2.—Krupp Hill; a table-hill of desert sandstone unconformably overlying primary schists.

Plate XVI.

Fig. 1.—Table-hills of the desert sandstone formation east of Indulkana.

Fig. 2.—Talus blocks of gneiss in Garnet Glen, south of Mount Edwin, Mann Ranges. This rock is described in the text on page 95.

Plate XVII.

Fig. 1.—Olivine gabbro, Mount Davies, Tomkinson Ranges.

Fig. 2.—Garnetiferous gneiss, north of Mount Davies, Tomkinson Ranges.

Fig. 3.—Diorite, Indulkana.

Fig. 4.—Epidote rock, Titania Spring, Musgrave Ranges.

Plate XVIII.

Fig. 1.—Gneiss, Indulkana, west of Krupp Hill.

Fig. 2.—Hornblendic granite, Glen Ferdinand, Musgrave Ranges.

Fig. 3.—Hypersthene-bearing granulite, north of Mount Davies, Tomkinson Ranges.

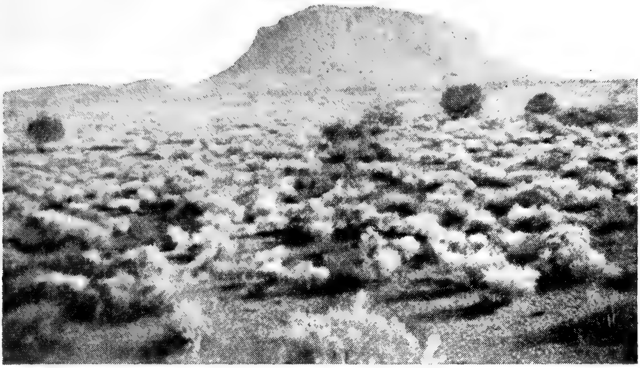
Fig. 4.—Altered augite granite, south of Giles' West Camp, Musgrave Ranges.

Plate XIX.

Sketch section across the Mann Ranges, extending south from Mount Cockburn. Distance, about 2½ miles.

Plate XX.

Geological sketch map of the Ayers Ranges.



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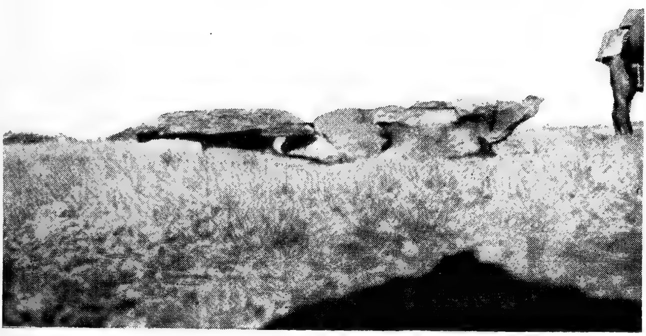

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H. Basedow, Photo.

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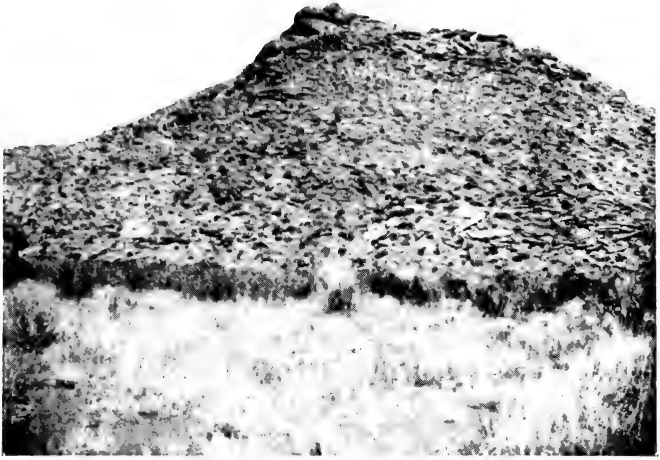

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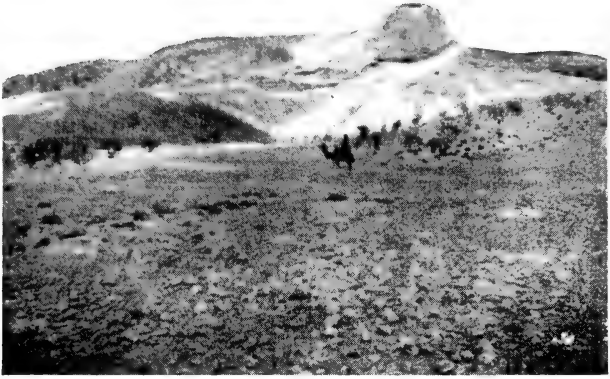

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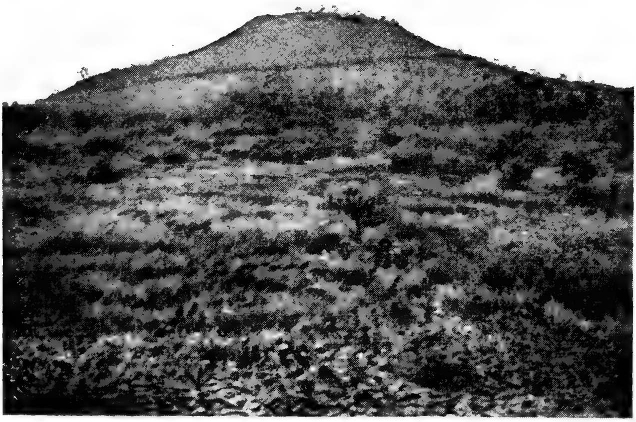

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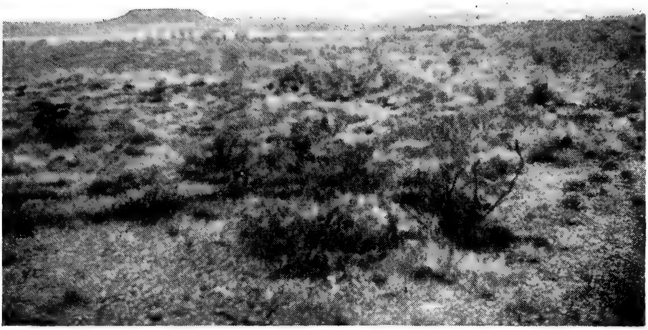

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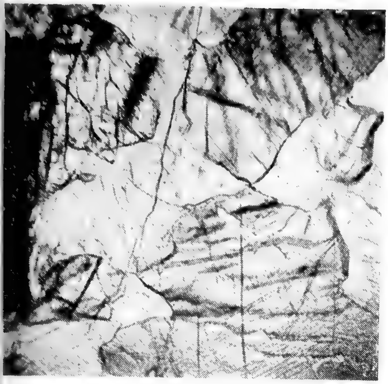

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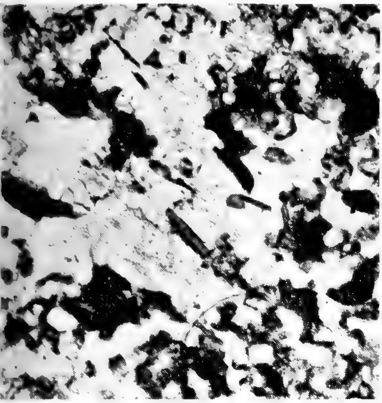

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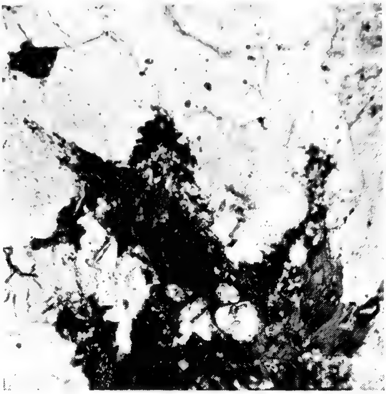

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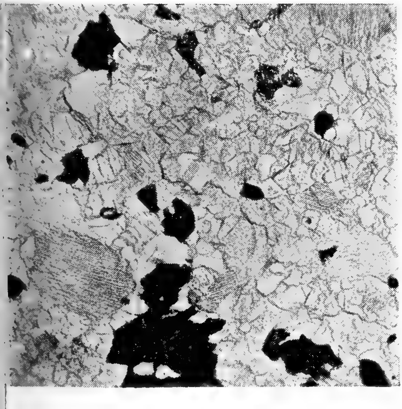

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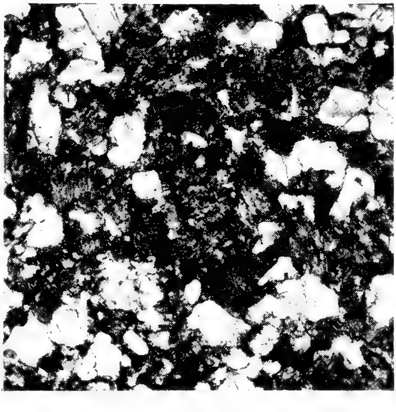

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SKETCH SECTION

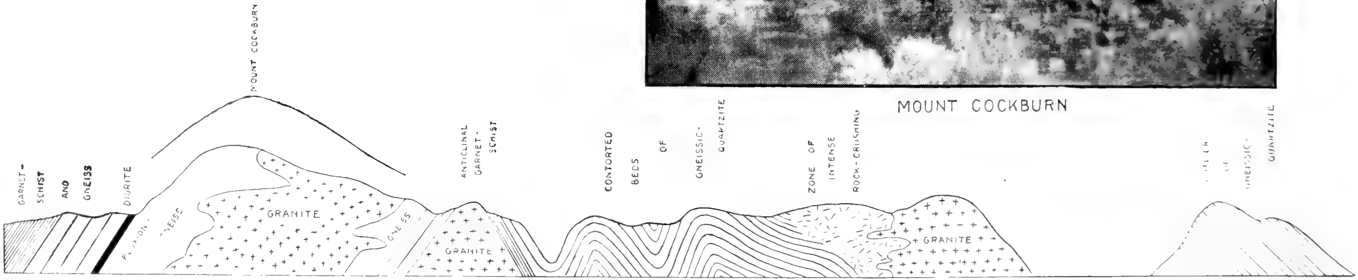
across the

MANN RANGES,

extending South from Mount Cockburn.

Distance: About 2½ Miles.

MOUNT COCKBURN



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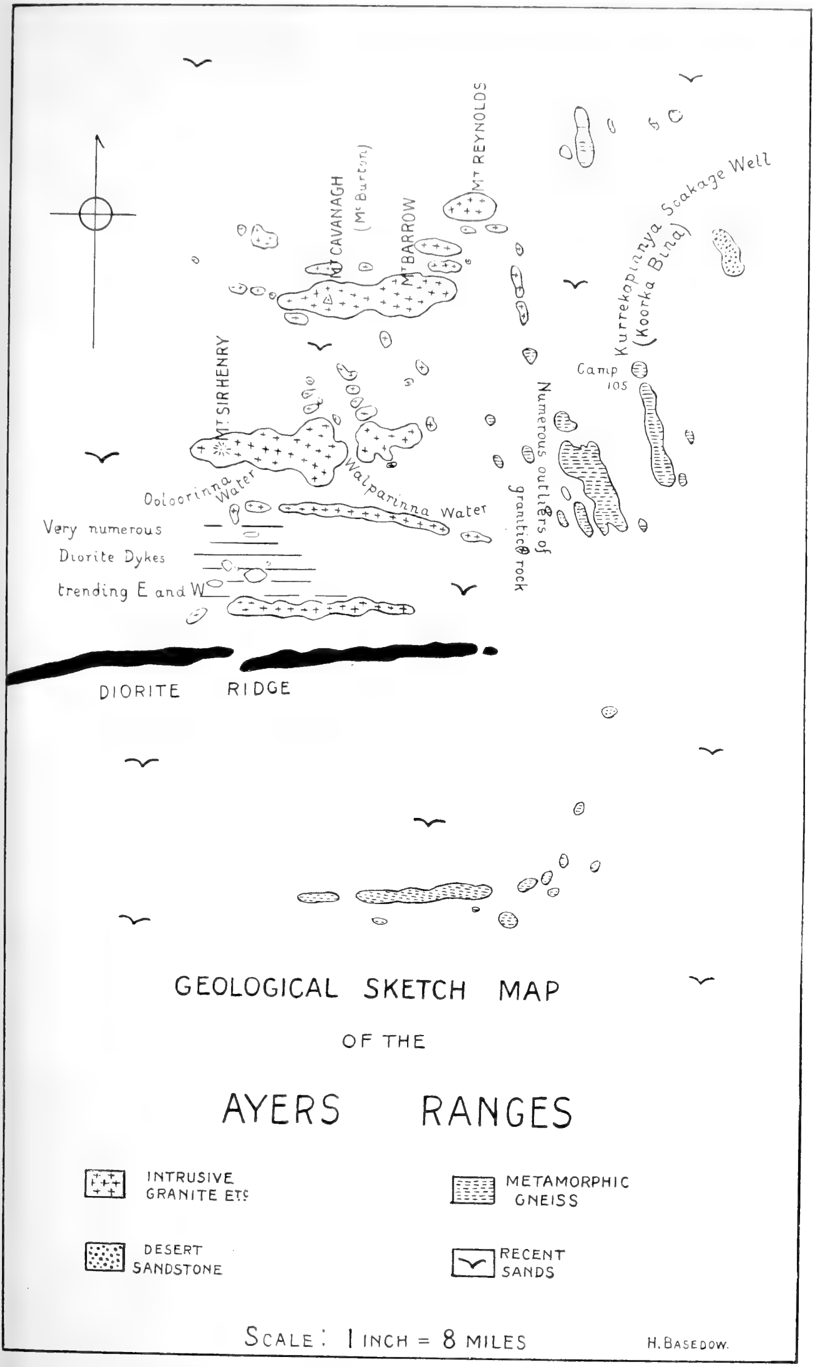


Hussey & Gillingham, Printers, Adelaide.

New Australian Lepidoptera. No. 22.

By Oswald B. Lower, F.E.S. (Lond.), etc.

[Read April 4, 1905.]

PYRALIDINA.

GALLERIANÆ.

Melissoblaptes disema, n. sp.

Female, 18 mm. Head, face, and antennæ dark fuscous, head sprinkled with whitish. Thorax whitish-grey, patagia fuscous. Abdomen and middle legs fuscous, tibiæ and tarsi ringed with whitish, posterior pair suffusedly whitish. Abdomen dark fuscous. Forewings elongate, moderate, costa nearly straight, arched towards apex, greyish-white, minutely and irregularly irrorated wth black scales; markings blackish; a narrow line along costal edge, from base to first line; a nearly straight, waved, narrow line from costa beyond one-third to dorsum at one-third; a similar line, gently curved throughout, from costa at three-quarters to dorsum, before anal angle; a row of spots along termen and apical fourth of costa; cilia blackish, with a median line of black scales. Hindwings somewhat transparent; pale greyish-fuscous, paler on basal half; cilia greyish.

Birchip, Victoria. One specimen; received from Mr. D. Goudie.

CRAMBINÆ.

Talis cyclosema, Low.

(*Talis cyclosema*, Low. Tr.R.S.S.A., p. 158, 1896;
T. diacentra, Meyr. Tr.E.S., Lond., p. 379, 1897.)

I have received this species from Balaklava, South Australia, and Birchip (D. Goudie), Victoria.

Surattha hedyscopa, n. sp.

Male, female, 18, 24 mm. Head, palpi, and thorax ochreous-brown, palpi short. Abdomen ochreous-grey. Antennæ strongly bipectinated throughout. Legs white, tibiæ and tarsi infuscated above, tarsi banded with white; thorax and abdomen white beneath. Forewings elongate, moderate, costa gently arched, termen obliquely rounded; vein 6 absent, coincident with 7; 4 and 5 stalked; 8 and 9 stalked; ochreous, somewhat irrorated with ferruginous and fuscous; a thick, rather indistinct, irregular, fuscous fascia, from costa at one-fifth to dorsum at one-quarter, more prominent on lower half; between this and base the ground colour is mixed with whitish; a rather obscure, strongly waved, oblique, fuscous fascia, from before middle of costa to middle of dorsum; a very broad fuscous band, mixed with bluish-white scales, and containing a small, clear, white spot, somewhat triangular in shape, near its anterior edge above middle; anterior edge somewhat waved, from beyond middle of costa to beyond middle of dorsum; posterior edge dentate, from five-sixths costa to five-sixths dorsum, projecting somewhat below costa; a fine dentate fuscous line along termen; cilia whitish, mixed with some blackish scales. Hindwings, with vein 5 present, fuscous grey, paler and becoming grey on basal half; cilia white, with a fuscous sub-basal line.

Somewhat allied to *termia*, Meyr., but apart from the very much shorter palpi and the neural characters it differs in markings; it would be possible to form a new genus to receive it. One specimen has vein 5 absent in hindwings, in the remainder, four in number, it is present; but the whole of the specimens before me have vein 6 of the forewings absent. The peculiarity with reference to the absence or presence of vein 5 of hindwings is also noticeable in *bathrotricha*, Low., vein 6, however, in the forewings of that species is present.

Broken Hill, New South Wales. Five specimens; in February, at light. These were all taken at the same time and place, but I have never since met with the species, although continually collecting in the same locality.

Platytes poliopepla, n. sp.

Female, 16 mm. Head, palpi, thorax, and antennæ dark fuscous, palpi very long, darker beneath, abdomen broken, legs dark fuscous. Forewings elongate, moderate, costa hardly arched, termen oblique, hardly rounded; fuscous, mixed with dark fuscous; some scattered, short, black streaks and spots in disc; a small, clear white spot at two-thirds from base in middle, more or less surrounded by blackish; an obscure row of black scales along termen; cilia fuscous. Hindwings light fuscous; cilia greyish-fuscous.

An obscure species, but may be known by the long palpi and white spot of forewings.

Melbourne, Victoria. One specimen; probably taken in April.

PHYCITINÆ.

Euzopherodes poliocrana, n. sp.

Female, 18 mm. Head, thorax, and antennæ ashy-grey-whitish, palpi dark fuscous, mixed with whitish beneath. Abdomen dark fuscous, whitish beneath. Legs fuscous, strongly suffused with white. Forewings elongate, rather narrow; ashy-grey-whitish, mixed with dark fuscous and blackish; whole of cell filled in with blackish and with a black bar at posterior extremity; a strongly waved, fine, black line from costa towards dorsum at three-quarters, but not quite reaching it; a row of short, elongate fuscous along termen, more or less preceded by black inter-neural streaks; cilia fuscous, with two darker fuscous lines. Hindwings semi-transparent; pale greyish, mixed with fuscous around margins; cilia grey, with a fuscous basal line.

Broken Hill, New South Wales. Two specimens; in March.

METALLOSTICHA METALLICA, n. sp.

Female, 10 mm. Head and antennæ ochreous-fuscous. Palpi and thorax purplish-fuscous, thorax shining metallic. Abdomen greyish-fuscous. Legs dark purplish-fuscous, posterior pair greyish. Forewings elongate, moderate, termen gently rounded; shining metallic-purplish fuscous; cilia purplish-fuscous. Hindwings greyish-fuscous, paler towards base; cilia greyish-fuscous, with a darker fuscous line at base.

Mackay and Townsville (Dodd), Queensland. Two specimens; in December.

HYPHANTIDIUM HYPOSCOPA, n. sp.

Female, 10 mm. Head, palpi, thorax, antennæ, and abdomen dark fuscous. Legs dark fuscous, posterior pair yellow. Forewings elongate, moderately dilated posteriorly, termen oblique; dark fuscous, crossed by several irregular, waved, spot-like, blackish strigulæ; a broad, slightly curved, dull whitish fascia, from three-quarters costa to anal angle, clearest on upper half; indications of the blackish strigulæ crossing the fascia, but more pronounced on costa, where they form three or four cuneiform spots; ground colour beyond this fuscous, with several black spots irregularly placed, cilia dark fuscous. Hindwings orange, slightly tinged with fuscous around apex; cilia dull orange, becoming fuscous towards apex, and with an obscure, fuscous sub-basal line throughout.

At once recognised by the orange hindwings.

Melbourne, Victoria. One specimen; in October.

NEPHOPTERYX HABROSTOLA, n. sp.

Male, 18 mm. Head, palpi, thorax, and antennæ ferruginous red, face slightly white. Legs deep ferruginous red, strongly mixed with fuscous, tibiæ and tarsi more or less banded with whitish. Abdomen blackish, reddish beneath anteriorly. Forewings elongate, moderate, costa gently arched, termen nearly straight; deep reddish, somewhat purplish and slightly shining; a narrow, oblique, white fascia, from costa at one-quarter to dorsum at one-quarter, more or less edged on either side with deep reddish; a dark reddish waved line from costa at about two-thirds to just above dorsum at three-quarters, with a somewhat lunate white mark on anterior edge of lower extremity; an obscure narrow white sub-terminal line from five-sixths costa to four-fifths dorsum, attenuated on upper half; a row of elongate, dull whitish spots along termen; cilia reddish-ferruginous. Hindwings dark fuscous, paler on basal half; cilia greyish, with a fuscous, sub-basal line.

Townsville (Dodd) and Mackay, Queensland. Four specimens; in June.

Cryptoblabes centroleuca, n. sp.

Male, 12 mm. Head, palpi, antennæ, and thorax dark reddish-fuscous, collar whitish. Abdomen greyish. Legs fuscous, strongly irrorated with whitish. Forewings elongate, rather narrow, reddish-fuscous, purplish tinged; a moderate, oblique, white fascia from costa at one-third to beyond one-third of dorsum, edged posteriorly by twice its own width of deeper ground colour; a somewhat waved, oblique, whitish line from costa at five-sixths to dorsum at four-fifths; space between this and first fascia finely irrorated with white, and with an obscure fuscous dot in middle, nearer to posterior fascia; a fine, obscure whitish line before termen; a waved fuscous line along termen; cilia reddish-purple mixed with whitish. Hindwings greyish, slightly fuscous-tinged; cilia greyish, with a fuscous line.

Broken Hill, New South Wales. One specimen; in November.

Ephestiopsis poliella, n. sp.

Male, 14 mm. Head and thorax ashy-grey-whitish. Antennæ and palpi fuscous, palpi beneath mixed with whitish. Abdomen silvery-grey. Legs suffusedly white, tarsi banded with fuscous. Forewings elongate, rather narrow; ashy-grey-whitish, costal half broadly suffused with white; a rather obscure, oblique, fuscous fascia, from beneath one-third of costa to just beyond one-third dorsum, but not reaching it; an obscure, waved, fine, fuscous line from five-sixths costa to just before anal angle, followed by a narrow, parallel reddish shade, not entire; a fine, interrupted black line along termen; cilia greyish, with a fuscous, sub-terminal line Hindwings greyish, slightly infuscated along termen; cilia greyish, with a fine, fuscous, sub-basal line.

Townsville, Queensland. One specimen; received from Mr. F. P. Dodd. I have also seen specimens from Cooktown, Queensland. Taken in December.

HYDROCAMPINÆ.

Clupeosoma rhodea, n. sp.

Female, 18 mm. Head, palpi, antennæ, thorax, and abdomen reddish-carmine, somewhat coppery-tinged, basal half of palpi beneath snow-white. Middle and posterior legs ochreous, middle tibiæ and tarsi fuscous, banded with white. Abdomen beneath ochreous. Forewings elongate-triangular, termen oblique, hardly rounded; reddish-carmine, tinged with coppery metallic scales, especially along costa; markings deep reddish-fuscous; a waved, somewhat dentate, line from two-thirds of costa to two-thirds dorsum; an oblique, fine, waved line from costa at four-fifths to dorsum, before anal angle, with a strong sinuation outwards in middle; a discal dot above middle, midway between first and second lines; termen suffused with pale fuscous-purple, thicker on upper half; cilia orange-yellow, basal half light reddish-carmine. Hindwings pale yellow, suffused with reddish-carmine on terminal third, except along dorsum; first line and discal dot absent; second line nearly straight, reddish-carmine, from beneath costa at about four-fifths to three-quarters across wing; a suffused, moderate, reddish-carmine line along termen; ground colour between the two lines suffused with light reddish-carmine; cilia as in forewings.

Mackay, Queensland. One specimen; in December.

SCOPARIANÆ.

Scoparia platymera, n. sp.

Male, 20 mm. Head, palpi, antennæ, thorax, and abdomen fuscous, palpi and thorax beneath white. Abdomen more or less ringed with silvery white, especially beneath. Legs fuscous, strongly infuscated with white, middle tibiæ and tarsi banded with white. Forewings elongate, moderate, termen obliquely rounded; whitish, with fuscous markings; a basal patch, outer edge waved from one-sixth costa to one-sixth dorsum; a very broad fascia occupying median third of wing, constricted on lower third, edges waved, anterior from about two-fifths of costa to one-third dorsum, posterior edge from three-quarters costa to two-thirds dorsum, with a somewhat rounded projection about middle; a fuscous discal dot in fascia near posterior edge above middle; an irregular band along termen, narrowed on lower half, with a projection above middle; a row of blackish elongate streaks along termen; cilia grey-whitish, barred with fuscous. Hindwings pale greyish, thinly scaled, tinged with fuscous along termen on upper half. Closely allied to *eumeles*, Meyr., but differently coloured.

Hobart, Tasmania. One specimen.

TINEINA.

ŒCOPHORIDÆ.

Pleurota xiphochrysa, n. sp.

Male, 14 mm. Head ochreous. (Palpi broken.) Thorax and abdomen dark fuscous. Antennæ fuscous. Legs dark fuscous, posterior pair obscurely banded with ochreous. Forewings elongate, moderate, costa gently arched, termen obliquely rounded; pale yellow, darker along costa, more or less mixed with fuscous; an obscure fuscous sub-costal streak near base; a moderately thick, well-defined, blackish streak along dorsum, edged above throughout by a streak of brighter orange-yellow, from base to anal angle; faint indications of a narrow streak, near and parallel to termen; cilia fuscous. Hindwings and cilia dark fuscous.

Perhaps nearest *callizona*, Meyr., but amongst the yellow-winged species it is easily separated by the dark fuscous cilia of both wings.

Stawell, Victoria. One specimen; (? in October).

Pleurota perisema, n. sp.

Female, 14 mm. Head and palpi ochreous-yellow, second joint of palpi externally fuscous, terminal joint fuscous. Thorax light fuscous. Abdomen greyish-fuscous, segmental margins whitish. Legs greyish, anterior pair slightly infuscated. Forewings elongate, moderate, costa gently arched, termen obliquely rounded; pale yellow; a moderately thick, fuscous streak along dorsum, from base to near anal angle, alternated towards base, but gradually becoming dilated posteriorly, and with a projecting tooth on upper edge at about three-fifths; an inwardly oblique ferruginous fascia from just beneath costa at about two-thirds to termen immediately above anal angle, leaving a space of ground at anal angle; space between the ferruginous fascia and termen more or less wholly irrorated with pale ferruginous, except beneath costa; cilia yellowish (imperfect).

Distinct, by the outwardly oblique ferruginous fascia; in most of the other described species the markings are inwardly oblique.

Tasmania (? Hobart). One specimen; in January.

Borkhausenia zophosema, n. sp.

Male, 18 mm. Head, palpi, antennæ, and thorax fuscous, palpi mixed with grey-whitish beneath, except at base; antennal ciliations, 1, with strong pecten. Abdomen fuscous. Legs greyish, banded with fuscous, posterior pair greyish, mixed with blackish. Forewings elongate, moderate, costa gently arched, termen obliquely rounded; 2 and 3 stalked, from just before angle; 7 and 8 stalked, 7 to costa; dark fuscous, with blackish markings; a moderate, well-defined, rather suffused spot at base, reaching dorsum; a suffused spot in middle at one-fifth from base; a second, just below, joining first; a spot in middle of cell, and one or two others at end of cell; an obscure curved series of small dots from beneath costa at three-quarters to dorsum before anal angle; cilia dark fuscous, mixed with some black scales. Hindwings with 3 and 4 from a point, 5 widely remote from 4 at base; pale fuscous, paler at base; cilia grey, with a fuscous sub-basal line.

Could easily be mistaken for *Eulechria photinopis*, Low., to which it has considerable superficial resemblance, but the neural characters are very reliable points of distinction.

Broken Hill, New South Wales. One specimen; in August.

Macrobathra gastroleuca, n. sp.

Female, 14 mm. Head, palpi, and thorax greyish, terminal joint of palpi fuscous. Antennæ white, strongly annulated with fuscous. Abdomen dark fuscous, sharply white beneath. Legs whitish, anterior and middle pair mixed with fuscous. Forewings elongate, moderate, lanceolate; white, dorsal half greyish-tinged; termen more or less thickly strewn with ferruginous scales, more pronounced at apex and anal angle, where they become suffused into dorsal colour; cilia greyish-fuscous. Hindwings fuscous; cilia greyish, becoming ochreous on costa and upper half of termen.

This species departs from the general colouring and markings of the group previously described, and is easily determined by the white ground colour and ferruginous scales along termen.

Broken Hill, New South Wales. One specimen; in November.

Paratheta cyclozona, n. sp.

Male, 14 mm. Head ochreous-white. Thorax whitish, anteriorly fuscous. Palpi and antennæ fuscous, second joint of palpi with a fuscous apical ring. Abdomen and legs greyish, tarsi obscurely banded with fuscous. Forewings elongate, moderate, costa gently arched, termen strongly oblique; white, very minutely irrorated with fuscous around the margins; the irroration tends to accumulate more densely along costa from base to two-thirds, and forms a more or less developed costal streak; a well-defined, moderate, slightly outwardly curved dark fuscous transverse fascia, from about two-thirds of costa to two-thirds dorsum, but not reaching it;

a small fuscous dot on fold, above anal angle, and another obscure, at end of cell; cilia ashy-grey-whitish. Hindwings light fuscous; cilia fuscous, at base greyish.

At once known by the curved fuscous fascia.

Duaringa, Queensland. One specimen; in January.

XYLORYCTIDÆ.

Cryptophaga aglaodes, Low.

(Tr.R.S.S.A., p. 171, 1893.)

Male, 38 mm. I have received from Mr. S. Angel the male of this species. In colour and markings it does not differ from the female; the antennal pectinations are about $1\frac{1}{2}$; this is a similar character to that observed in *sarcinota*, Meyr. (to which this species is mostly allied), but is easily separated from that species by the totally different colouring, shorter terminal joint of palpi, and absence of double black dot on forewing, which is conspicuous in *sarcinota*.

The male was taken by Mr. Field at Tennant's Creek, Central South Australia, and the female (type) at Arthurton, Yorke's Peninsula, South Australia.

Cryptophaga Blackburnii, Low.

(Tr.R.S.S.A., p. 15, 1892; *Xylorycta neomorpha*, Turn, Ann. Queens. Mus., p. 13, 1897.)

I have recently taken the male of this species at Broken Hill, which is precisely in accordance with Dr. Turner's description of *neomorpha*. The type (female) was taken at Port Lincoln, South Australia.

Hypertricha stenadelpha, n. sp.

Female, 20 mm. Head, palpi, and thorax cinerous grey-whitish, second joint of palpi fuscous at apex, terminal joint nearly half of second, acute. Antennæ fuscous, obscurely annulated with white. Abdomen dull silvery-grey, segmental margins dull reddish. Legs cinerous-grey-whitish, anterior coxæ whitish, posterior legs greyish. Forewings elongate, moderate, costa gently arched, termen strongly oblique; 7 and 8 coincident; cinerous-grey-whitish; a streak of white along fold from base to end of cell, containing an oblique fuscous patch in middle, and two or three fuscous dots on upper half at and near extremity; cilia cinerous-grey-whitish, terminal half grey-whitish; hindwings pale grey-whitish, somewhat fuscous tinged around apex; cilia grey, with a fuscous basal line.

Bears a striking resemblance to *Procometis tetraspora* Low., but the resemblance is superficial only; the neuration of the forewings is a specific distinction. Although the terminal joint of palpi is somewhat longer than the characters of *Hypertricha*, that is, one-quarter of second, I scarcely consider it necessary to erect a new genus for its reception, but should the male show additional characters there may be some justification for doing so.

Broken Hill, New South Wales. One specimen; in March.

ELACHISTIDÆ.

Coleophora, Hb.

Antennæ four-fifths, porrected in repose, often thickened with scales towards base, in male simple, basal joint long, usually with rough scales or projecting tuft. Labial palpi, long, recurved, second joint more or less roughened or tufted towards apex beneath, terminal shorter, acute. Posterior tibiæ rough-haired. Forewings with costa often long-haired beneath; 1b furcate, 4 sometimes, 5 absent, 6 and 7 connate or stalked, 7 to costa, 8 absent. Hindwings two-thirds, linear-lanceolate; cilia 3-4 transverse veins sometimes partly absent, 4 usually absent, 6 and 7 closely approximated or stalked.

Coleophora ochroneura, Low.

(*Plutella ochroneura*, Low., Tr.R.S.S.A., p. 59, 1897.)

Semaphore, South Australia.

Coleophora pudica, n. sp.

Male, 16, 18 mm. Head, palpi, thorax, antennæ, legs, and abdomen snow-white; base of palpi, antennæ, and thorax beneath faintly ochreous-tinged. Forewings elongate-lanceolate; snow-white, veins very faintly outlined with pale fuscous, not perceptible in some species; cilia white. Hindwings and cilia snow-white.

Differs from *ochroneura* by its smaller size, white ground colour, and absence of ochreous streaks. This genus has not been previously recorded from Australia, but is numerously represented in Europe, Asia, and North America. Mr. Meyrick, to whom specimens were submitted, mentions that the different species are very difficult to distinguish unless the larval habits are known; the larvæ when very young are leaf miners, but afterwards inhabit a portable case; attaching this to the leaf or seed vessel on which it feeds, it bores into the interior; in leaves a pale blotch is usually produced, with a round hole in one membrane, which distinguishes the mines of this genus from all others. I know nothing of the larval habits of either of the above species; they were taken at light.

Broken Hill, New South Wales. Nine specimens; in April.

PLUTELLIDÆ.

Glyphipteryx calliscopa, n. sp.

Male, 12 mm. Head and thorax brownish-fuscous. Palpi, antennæ, and abdomen fuscous, palpi ringed with white. Abdomen beneath ochreous-white. Legs fuscous, ringed with white. Forewings elongate, moderate, costa gently arched, termen rounded, sinuate beneath apex; brownish-ochreous, with greenish-metallic markings; a moderate, oblique fascia from one-third costa to before middle of dorsum, and other similar fasciæ between this and two-thirds, all more or less interrupted, first reaching to fold, broken in middle, blackish posteriorly; second reaching half across wing, becoming black at extremity, and there almost meeting first; third curved outwards, reaching dorsum, more or less broken in middle; a similar fascia starting from an ochreous spot on costa at three-quarters to anal angle; below this and previous fascia are about six strongly defined black longitudinal streaks, the middle one smallest; a similar fascia starting from an ochreous spot and ending on sinuation on termen; cilia ochreous-white, at apex fuscous, with a blackish basal line throughout. Hindwings and cilia dark fuscous.

Melbourne, Victoria. One specimen; in November.

Glyphipteryx perimetalla, n. sp.

Female, 12 mm. Head and thorax ochreous-fuscous. Antennæ and palpi fuscous. Legs ochreous, posterior pair grey. Abdomen grey-whitish. Forewings elongate, moderate, costa gently arched, termen rounded; ochreous, with golden-metallic markings, very slightly edged with fuscous; a narrow, somewhat cuneiform sub-costal streak, frm base to one-third, narrowed towards base; a second similar streak along fold, terminating below first costal streak; three somewhat oblique nearly equi-distant moderate costal streaks; first from costa beyond one-third to just above fold; second from middle of costa to middle of dorsum; third from about two-thirds costa to anal angle; a narrow streak from apex, continued along termen, but not reaching anal angle; a short streak on costa, between third and last mentioned streak, all streaks more or less ochreous, whitish on costa; cilia ochreous, terminal half greyish, with a fuscous median line. Hindwings and cilia whitish-grey.

Somewhat allied to *cyanochalca*, Meyr., but differs from that and the allied species by the absence of any black markings.

Stawell, Victoria. One specimen; in November.

Phryganostola macrantha, n. sp.

Male, 11 mm. Head, palpi, thorax, antennæ, abdomen, and legs dark fuscous, face white, palpi tufted, mixed with whitish beneath. Legs ringed with whitish. Forewings elongate, moderate, costa gently arched, apex somewhat pointed, termen very oblique; dark fuscous, with ochreous-whitish and metallic markings, more or less blackish margined; a well-marked streak along fold from base to just before anal angle; six outwardly oblique fascia, becoming metallic below costa; first, from before costa at one-third, reaching one-third across wing; second, from costa at two-fifths, reaching nearly half across wing; third from before two-thirds to just beyond termination of dorsal streak, with an extra metallic dot below extremity; a small sub-costal dot just beyond; fourth, from three-quarters costa reaching more than half across wing; fifth and sixth short, close together and similar, on costa at five-sixths; an interrupted metallic streak along termen; a round black dot at apex, containing a metallic spot on lower edge; cilia whitish, basal half blackish, and with an elongate black apical tooth. Hindwings and cilia dark fuscous.

Gisborne, Victoria. One specimen; in October.

Simaethis hypocalla, n. sp.

Female, 10 mm. Head, palpi, thorax, antennæ, legs, and abdomen fuscous, palpi ringed with white, antennæ ringed with whitish, and whitish beneath, abdomen whitish beneath, coxæ whitish, tibiæ and tarsi ringed with whitish. Forewings rather broad, costa gently arched, termen rounded; dark fuscous, minutely irrorated obscurely with whitish, which forms about five transverse, fascia-like series; four large black spots along termen, lower two larger and occupying lower two-thirds, each with a purplish-metallic spot in middle; cilia fuscous, basal third darker. Hindwings dark fuscous; a large dull whitish black-centred spot in cell; a narrow, transverse, dull whitish line from five-sixths costa to anal angle; a narrow, bright violet-metallic line just below; cilia dark fuscous, basal half darker, terminal half white, irregularly chequered with fuscous.

Recalls *Choreutis* in appearance, but the palpi being without a tuft I prefer to place it in *Simaethis*. Probably the male may show some additional characters sufficient to warrant forming a new genus for its reception. The violet-metallic line of hindwings is a special character.

Mareeba, Queensland. One specimen; in April. I have seen a specimen from New Guinea.

TINEIDÆ.

Comodica decaspila, n. sp.

Male, female, 12, 20 mm. Head, palpi, and thorax snow-white, palpi blackish at base, externally and beneath, thorax with a narrow blackish anterior band, antennæ fuscous, basal joint white, fuscous beneath. Abdomen greyish. Legs white, broadly banded with black, anterior pair wholly blackish beneath. Forewings elongate, moderate, costa gently arched, termen oblique; an elongate, transparent patch near base; snow-white, with black markings; ten spots, arranged as follows:—Four oblique, equi-distant, on costa, first basal; four at five-sixths, reaching one-quarter across wing; four others, similar, on dorsum, apices pointed, first at base; fourth at anal angle, the second one hardly traceable and hardly reaching dorsum; two in middle of wing, ovoid, before and beyond middle; indications of another on termen beneath apex; cilia white, becoming blackish at base on markings. Hindwings pale fuscous; cilia grey, becoming white around apex.

Cooktown, Queensland. Two specimens; in December.

Comodica epispora, n. sp.

Female, 18 mm. Head and palpi whitish, faintly ochreous tinged, palpi at base beneath dark fuscous. Antennæ fuscous. Thorax dark ferruginous-ochreous, patagia paler. Abdomen ochreous, banded with dark fuscous. Legs ochreous, irregularly banded with fuscous. Forewings elongate, moderate, costa gently arched, termen obliquely rounded; 3 and 4 coincident, 7 and 8 coincident, to costa, lower fork of vein 1 obsolete; deep ferruginous-ochreous, with whitish markings; a rather broad, transverse fascia, from near base of costa to base of dorsum, slightly angulated below costa; a rather large spot on costa beyond middle, and a smaller one midway between fascia and last mentioned spot; a large spot on middle of dorsum; a small spot on dorsum before anal angle; a suffused spot below middle of termen; cilia yellowish-orange, basal half ferruginous-fuscous. Hindwings with veins 5 and 6 stalked, 6 to costa; dark fuscous; cilia yellowish-orange.

Mackay, Queensland. One specimen; taken on a fence in December.

Comodica citrinopa, n. sp.

Male, female, 12, 14 mm. Head, palpi, and thorax white, palpi mixed with ochreous and fuscous beneath, thorax with a narrow orange anterior margin. Antennæ fuscous. Abdomen greyish, beneath ochreous. Legs ochreous, banded above with fuscous. Forewings elongate, moderate, termen obliquely rounded; bright orange-ochreous; markings whitish, rather obscure; four equi-distant fuscous spots on costa between one-sixth and three-quarters; two oblique fasciæ from one-quarter and middle, reaching two-thirds across wing, and thence meeting a thick streak along dorsum from base to two-thirds; a moderate spot on costa before three-quarters; an obscure spot on costa near apex; cilia citron-yellow, mixed with light ferruginous. Hindwings fuscous; cilia fuscous, around apex and upper half of termen greyish-ochreous.

Mackay, Queensland. Two specimens; in November. Mr. Dodd has sent me several specimens taken at Townsville, Queensland.

This may prove to be a variety of the previous species, but it presents such a different appearance as to justify me in giving it a distinctive name.

Tinea tetraspila, n. sp.

Male, 8 mm. Head ochreous. Thorax, palpi, antennæ, abdomen, and legs dark fuscous. Forewings elongate, moderate, costa gently arched, termen obliquely rounded; dark fuscous, coppery tinged and somewhat shining; markings ochreous-yellow; a moderate quadrate spot on dorsum at one-third; a second, similar, but smaller, on dorsum before anal angle; a third, obscure, on costa at two-thirds; a fourth, obscure and small, on costa near apex; cilia dark fuscous. Hindwings elongate-lanceolate; fuscous, somewhat coppery shining; cilia fuscous.

Probably nearest *tetropa*, Meyr., but widely distinct.

Parkside, South Australia. Gisborne, Victoria. Three specimens; in October and November.

Ereunetis streptogramma, n. sp.

Female, 8 mm. Head, palpi, antennæ, thorax, and legs pale whitish-ochreous. Abdomen greyish-ochreous. Forewings elongate, rather narrow, termen obliquely rounded; pale ochreous, with fuscous markings; six outwardly oblique streaks from costa; first at base, spot-like; second at one-sixth, larger; third before middle, very oblique, hardly reaching one-third across wing; fourth beyond middle, similar; fifth and sixth small, between five-sixths and apex; last three more or less connected by a thick, longitudinal streak, which is continued to below apex; a moderately thick streak along dorsum from base to three-quarters, with about five projections on upper edge, third anteriorly oblique and nearly reaching second costal spot; a fine line along termen, not quite connected with dorsal streak; cilia ochreous. Hindwings fuscous; cilia fuscous.

Duaringa, Queensland. One specimen; in December.

Notes on South Australian Decapod Crustacea. Part II.

By W. H. Baker.

[Read May 2, 1905.]

Plates XXI. to XXIV.

The following paper is a study of a group of Maioid crabs or *Oxyrhyncha*. The first four species and one variety belong to the genus *Halimus*, found on our coast, two of which, *H. lævis*, Haswell, and *H. truncatipes*, Miers, are important on account of their usual large size and frequency of occurrence, and which, as far as my knowledge goes, have never been figured; one, *H. tumidus*, Dana, a figure of which is to be found in another connection, in Kongl. Svenska Vetenskaps Akademiens Handlingar, Band 23, Plate ii., fig. 6, a notable variety of this species, which I have described in detail; and another which is here described for the first time. The others belong to different genera.

In Professor Haswell's catalogue of Australian crustacea the first three species are described; but there are several points of difference which I would like to set forth which are scarcely mentioned by the above authors.

The definition of the genus given by Miers in his classification of Maioid crustacea, Jnl. Lin. Soc. vol. xiv. p. 646, runs thus:—"Carapace sub-triangular, with lateral marginal spines. Three spines above the eye. Merus joint of the outer maxillipeds somewhat auriculated and produced at its antero-external angle. Anterior legs in the male enlarged, palm slightly compressed. Ambulatory legs, with the penultimate joint more or less flattened and dilated towards its distal end. Type, *Halimus auritus*, Latreille. This genus establishes a transition to the Maiidæ."

In the species of this genus under consideration the structure of the orbital region may first attract attention as of importance, especially when compared with the corresponding parts of some members of other genera of the family Maiidæ, with which the relationship of *Halimus* is undoubted; to mention some genera, viz., *Maia*, *Chlorinodes*, *Micippa*, *Schizophrys*, *Paramithrax*, and others, in which, while the lower margin of the orbit is usually very incomplete, being partially formed by the basal joint of the antenna, the upper is divided into, first, a short, usually thickened arcuate portion immediately above the socket of the eye peduncle, and posteriorly to this usually two spines—or more or less spiniform processes—the more posterior one of which is on a slightly lower level. This I take to be the true post-ocular spine, representing the posterior or outer angle of the orbit; the preceding one I have called the intermediate spine of the upper orbital margin. In *Paramithrax*, *Schizophrys*, etc., these parts are well shown, but have become, as it were, squeezed together to form a more complete orbit; but in the species of *Halimus* under consideration the spines are distant, the posterior portion of the orbit being a widely open space.

Within the genus itself the arrangement of these parts is useful for classification, the anterior arcuate portion being spiniform, dentiform, tuberculate, or merely rounded at the anterior or posterior end, and the two succeeding spines in different degrees of development and relationship.

If *Chlorinodes coppingeri*, Haswell, be examined, these parts will be seen to be much exaggerated in shape.

Also, in the interocular space on each side, near the orbital margin above, there is in these species of *Halimus* a tubercle with a more or less distinct ridge extending from it on to the rostral horn; these elevations are supplied plentifully with the curled corneous bristles so much in evidence amongst these crabs. In the same species of *Chlorinodes* mentioned above this ridge is very distinct; it is also shown in *Paramithrax* and others.

Again, in the species of *Halimus* under consideration a more or less papilliform tubercle is situated on the subhepatic region; in *H. truncatipes* this is somewhat anvil-shaped and very distinctive.

In the cardiac region of *Halimus* are usually seen a pair of tubercles showing a tendency to coalesce, represented in the species of *Chlorinodes* again by a lamellar, bifid structure which is very prominent.

Lastly, in these allied species, the chelipeds of the males are subject to great variation as to size, their enlargement apparently taking place well on in the life of the animal, as in some specimens they scarcely exceed those of the female. I would instance the case of *Leptomithrax spinulosus*, Haswell, where certain males—doubtless adults, on account of size and being covered by much of the usual foreign matter—have the chelipeds little if at all exceeding in size and shape those of the female, while in others they are massive, with the fingers very unsymmetrical. In *Schizophrys aspera* somewhat similar conditions obtain.

In these four species of *Halimus* the normal chelipeds scarcely differ; in all, the hands become slightly narrower distally in the vertical direction, and are more or less provided with scattered punctations, from which fasciculi of hairs arise.

The following points, therefore, are common to the four species:—The carapace is sub-pyriform, more or less acutely pointed medianly on the posterior border, convex, usually more depressed anteriorly than posteriorly; the rostral horns are well developed and divergent and usually curved outwards; the posterior part of the orbit is widely open, the upper margin consists of, first, an anterior portion forming an arch over the socket of the eye-peduncle, spined or projecting each end; second, an intermediate spine more or less distant from the posterior end; and third, a strong, post-ocular spine, usually pointing forwards, and distant from the intermediate spine at a lower level.

The lateral spines of the carapace are, viz., one on the hepatic region, and three on the branchial, the most posterior of which approaches nearer the middle of the carapace.

The basal antennal joint has a strong spine at the external distal angle, and usually a small one at the internal angle. There is a small conical tubercle close to the base of this joint, on the outer side, usually tipped with hairs.

The external maxillipeds have the ischium joint with its internal distal angle very much produced above the transverse line. The merus joint, inverted-triangular in shape, is rounded and produced at its external distal angle partially covering the end of the exopod, truncate, and the margin insinuate at the internal angle; the ends of the margin thus defined are acute or spined, the following joint originating close to the outer (or upper) end of this margin.

Sub-hepatic and pterygostomial regions each with a more or less conical tubercle.

Chelipeds usually rather weak in the females and in some males, in others much enlarged, with the fingers widely gaping, but not unsymmetrical. The merus has a spine at the distal end above. The carpus is strongly keeled in the males.

Ambulatory legs long, becoming successively shorter behind, the joints mainly cylindrical, the ischium joints each with a small conical tubercle below at the distal end, the penultimate joints more or less expanded towards their distal ends, the expansions usually becoming wider on the more posterior legs. The dactyli curved, sharp, with two rows of small teeth.

Pleon seven-jointed in the males, the fourth, fifth, and sixth coalesced in the females.

The species of this genus are, as in other Maioid genera, well supplied with more or less curved corneous bristles springing in groups usually from the tubercles, rostral horns, etc., and also from the ambulatory legs. These are used for the attachment of foreign substances for purposes of obscuration.

The genus may be briefly characterised in the following manner:--

Family ~~MAIIDÆ~~. Inachidae

Genus **Halimus,** *Latreille.*

Carapace sub-pyriform, more or less acutely pointed medianly on the posterior border.

Rostral horns divergent, and sometimes depressed.

Orbits incomplete, especially below.

A large lateral spine on the hepatic region.

Three lateral spines on the branchial region.

The basal antennal joint with a spine on its external distal angle.

The external maxillipeds with the ischium joint much produced at its internal distal angle, the merus joint rounded and produced at its external distal angle, truncate at the internal angle.

Sub-hepatic and pterygostomial regions each with a more or less conical tubercle.

Chelipeds usually weak in the females and some males; in other males much enlarged.

Ambulatory legs long, the joints cylindrical, except the propodi, which are more or less expanded towards their distal ends.

Pleon seven-jointed in the males.

Halimus lœvis, *Haswell.* Pl. xxi., figs. 1, 1*a*.

(Pr. L.S., N.S.W., Ser. i., vol. iv., p. 435.)

This species is very variable, especially as to size. The chelipeds of the males are sometimes normal, sometimes massive.

The following characteristics, in addition to those given by Professor Haswell, are tolerably constant in a moderate series of examples noted.

The rostral horns project horizontally. The anterior portion of the carapace is well depressed from the middle of the gastric region forwards, and with a less curve behind. The inter-ocular tubercles are large. There is one well-marked but low tubercle on each epibranchial region, two more faintly marked on the mid-branchial, obliquely placed. A pair of transverse, separate tubercles on the cardiac region, one median conical tubercle on the intestinal region, and between this and the cardiac pair a faint indication of a pair of transverse tubercles; these are more pronounced in some specimens. The tubercles have a tendency in old specimens to become worn away. The branchial regions are marked off from the urogastric and cardiac by a row of pits lying in the grooves which separate these regions. The posterior margin is more or less pointed medianly, in some examples broad, thick, and polished, in others almost or quite spiniform.

The supra-ocular border is anteriorly thrown into a prominent acute spine; posteriorly there is a smaller one. The intermediate spine is well developed, projecting nearly horizontally, and further than the preceding one; it is situated slightly nearer this than to the post-ocular. The post-ocular sine is long, and is inclined in a forward direction. The hepatic region has a spine about the same size. The three lateral spines of the branchial region successively shorten.

The sub-hepatic tubercle is papilliform, as also is that of the pterygostomial region.

The basal antennal joint has a broad, oblique sulcation, extending from near the external distal angle. The external distal spine is rather small, and is only slightly pressed upward. The remainder of the peduncle is not covered by the rostral horn.

The normal chelipeds have the fingers rather long, approximating nearly their whole length, slightly curved, and minutely dentate.

The segments of the pleon in the male are moderately prominent in the median line.

Length of medium-sized specimen, 45 mm.
Breadth in the mid-branchial region, 33 mm.
Length of rostral horn, 7 mm.
Inter-ocular space, 11 mm.
Length of cheliped, male, 40 mm.
Length of first ambulatory leg, 54 mm.

Halimus truncatipes, *Miers*. Plate xxii., figs. 2, 2*a*.

(An. and Mag. Nat. Hist., Ser. v., vol. iv., p. 3.)

My specimens agree well with Miers' description. The species attains to as large a size as *H. lævis*. The chelipeds of the male also are capable of assuming the larger development. The lateral spines are stronger, and the tubercles of the carapace more spiniform, also tubercles are shown where in the former species there are merely groups of bristles, the carapace itself is more convex, the rostral horns longer and a little depressed and more divergent. The inter-ocular tubercles are very distinct; there are four papilliform tubercles occupying the front of the gastric region, the two outermost smaller, and not in the same transverse line. The supra-ocular arcuate margin has the anterior spine very prominent but obtuse, the intermediate spine is large, and has a more forward direction than in *H. lævis*. Its position with regard to the one immediately preceding it is about the same as in that species. There are six tubercles of varying sizes on each branchial region—apart from the lateral spines—and the two cardiac tubercles are distinct. The cardiac and intestinal regions are marked off by sinuous rows of pits, which assume irregular groups on the sides of the intestinal region.

The eyes are rather small.

The sub-hepatic region has the anvil-shaped spine before mentioned.

The external distal spine of the basal antennal joint is large, the internal one very small. There is an oblique sulcation on this joint, as in the preceding species.

This species is common in shallow water at Port Willunga, Edithburg, and elsewhere, and Mr. Fulton has sent me specimens from Western Port, Victoria.

Length of carapace, 44 mm.
Breadth of carapace, 32 mm.
Length of rostral horn, 9 mm.
Inter-ocular space, 11 mm.
Length of first ambulatory leg, 56 mm.

Halimus tumidus, *Dana*. Plate xxii., figs. 3, 3a.

(U.S. Exploring Exped. Crust., 1, p. 165.)

My specimens of this species are small.

The carapace is very convex, anteriorily depressed, as are much so the rostral horns, which also are somewhat vertically compressed. The tubercles of the upper surface are not strongly marked, but are more numerous than in the preceding species. The inter-ocular tubercles are very low. There is no spine on the posterior border, an intestinal tubercle is present, as also are two on the cardiac region, with a small one tending to become double between them. The anterior portion of the upper orbital margin is merely thickened, rounded anteriorly, and posteriorly scarcely acute. The intermediate spine is nearly horizontal in position, and is near to the post-ocular. The post-ocular spine is well developed, but the remaining lateral spines poorly, especially the last.

The basal joint of the antenna has its external distal spine very large and somewhat compressed, showing well from above, spinulose on its outer margin, and strongly pressed upwards. The internal distal spine is very small, the oblique sulcation wide and shallow, the remaining peduncular joints are almost totally hidden by the rostral horn.

The pleon of the male has the segments scarcely prominent medianly except the first two. The pleon of the female ends in a distinct though obtuse point.

The chelipeds in the male are of moderate size, the hand is short and rather tumid, the fingers are short, narrow, and evenly dentate. The arm is provided with a distal tooth above, and there are faint indications of two more further back. The carpus is strongly keeled with a minute tooth at the proximal end.

The sub-hepatic tubercle is spiniform, and points forward.

The penultimate joints of the posterior pair of ambulatory legs are nearly as much expanded as in *H. truncatipes.*

This is a shallow water species, St. Vincent Gulf.

Length of carapace, 18 mm.

Breadth of carapace, 13 mm.

Length of rostral horn, 3 mm.

Inter-ocular space, 5 mm.

Length of chelipeds, 15 mm.

Length of first ambulatory leg, 17 mm.

Specimens in Adelaide Museum.

Halimus tumidus, var. **gracilipes,** *n. var.* Pl. xxiii., fig. 5.

Carapace very convex. Rostral horns rather slender, well depressed, and divergent, more so from their distal halves, but little vertically compressed. The upper orbital border is anteriorly tuberculate, but not so nearly spiniform as in *H. truncatipes*, the posterior end bears a small, acute tooth, the intermediate spine is well developed and acute, separated from the preceding tooth by a narrow V-shaped cleft, while it is separated from the post-ocular by a much wider space. The post-ocular spine is long, inclined forwards, and is slightly sigmoid in shape. The hepatic region bears a small conical spine. The three lateral spines of the branchial region are moderately developed. The inter-ocular space has two strong conical tubercles, with a smaller one in advance of each; the space between these pairs is somewhat concave, extending forwards to the base of the rostral horns. Five gastric tubercles are arranged in the usual manner, and are well marked; four or six more lateral ones less distinctly. There are two, very small, on the urogastric region. The cardiac region consists of two elevations, each bearing three small tubercles, and behind these there are three median, sub-acute, and well-defined, including one on the posterior border, which is slightly turned up at the apex and slightly bifid. The epibranchial regions are slightly tumid, each bearing two small tubercles, arranged obliquely, and there are nine or ten more on each branchial region (omitting the lateral spines) more or less developed. There are two or three very small tubercles on each hepatic region. Apart from the tubercles, the surface of the carapace is smooth. The limiting rows of pits between the branchial and cardiac regions are very faintly indicated.

The basal antennal joint is large, broadly sulcate in an oblique manner. The external distal spine is large, but not compressed, and is distant from the rostral horn. There is a small tooth at the inner distal angle. The external margin of the joint is slightly sinuate, and bears two spiniform teeth, one of which is on the distal spine. The remaining joints of the peduncle are not hidden by the rostral horn.

The eyes are well developed. There is a small tubercle tipped with hairs above the ophthalmus.

The epistome is somewhat excavate.

The external angles of the buccal frame are prominent, the margin bearing some small, ill-formed tubercles.

The pleon in the female has the fourth, fifth, and sixth segments very broad and coalesced, medianly sulcate, the groove marked with a few irregular punctations. The first three segments are very prominent medianly, especially the first. The external margin of the coalesced segments is raised. The terminal segment is broad and distally rounded.

The sub-hepatic spine is strong, acute, and points forward. The pterygostomial one is small.

The chelipeds in the female are slender, the merus joint short, not reaching as far forward as the post-ocular spine. It is sub-cylindrical, and bears externally three well-developed, forward-directed spines, the last larger and at the distal end. The carpus bears a small tooth near the proximal end on the outer side. The palm is laterally compressed. The fingers are slender, long, about two-thirds the length of the palm, with minute teeth towards their ends.

The ambulatory legs are long and rather slender. The merus joint of the first pair is cylindrical, and reaches nearly as far as the carpus of the cheliped. The carpus is sub-equal in length to the propodus. The proximal half of the propodus is cylindrical, the distal half not much expanded. The dactylus is slender.

This specimen differs from the typical *H. tumidus* in the following respects:—The tubercles and spines of the carapace are much more accentuated. The inter-orbital region has two tubercles on each side, with a broad, shallow concavity between them. The rostral horns are longer, much slenderer, and little compressed in the vertical direction. The upper orbital border has anteriorly a distinct tubercle and an acute spine posteriorly, the intermediate one being very close to this. There is a strong median tooth on the posterior margin. The second and third joints of the antennal peduncle are not hidden by the rostral horn. In the cheliped the merus joint bears two strong projecting spines, besides the one at the distal end. The ambulatory legs are longer and slenderer, the penultimate being not so much expanded. The penultimate joint is more than three times as long as broad.

Habitat, St. Vincent Gulf. Dredged by Dr. Verco.

Length of carapace, 18 mm.

Breadth of carapace, 13 mm.

Length of rostral horn, 4 mm.

Length of cheliped, 15 mm.

Length of first ambulatory leg, 24 mm.

One specimen, a female, in Adelaide Museum.

I have referred this specimen to Mr. G. M. Thomson, of Dunedin, who has been good enough to examine it, with the result that it is here recorded as a variety of *H. tumidus*, Dana.

Halimus gracilis, *n. sp.* Pl. xxiii., figs. 4, 4*a*.

Carapace elongate, shrunken, anteriorly moderately depressed. The rostral horns are long, rather slender, very divergent, especially distally, projecting forward horizontally. Tubercles of the carapace not so numerous as in the preceding species; there are two inter-ocular, well marked, two transverse, with three longitudinal behind, on the gastric region, the last of which is almost obsolete; four others laterally placed on the gastric region are also nearly obsolete, one on each epibranchial region, with one a little below and outward from each. The cardiac tubercle is single, and there is one on the intestinal, which is very close to the strong median spine of the posterior border. The rows of pits noticed in the other species are faintly marked.

The supra-orbital border is thin, without anterior tubercle, the posterior end has a small acute point, the intermediate spine is short, and is situated much further from the post-ocular than from the point which precedes it. The post-ocular is longer than the other lateral spines, and projects well forward, the following hepatic spine projects horizontally, and is situated close behind on the prominent hepatic region, behind which the carapace is strongly constricted. The three lateral spines of the branchial region are well developed, rather contiguous, each being curved forwards.

The basal antennal joint is elongate, narrow, the oblique sulcation scarcely indicated. The external distal spine is rather short, scarcely showing from above, the remaining peduncular joints are not hidden by the rostral horn; there is a small spine at the internal distal angle.

The epistome is narrow and rather long.

The anterior angles of the buccal frame are very prominent.

The sub-hepatic and pterygostomial tubercles are papilliform.

The normal chelipeds in the male have the arm subcylindrical, the distal spine well developed, and with a well-marked tooth near the proximal end above. The carpus is strongly keeled outwardly, the proximal end very prominent. The palm is compressed, narrowing in the vertical direction towards the distal end. The fingers are moderately long, slightly curved, rather slender, finely denticulate, and approximating for nearly their whole length. The enlarged cheliped sometimes occurs in this species in the males.

The ambulatory legs are long, rather slender, sparingly setose, with the merus joints cylindrical; the carpal and propodal joints nearly equal in length, the propodal little expanded distally. The dactyli are slender, curved, and acute.

The pleon of the male is narrow, the two first segments more so, the third slightly wider than the rest; their median portions are only very moderately prominent.

This species may easily be distinguished from the former ones by its shrunken appearance, by the length of the lateral spines and rostral horns, its single tubercle on the cardiac region, etc. In the position of the intestinal tubercle it resembles *H. aries*.

Length of carapace, 30 mm.
Breadth of carapace, 20 mm.
Length of rostral horn, 8 mm.
Length of cheliped, 34 mm.
Length of first ambulatory leg, 49 mm.
Inter-ocular space, 6½ mm.
Dredged by Dr. Verco, Investigator Straits, 20-30 fms.
Types in Adelaide Museum.

The next species is referred to the genus *Paramicippa*, M.-Edw. I have been able to compare it with *P. tuberculosa*, M.-Edw., and find the following characteristics common to both.

The carapace is rounded behind. The rostral horns are depressed, though not quite so much as in *P. tuberculosa*. The orbits are similar, although in *P. tuberculosa* the intermediate spine has disappeared, but is perhaps represented by the bifid, post-ocular spine. The eye peduncles are long, non-retractile, and project upwards. The basal joint of the antenna is broad and sloping outwards. The second joint of the peduncle (although not compressed) is large and prominent. The external maxillipeds resemble those of *Halimus*. The pleon segments in the female are free. The dactyli of the ambulatory legs are without spinules.

Family Maiidæ.

Genus *Paramicippa*, M.-Edw.

Paramicippa hispida, *n. sp.* Pl. xxiv., figs. 6, 6*a*.

Body thickly covered with long, bristly hairs, especially on the legs, where they are sometimes curved at the tips.

Carapace pyriform, convex, smooth beneath the hairs, most elevated in the protogastric region. The gastric region is broad in front, narrowing behind. The urogastric region is distinct, as also are the cardiac and intestinal. These are separated from the branchial by an irregular shallow groove extending longitudinally from the cervical groove to a shallow meta-branchial depression; this groove is bounded on the outer side by an obscurely marked, rounded ridge following the same direction but interrupted in the middle. The branchial regions are well rounded, moderately tumid, and without spines. The posterior margin is slightly produced medianly, and rounded.

The anterior portion of the upper margin of the orbit is slightly thickened and strongly arched; the posterior end of the arch is sub-acutely prominent and pressed down behind the eye peduncle; the intermediate spine, which is somewhat compressed and sub-acute, follows close behind with the post-ocular, which is a little longer and also sub-acute, following close after it in the same oblique line. The orbit is very widely open below.

The hepatic region is slightly tumid.

The rostral horns are short, nearly parallel, acute, and much, though not vertically, depressed. Two ridges, with a median groove between, extend from the base of the rostrum to the front of the gastric region, slightly diverging backwards.

The ocular peduncles are very long, project upwards, and are slightly curved in that direction.

The basal antennal joint is short, slightly oblique, sloping outwards, ending distally in a slightly curved, transverse ridge, which on the outer side is produced to a strong spine, projecting outwards and upwards, and but very little forwards, and on the inner side bearing a small tooth. The remaining joints of the peduncle are well clear of the rostral horn, the more proximal one is short and broad, but not compressed.

The sub-hepatic region is tumid.

The pterygostomial region has a compressed tubercle or spine.

The epistome is depressed.

There is a small, rounded swelling between the orbit and the external angle of the buccal frame.

The external maxillipeds are similar to those of *Halimus*, though the internal distal angle of the ischium and the external angle of the merus are not so much produced.

The chelipeds are very weak in both sexes, smooth, unarmed. The merus is short, cylindrical, and slightly constricted near the distal end. The carpus is narrow and rounded above. The hand is not much compressed, and narrows in the vertical direction. The fingers are nearly straight, very faintly toothed, more than half the length of the palm, nearly cylindrical, and with a proximal hiatus.

The ambulatory legs are moderately long, with the pairs not differing much in length, very hairy, the joints cylindrical, the carpal joints longitudinally grooved above. The dactyli are acute and slightly curved.

The male pleon is seven-segmented, the sides slightly insinuate from the third segment. The segments are medianly umbonate, especially at their distal margins; the third segment has a slight swelling on each side; the terminal segment is broadly triangulate. The female pleon has the seven segments distinct.

Length of carapace, 26 mm.

Breadth of carapace, 22 mm.

Inter-ocular space, 7 mm.

Length of cheliped, 23 mm.

Length of first ambulatory leg, 32 mm.

Littoral species, Port Willunga, Mr. W. J. Kimber; Port Lincoln, etc.

Types in Adelaide Museum.

This species has the habit of covering itself with extraneous materials to an excessive degree, scarcely more than the chelipeds and eyes are uncovered. The material consists of sand, calcareous matter, seaweeds, etc., very difficult of removal.

Family Maiidæ.

Genus *Micippa*, Leach.

Micippa mascarenica, *Kossman*, var. **nodulifera**, *n. var.*

Pl. xxiv., figs. 8, 8*a*.

The carapace is sub-oblong, broadest near the posterior border, depressed—more so in the male. The surface is granulate to tuberculate and nodular. The tubercles or nodules and the larger granules are white, many apparently formed by coalescence of granules; these are much more crowded near the posterior border. Groups have the following positions:—One on each hepatic region, one on each epi-branchial region, one on the meso-gastric, preceded in the median line by two or three large single granules, one on the urogastric and two on the cardiac region. Three well-marked, compressed tubercles, closely succeed each other on the lateral margin behind the orbit, and behind the last of these are numerous smaller tubercles, which become almost spiniform posteriorly. The median regions are slightly raised, and a strong depression exists in each hepatic region.

The upper margin of the orbit is anteriorly thin and arcuate, with a longitudinal row of granules near the edge. Its posterior end is produced to a slight prominence, the succeeding parts—representing the intermediate and post-ocular spines—are tuberculiform, compressed in the vertical direction, and separated from each other by almost closed fissures. The outer one is similar to those which succeed it on the lateral margin, and has a somewhat T-shape.

The front is strongly declivous, but not vertically deflexed, it is slightly narrower proximally, and faintly crenulate on the sides, terminating in four acute lobes or teeth, the outer ones slightly raised along with the lateral margins, projecting outwards and slightly upwards, the inner ones projecting downwards.

The basal antennal joint is broad, oblique, and much produced at its external distal angle; this is sub-acute and strongly pressed upwards, showing well when viewed from above. The outer margin of the joint is slighty crenulate, the second joint is dilated, the third less so.

The sub-hepatic and pterygostomial regions are tumid and coarsely granular.

The external maxillipeds are like those of *Halimus*. The outer distal angle of the merus is produced and broadly rounded, the distal margin not insinuated, and bearing minute teeth.

The pleon of the male is sub-oblong, proximally a little constricted, the third, fourth, fifth, and sixth segments are sub-equal in length, the terminal segment is rounded to almost semi-circular form. In the female the segments are distinct.

The chelipeds are rather weak in the male, smooth, the merus sub-cylindrical, and slightly curved, the carpus is rounded above, the palm is scarcely one and a half times as long as the carpus, the fingers are shorter than the palm, slightly curved, meeting for nearly the whole length of their opposable edges, very faintly toothed.

The ambulatory legs are rather short, the first pair scarcely exceeding the length of the chelipeds, the other pairs becoming successively shorter, the merus joints are sub-cylindrical, the distal ends of these and the carpal joints are nodular, the carpal joints are short, vertically compressed, and grooved above, the propodal joints are cylindrical, the dactyli are curved, strong, and without spinules.

Length of carapace, 10 mm.
Breadth of carapace, 8 mm.
Length of cheliped, 7 mm.
Dredged by Dr. Verco, S.A. coast, 20 fms.
Specimens in Adelaide Museum.

Family PARTHENOPIDÆ.

Genus *Thyrolambrus*, Rathbun. Pr. U.S. Mus., vol. xvii.

Thyrolambrus excavatus, *n. sp.* Pl. xxiv., fig. 7.

The whole of the body is covered with irregular granules, forming in parts jagged points, becoming more or less spiniform on the ambulatory legs.

Carapace triangular, broader between the lateral angles than long, produced to some extent over the bases of the chelipeds and first two pairs of legs. Surface much eroded, being covered with irregular granules, for the most part connected together by small ridges, forming somewhat stellate reticulations. The regions are well defined, those most in relief are the protogastric and branchial, and most depressed the meta-gastric and intestinal. The meta-gastric depression extends laterally to the margin behind the hepatic region, and posteriorly between the cardiac and branchial to join the intestinal, though becoming shallower. The branchial regions are tri-lobed, the lobes arranged in a triangular manner, the apex forming the lateral angle of the carapace. Of these three lobes the anterior one is the largest. The hepatic region is small and depressed. The epi-gastric region has a deep median excavation, between which and the front is a shallow median groove, which is continued behind the cavity, bifurcating in front of the meso-gastric region to join the meta-gastric depression. The meso-gastric region is triangular, and behind it the median portion of the carapace, after being a little depressed, becomes gradually elevated again at the cardiac region. This has on each side two or more irregular transverse ridges connecting it with the meta-branchial lobe, and posteriorly it is abrupt to the intestinal depression. The sides of the carapace are very declivous, and below the antero-branchial lobe there is a slight excavation, beneath which the margin expands to a ridge immediately above the chelipeds, bearing some spiniform tubercles and uniting anteriorly with the pterygostomial ridge. The latero-posterior and posterior margins are nearly in the same transverse line, the former slightly insinuate, bearing some obtuse points, especially at the junction with the posterior border. The posterior margin is short, slightly raised, and granulate, with a small transverse ridge, usually bearing three distinct granules close above it.

The front is almost vertically depressed, narrowing, and produced well beyond the orbits, terminating in a small rostral process, which projects downwards between the antennules.

The orbits are nearly circular, the internal sub-orbital angle slightly accentuated.

The basal antennal joint is slightly oblique, becoming narrower distally, barely reaching the sub-orbital angle: the second joint is much smaller, and just reaches the contiguous part of the front; the third joint and flagellum are very small and lie in the orbital cavity.

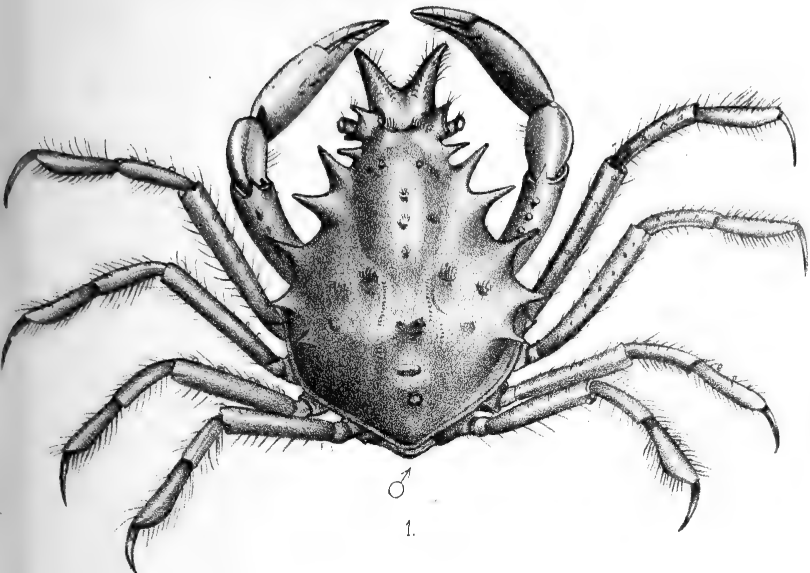
The epistome is sunken, but strongly bordered all around.

The sub-orbital region is rather tumid; an excavation behind divides it from the sub-hepatic lobe, and joins a large cavity, separating the sub-hepatic from the pterygostomial region.

The external maxillipeds completely close the buccal cavity. The ischium is about twice as long as the merus; its internal distal angle is slightly produced above the transverse line; it has a longitudinal groove, and strongly granulate ridge. The merus is sub-quadrate, its external distal angle slightly overlapping the end of the exopod, its inner distal angle truncated, the space filled by the succeeding joint. The exopod has a longitudinal series of strong granules.

The chelipeds are moderately robust, the merus is thicker proximally, sub-cylindrical, very rough above, with a conical, erect process near the proximal end; anteriorly there are two or three triangular processes, also proximal; the lower surface is more evenly granulate, and has two small projections about the middle; there are also one or two projections posteriorly. The carpus is somewhat flattened above. The hand is trigonous, its upper surface flattened and ascending to the base of the mobile finger, where it is very prominent and jagged. The inner margin bears three compressed processes projecting inwards, the middle one of which is much larger. The lower margin bears a series of five or six forward-projecting, compressed processes, usually acute, extending on to the immobile finger. The outer surface is slightly convex, and bears an obscure tubercle or two about the middle. The fingers are as rough as the hand, very much compressed laterally, the apices are crossed, and when in this position the opposable edges meet.

The ambulatory legs are small, covered with more or less spiniform points; the first pair does not reach as far as the



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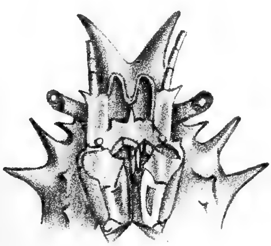
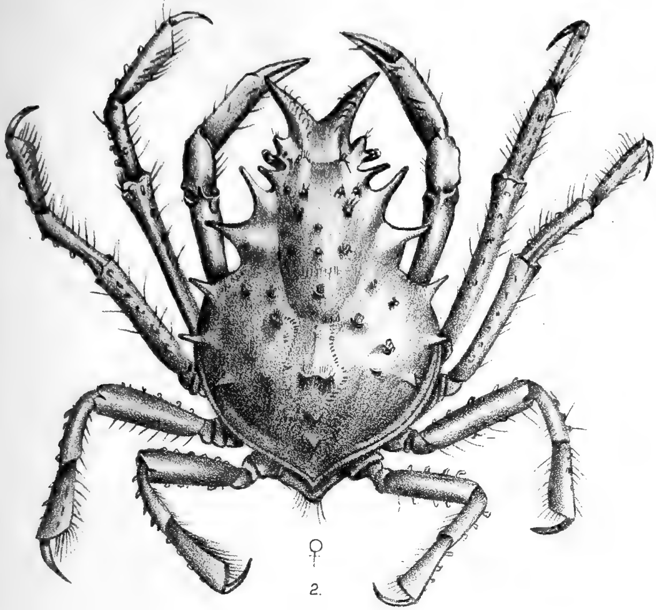


1a.

W.H.B. DEL.

HUSSEY & GILLINGHAM. LITH.

HALIMUS LÆVIS.



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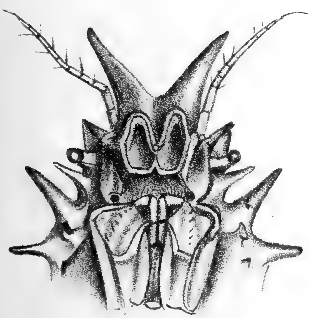
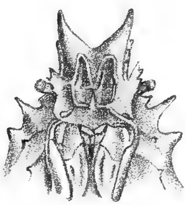


2a



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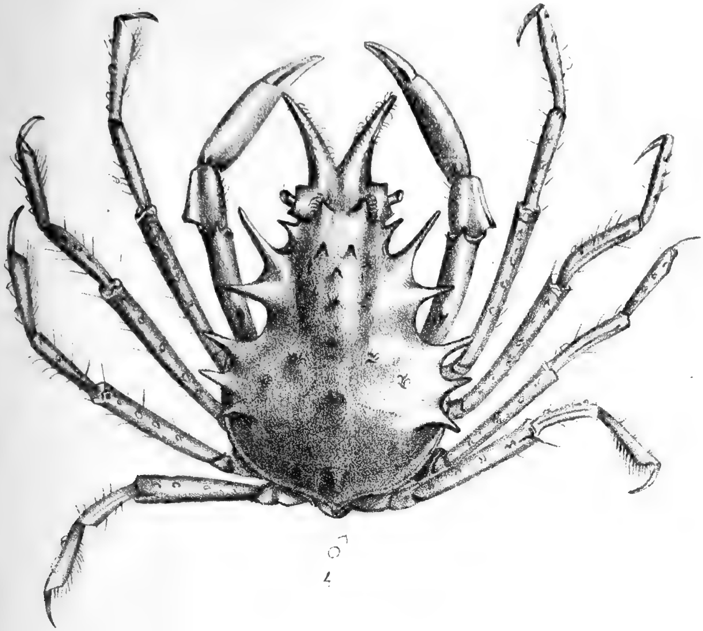
HUSSEY & GILLINGHAM. LITH.

HALIMUS TRUNCATIPES. H. TUMIDUS.



♂ 4

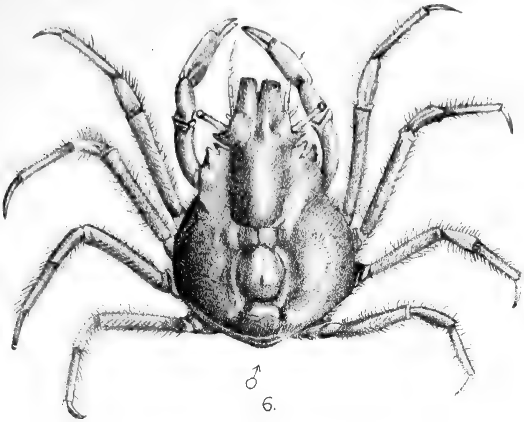
4a.

5.

W.H.B. DEL.

HUSSEY & GILLINGHAM. LITH.

HALIMUS GRACILIS. H. TUMIDUS var. GRACILIPES.



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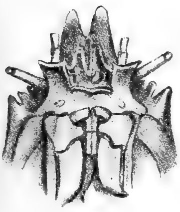
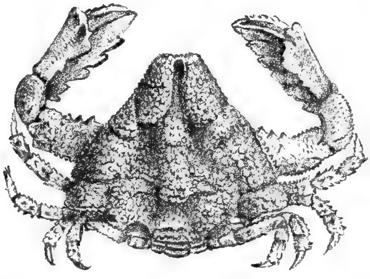


6a.



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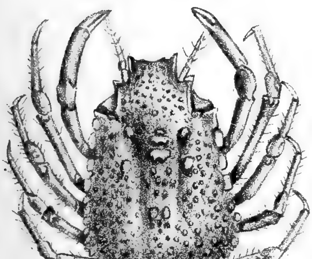

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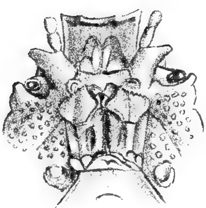

8a.

W.H.B. DEL. HUSSEY & GILLINGHAM, LITH.

PARAMICIPPA HISPIDA. MICIPPA MASCARENICA. THYROLAMBRUS EXCAVATUS.

carpus of the chelipeds; the dactyli are nearly straight. The posterior pair of legs are very short.

The pleon of the female covers the whole of the narrow sternum between the legs: the distal half is slightly broader and is medianly very prominent, the prominence broken by transverse, jagged ridges, which extend to the margins, and on the last segment have a radiate arrangement. In the male the pleon is very narrow, especially the distal half, the sternum showing a deep excavation between its last segment and the base of the buccal frame.

Length of carapace, 19 mm.

Breadth of carapace, 25 mm.

Length of cheliped, 30 mm.

Dredged by Dr. Verco, Investigator Straits, 20-30 fms.

Types in Adelaide Museum.

I am in doubt whether this species should not be placed in the genus *Parthenope*, Fabricius, but its complete agreement with *Thyrolambrus*, as presented by Miss Rathbun, has decided me here.

EXPLANATIONS OF PLATES.

PLATE XXI.

Fig. 1 *Halimus lævis*, Haswell—Natural size.

Fig. 1a. *Halimus lævis*, Haswell—Inferior view of anterior regions. Enlarged.

PLATE XXII.

Fig. 2. *Halimus truncatipes*. Miers—Natural size.

Fig. 2a. *Halimus truncatipes*, Miers—Inferior view of anterior regions. Enlarged.

Fig. 3. *Halimus tumidus*, Dana—Inferior view of anterior regions. Enlarged.

~~Fig. 3a. *Halimus tumidus*, Dana—Side view.~~

PLATE XXIII.

Fig. 4. *Halimus gracilis*, n. sp.—Enlarged.

Fig. 4a. *Halimus gracilis*. n. sp.—~~Enlarged~~. Inferior view of anterior region

Fig. 5. *Halimus tumidus*, var. *gracilipes*, n. var.—Enlarged.

PLATE XXIV.

Fig. 6. *Paramicippa hispida*, n. sp.—Enlarged.

Fig. 6a. *Paramicippa hispida*, n. sp.—Inferior view of anterior regions. Enlarged.

Fig. 7. *Thyrolambrus excavatus*, n. sp.—Slightly enlarged.

Fig. 8. *Micippa mascarenica*, Kossman, var. *nodulifera*, n. var.—Enlarged.

Fig. 8a. *Micippa mascarenica*, Kossman, n. var.—Inferior view of anterior regions. Enlarged.

On the Alpha Particles of Radium, and their Loss of Range in passing through various Atoms and Molecules.

By W. H. Bragg, M.A., Elder Professor of Mathematics and Physics in the University of Adelaide, and R. Kleeman, B.Sc.

[Read June 6, 1905.]

Abstract.

In a previous paper laid before the Royal Society of South Australia on September 6, 1904 (see Vol. xxviii., p. 298; also *The Philosophical Magazine*, December, 1904), the authors had adduced theoretical and experimental evidence in support of the following propositions:—

1. The alpha particle moves always in a rectilinear course, spending its energy as it traverses atoms of matter, until its velocity becomes so small that it cannot ionise, and there is in consequence no further evidence of its motion.
2. Each particle possesses, therefore, a definite range in a given medium, the length of which depends on the initial velocity of the particle and the nature of the medium.
3. The alpha particles of radium which is in radio-active equilibrium can be divided into four groups, each group being produced by one of the first four radio-active changes in which alpha particles are emitted.
4. All the particles of any one group have the same initial velocity and the same range.

The present paper could be regarded as a continuation of the previous communication. Its contents were arranged under the following heads:—

1. Improvements in the apparatus used for measuring the ranges and relative strengths of the four groups of rays.

2. Results of experiments with the new apparatus, giving the following values of the ranges in air at 76 cm. pressure and 20° C.:—

Radium, 3·50.
Emanation or Radium A } 4·23
Radium A or Emanation } 4·83
Radium C, 7·06

These were probably correct to ·05 cm.

It also appeared that the four groups were alike in all respects save that of initial velocity, and that the alpha particle spent

its energy at a rate proportional, approximately, to the inverse square root of its speed.

3. Determinations of the loss of range of alpha particles in consequence of their passage through various substances, from which it appeared that for all the materials examined the loss in traversing any atom was nearly proportional to the square root of the weight of the atom. The loss in the case of a complex molecule was proportional to the sum of the square roots of the weights of the constituent atoms. The results were presented in the following table:—

TABLE, showing "stopping power" of various atoms and molecules, as compared to air. The atomic weight of the imaginary standard atom of air is taken as 14·4, and the atomic square root as 3·79:—

Substance.	Stopping Power.	Ratio of Atomic or Molecular Square Roots.	Ratio of Atomic or Molecular Weights.
Hydrogen	·246	·265	·069
Air	1	1	1
Aluminium	1·53	1·38	1·88
Copper	2·42	2·1	4·53
Silver	3·12	2·75	7·5
Tin	3·42	2·88	8·2
Platinum	4·12	3·7	13·5
Gold	4·45	3·7	13·7
Methyl bromide ...	2·09	2·09	3·28
Ethyl chloride	2·30	2·36	2·23
Methyl iodide	2·49	2·35	4·9
Ether	3·30	3·68	2·56
Carbon tetrachloride ...	3·8	3·61	5·41

When these results were plotted, the metals and gases seemed to lie on rather different lines.

4. Discussion of these results. The authors suggested as a possible explanation that, if atoms had a disc-like form (see Meyer's Kinetic Theory of Gases, § 112), and if ions could only be produced on the edges of the discs, then the chances of ionisation by an alpha particle traversing any atom would be proportional to the square root of the atomic weight. This explanation involved the assumption that the energy required to produce a pair of ions was a constant under all conditions, as stated by Rutherford. The authors believed that this assumption was correct, in spite of the fact that in some of their experiments on gases with complex atoms the alpha particle did not produce as much total conductivity as in air, and they suggested, as an explanation of the apparent contradiction, that ions made in complex molecules sometimes re-combined before getting free of the molecules.

South Australian Nudibranchs, and an Enumeration of the known Australian Species.

By Herbert Basedow and Charles Hedley.

[Read April 4, 1905.]

Plates I. to XII.

Historical Sketch.

Our earliest information of Australian Nudibranchs dates from Baudin's expedition. The untrained collectors who visited Australia previously were unlikely to trouble with objects so difficult to procure or preserve.

In the first years of the last century, those distinguished marine zoologists, Peron and Lesueur, took back with them to Paris several species, which were studied by Cuvier. These included *Scyllæa pelagica*, *Phyllirhoa lichtensteinii*, *Kentrodoris maculosa*, and *Casella atromarginata*.

The next contribution was also from a French source. Quoy and Gaimard, the famous surgeon-naturalists of the Astrolabe Expedition, dredged their *Doris violacea* and *D. aurea* in nine fathoms, in Jervis Bay, N.S.W., and took *Elysia australis* on the beach near Sydney.

Several active naturalists, Jukes, Macgillivray, Huxley, and Ince, served on H.M.S.S. Fly and Rattlesnake when those vessels were surveying the coast of Queensland. Hence the British Museum obtained much material. Gray was provided with *Sphaerodoris incii* and *Asteronotus cruenta*, and Abraham with *Platydoris coriacea*, and others.

During a brief visit to Sydney Dr. Stimpson procured there his *Doris obtusa*, *D. excavata*, *Goniodoris obscura*, and *Aeolis cacaotica*.

George French Angas resided for some years in Sydney. From 1858 to 1860 he took opportunities to make water-colour drawings from life of Sydney nudibranchs. He examined thirty species, most of which were then new. Crosse published these sketches and descriptions, with comments of his own, in the *Journal de Conchyliologie*. This important paper represents the only work done locally.

During the voyage of the Challenger several species were dredged off the coasts of Queensland and New South Wales, and were described by Dr. Bergh in the Challenger Results.

About the same time the naturalists of H.M.S. Alert collected five species in North Queensland, which were published in the Zoology of that voyage.

A period of twenty years then elapsed, during which no additions of importance were made to our knowledge.

Recently Professor Bergh has described six new species from material gathered by Miss Lodder in Tasmania.

As Angas was unacquainted with the work of his predecessors, and as Abraham did not know the species of Angas, the revision here commenced requires to be continued.

In concluding this brief sketch we wish to draw attention to the valuable assistance rendered by Dr. J. C. Verco, in allowing one of us to accompany him on his marine dredging excursion, and thus affording an opportunity of observing and sketching the forms collected in their natural state, a factor of extreme importance in the systematic study of these perishable beings.

CENSUS OF THE DESCRIBED SPECIES OF AUSTRALIA.

NUDIBRANCHIATA.*

NUDIBRANCHIATA CLADOHEPATICA.

FAMILY AEOLIDIADAE.

Genus **Aeolidiella**, Bergh, 1874.

AEOLIDIELLA FAUSTINA, Bergh.

A. faustina, Bergh, Zool. Jahrb. xiii. (3), 1900, p. 235-236, Pl. xx., f. 39-40. *Id.*, Reis. im Arch. der Phil., vi., 1904, p. 2, Pl. i., f. 27-31.

Hab.—Ulverstone, Tasmania (Miss Lodder).

Genus **Coryphella**, Gray, 1850.

CORYPHELLA FOULISI, Angas.

Aeolis foulisi, Angas, Journ. de Conch. xii., 1864, p. 64, Pl. vi., f. 3. *Coryphella foulisi*, Bergh, Reis. im Arch. der Phil. ii (2), 1892, p. 1029.

Hab.—Sydney Harbour (Angas).

CORYPHELLA (?) CACAOTICA, Stimpson.

Aeolis cacaotica, Stimpson, Proc. Acad. N. Sci. Philad vii., 1856, p. 388. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1878, p. xii.

Hab.—Sydney Harbour (Stimpson).

Obs.—This name perhaps refers to a species of Angas.

CORYPHELLA MACLEAYI, Angas.

Aeolis macleayi, Angas, Journ. de Conch. xii., 1864, p. 65, Pl. vi., f. 4. *C. macleayi*, Bergh, Reis. im Arch. der Phil. ii. (2), 1878, p. xvi.

Hab.—Sydney Harbour (Angas).

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* In the following list the sequence of the species is based on the classification proposed by Dr. Bergh in Semper's Reisen im Archipel der Philippinen.

Genus **Rizzolia**, Trinchese, 1877.

Rizzolia australis, Bergh.

R. australis, Bergh., Chall. Zool. x., 1884, p. 27, Pl. ix., f. 1-5. *Id.*, Reis. im Arch. der Phil. ii. (2), 1892, p. 1031.

Hab.—Sydney Harbour (Challenger).

Genus **Flabellina**, Cuvier, 1830.

Flabellina ianthina, Angas.

F. ianthina, Angas, Journ. de Conch. xii., 1864, p. 66, Pl. vi., f. 6. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1034.

Hab.—Sydney Harbour (Angas).

Flabellina ornata, Angas.

F. ornata, Angas, Journ. de Conch. xii., 1864, p. 67, Pl. vi., f. 7. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p 1034.

Hab.—Sydney Harbour (Angas).

Flabellina newcombi, Angas.

F. newcombi, Angas, Journ. de Conch. xii., 1864, p. 68, Pl. vi., f. 8. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1034.

Hab.—Coogee, near Sydney (Angas).

Genus **Fiona**, Alder & Hancock, 1853.

Fiona marina, Forskäl.

Limax marina, Forskäl, Descrip. Anim., 1775, p. 99. *Fiona marina*, Bergh, Chall. Zool. x., 1884, p. 9, Pl. xi., f. 1.

Hab.—Maroubra, near Sydney (Whitelegge).

Obs.—This world-wide mollusc has an extensive literature. It has been added to the Australian fauna by Hedley (Proc. Malac. Soc. i., 1895, p. 333). New Zealand specimens were described by Hutton as *Eolis plicata* (Trans. New Zealand Inst., xiv., 1882, p. 166, Pl. vi., f. 1). Plate discovered it in Chili (Bergh, Zool. Jahrb. xiii., 1900, p. 239).

Genus **Glaucus**, Forster, 1777.

Glaucus atlanticus, Forster.

G. atlanticus, Forster, Voy. Resolution i., 1777, p. 49. *Id.*, Bergh, Chall. Zool. x., 1884, p. 16. *Id.*, Hedley, Mem. Aust. Mus. iv., 1903, p. 401.

Hab.—Off Sydney and Southport, Queensland (Hedley).

Genus **Janus**, Verany, 1844.

Janus (?) sanguineus, Angas.

J. sanguineus, Angas, Journ. de Conch. xii., 1864, p. 63, Pl. vi., f. 5. *Id.*, Bergh., Reis. im Arch. der Phil. ii. (2), 1892, p. 1036.

Hab.—Sydney Harbour (Angas).

Obs.—This species has neither the crest nor the rhinophores of *Janus* (properly *Antiopa*), and is only retained here till a more suitable position may be found.

Genus **Janolus**, Bergh, 1884.

Janolus australis, Bergh.

J. australis, Bergh, Chall. Rep. x., 1884, p. 19, Pl. viii., f. 15-22, Pl. ix., f. 6-8.

Hab.—Arafura Sea (Challenger).

FAMILY DOTONIDÆ.

Genus **Doto**, Oken, 1812.

Doto australis, Angas.

Melibœa australis, Angas, Journ. de Conch. xii., 1864, p. 62, Pl. vi., f. 2. *Melibe australis*, Bergh, Zool. Jahrb. Syst. v., 1891, p. 48. *Doto (?) australis*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1047.

Hab.—Sydney Harbour (Angas).

FAMILY BORNELLIDÆ.

Genus **Bornella**, Gray, 1850.

Bornella adamsi, Gray.

B. adamsi, Gray, Fig. Moll. Anim. iv., 1850, p. 107, Pl. cxcvi., f. 6. *Id.*, H. & A. Adams, Gen. Moll., Pl. lxv., f. 2. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1053. *B. hermanni*, Angas, Journ. de Conch. xii., 1864, p. 61., Pl. vi., f. 1.

Hab.—Sydney Harbour (Angas).

Obs.—Prof. Bergh regards (Zool. Jahrb. Syst. v., 1891, p. 59) as doubtfully distinct from the above, *B. arborescens*, Pease, *B. caledonica*, Crosse, *B. semperi*, Crosse, and *B. hancockana*, Kelaart.

Bornella digitata, Ad. & Reeve.

B. digitata, Ad. & Rv., Voy. Samarang, 1850, Moll., p. 67, Pl. xix., f. 1. *Id.*, Ald. & Hanck., Trans. Zool. Soc. v., 1864, p. 140, Pl. xxxiii., f. 8-9. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (1), 1874, p. 301, Pl. xxxvii., f. 14-19, Pl. xxxviii.,

f. 13-22. *Id.*, Smith, Zool. Coll. Alert, 1884, p. 92. *Id.*, Eliot, Proc. Zool. Soc., 1904, ii., p. 101.

Hab.—Port Denison, Queensland (Alert).

Bornella excepta, Bergh.

B. excepta, Bergh, Chall. Zool. x., 1884, p. 36, Pl. vii., f. 13-22, Pl. viii., f. 1-13.

Hab.—Arafura Sea (Challenger).

FAMILY SCYLLAEIDÆ.

Genus **Scyllæa**, Linné, 1758.

Scyllæa pelagica, Linné.

S. pelagica, Linn. Syst. Nat. x., 1758, i., p. 644, 656. *Id.*, Cuvier, Ann. du Mus. vi., 1804, p. 424. *Id.*, Collingwood, Trans. Linn. Soc. Zool. ii., 1881, p. 137-8, Pl. x., f. 29-33. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1056. *Id.*, Hedley, Proc. Roy. Soc., Vict. vii., n.s., 1895, p. 199.

Hab.—Terre d'Edels, Western Australia (Peron), Port Phillip, Victoria (Bracebridge Wilson), St. Vincent's Gulf, South Australia (Verco).

Obs.—This world-wide species has too extensive a bibliography to insert here unabridged.

FAMILY PHYLLIROIDÆ.

Genus **Phyllirhoa**, Peron & Lesueur, 1811.

Phyllirhoa lichtensteinii, Eschscholtz.

Eurydice lichtensteinii, Eschscholtz, Isis, 1825, i., p. 737, Pl. v., f. 1. *Phylliroe punctulatum*, Quoy & Gaim., Voy. Astrolabe, Zool. ii., 1833, p. 407, Pl. xxviii., f. 15-18. *Id.*, Macdonald, Proc. Roy. Soc., Lond. vii., 1856, p. 363. *Id.*, Bergh. Reis. im Arch. der Phil. ii. (1), 1872, p. 210.

Hab.—Terre d'Edels, Western Australia (Quoy and Gaim.). Lord Howe Island (Macdonald).

Obs.—This bibliography is much abbreviated.

Nudibranchiata holohepatica.

FAMILY PLEUROPHYLLIDIADÆ.

Genus **Pleurophyllidia**, Meckel, 1810.

Pleurophyllidia cygnea, Bergh.

P. cygnea, Bergh, Malak. Blätt. xxiii., 1876, p. 9, Pl. i., f. 1-7. *Id.*, Reis. im Arch. der Phil. ii. (2), 1892, p. 1063.

Hab.—Swan River, W.A. (Cuming Coll.), St. Vincent's Gulf, S.A. (Veıco), and Sydney Harbour (Hedley).

DORIDIDÆ CRYPTOBRANCHIATÆ.
FAMILY DORIDIDÆ.

Genus **Hexabranchus**, Ehrenberg, 1831.

HEXABRANCHUS FLAMMULATUS, Quoy & Gaim.

Doris flammulata, Quoy & Gaim., Voy. Astrolabe, Zool. ii., 1833, p. 257, Pl. xvii., f. 6-10. *Hexabranchus flammulatus*, Wild, Nat. Hist. Soc. Queensland i., 1894, p. 90.

Hab.—Tweed Heads, Queensland (Wild).

HEXABRANCHUS IMPERIALIS, Kent.

Doris imperialis, Kent, Naturalist in Australia, 1897, p. 151, Pl. v.

Hab.—Rat Island, Abrolhos, W.A. (Kent).

Genus **Archidoris**, Bergh, 1878.

ARCHIDORIS VARIA, Abraham.

Doris variabilis, Angas, Journ. de Conch. xii., 1864, p. 44, Pl. iv., f. 1 (not *Doris variabilis*, Kelaart, Ann. Mag. Nat. Hist. (3), iii., 1859, p. 300). *Doris varia*, Abraham, Proc. Zool. Soc., 1877, p. 209. *Doris prætenera*, Abraham, Proc. Zool. Soc., 1877, p. 258, Pl. xxx., f. 10-12.

Hab.—Sydney Harbour (Angas). St. Vincent's Gulf, S.A.

ARCHIDORIS STAMINEA, *spec. nov.*

Hab.—Backstairs Passage, S.A. (Verco).

Genus **Staurodoris**, Bergh, 1878.

STAURODORIS PUSTULATA, Abraham.

Doris pustulata, Abraham, Proc. Zool. Soc. 1877, p. 205, 256, Pl. xxix., f. 18, 19. *Staurodoris (?) pustulata*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1093.

Hab.—Australia (Abraham). St. Vincent's Gulf (Verco).

Genus **Alloiodoris**, Bergh, 1904.

ALLOIODORIS MARMORATA, Bergh.

A. marmorata, Bergh, Reis. im Arch. der Phil. vi., 1904, p. 42, Pl. iii., f. 12-19.

Hab.—Ulverstone, Tasmania (Miss Lodder). St. Vincent's Gulf (Basedow).

Genus **Discodoris**, Bergh, 1877.

DISCODORIS DUBIA. Bergh.

D. dubia, Bergh, Reis. im Arch. der Phil. vi., 1904, p. 50, Pl. iii., f. 29-30, Pl. iv., f. 1-2.

Hab.—Ulverstone, Tasmania (Miss Lodder.)

DISCODORIS EGENA, Bergh.

D. egena, Bergh, Reis. im Arch. der Phil. vi., 1904, p. 54, Pl. iv., f. 7-14.

Hab.—Ulverstone, Tasmania (Miss Lodder.)

Genus **Thordisa**, Bergh, 1877.

THORDISA CLANDESTINA, Bergh.

T. clandestina, Bergh, Chall. Zool. x., 1884, p. 106, Pl. iii., f. 21-25. *Id.*, Reis. im Arch. der Phil. ii. (2), 1892, p. 1098.

Hab.—Torres Straits (Challenger).

Genus **Halgerda**, Bergh, 1880.

HALGERDA GRAPHICA, *spec. nov.*

Hab.—St. Vincent's Gulf, S.A. (Verco).

Genus **Kentrodoris**, Bergh, 1876.

KENTRODORIS MACULOSA, Cuvier.

Doris maculosa, Cuvier, Ann. du Mus. iv., 1804, p. 466. *Id.*, Quoy & Gaim., Voy. Astrolabe, Zool. ii., 1833, p. 249, Pl. xvi., f. 3-5. *Id.*, Abraham, Proc. Zool. Soc., 1877, p. 202. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1878, p. xxx. *Kentrodoris annuligera*, Bergh, Reis. im Arch. der Phil. ii. (2), **1890. p. 922**.

Hab.—Sharks Bay, W.A. (Peron).

Obs.—Lack of space has excluded numerous references.

Genus **Platydoris**, Bergh, 1877.

PLATYDORIS CORIACEA, Abraham.

Doris coriacea, Abraham, Proc. Zool. Soc., 1877, p. 203, 247, Pl. xxvii., f. 1-4. *Platydoris coriacea*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1102.

Hab.—Sir C. Hardy's Isles, Queensland (? H.M.S. Fly), Green and Masthead Islands, Queensland (Hedley).

Obs.—This species seems suspiciously like *Platydoris scabra*, Cuvier.

PLATYDORIS INFRAPICTA, Smith.

Doris infrapicta, Smith, Zool. Coll. Alert, 1884, p. 91.

Hab.—Queensland (Alert).

PLATYDORIS CRUENTA, Gray.

Asteronotus cruenta (Alder MS.), Gray, Fig. Moll. Anim. iv., 1850, p. 44, 102, Pl. ccxxvi., f. 2, 2a. *Doris cruentata*, Abraham, Proc. Zool. Soc., 1877, p. 201; not *Doris cruentata*, Quoy & Gaim., Voy. Astrolabe, Zool. ii., 1833, p. 260.

Hab.—Torres Straits (Ince).

Genus **Asteronotus**, Ehrenberg, 1831.

ASTERONOTUS MABILLA, Abraham.

A. mabilla, Bergh, Jahrb. Deut. Mal. Gesell. iv., 1877, p. 163 *(nom. nud.)*. *Id.*, Abraham, Proc. Zool. Soc. 1877, p. 249, Pl. xxviii., f. 1-4. *Id.*, Bergh, Reis. im Arch. der Phil. ii., 1876, p. 644, 1892, p. 1103.

Hab.—Sydney Harbour (Hedley).

Genus **Hypselodoris**, Stimpson, 1855.

Obs.—We would point out that the species which Stimpson described as *Goniodoris obscura* is obviously that which Angas afterwards found in the same place and named *G. crossei*. Stimpson saw that his species was unsuitably placed in *Goniodoris*, and proposed for its reception *Hypselodoris*. As this name, though unknown to any later writer, has nine years' precedence over Alder & Hancock's *Chromodoris*, it must certainly replace it.

HYPSELODORIS OBSCURA, Stimpson.

Goniodoris obscura, Stimpson, Proc. Acad. Nat. Sci. Philad., vii., 1855, p. 388. *G. crossei*, Angas, Journ. de Conch. xii., 1864, p. 54, Pl. v., f. 1. *Chromodoris crossei*, Bergh, Reis. im Arch. der Phil. ii. (2), 1884, p. 648-50. *Id.*, loc. cit., 1892, pp. 1109, 1110.

Hab.—Sydney Harbour (Angas).

HYPSELODORIS LINEOLATA, van Hasselt.

Doris lineolata, van Hasselt, Bull. Sci. Nat. Zool. iii., 1824, p. 258. *Chromodoris striatella*, Bergh, Chall. Zool. x., 1884, p. 73, Pl. iii., f. 26-29, Pl. iv., f. 1-4. *Id.*, Journ. Mus. Godeff. xiv., 1879, p. 5. *Id.*, Reis. im Arch. der Phil. ii. (2), 1892, p. 1106.

Hab.—Port Denison (Dietrich) and Torres Straits (Challenger).

HYPSELODORIS RUNCINATA, Bergh.

Chromodoris runcinata, Bergh, Reis. im Arch. der Phil. ii., 1877, p. 479-481, Pl. li., f. 32, 33, Pl. liii., f. 5-12; 1892, p. 1107. *Id.*, Chall. Zool. x., 1884, p. 76, pl. vi. f. 1-4. *Id.*, Eliot, Proc. Zool. Soc. 1904, i., p. 393. *C. iris*, Collingwood, Trans. Linn Soc. Zool. ii., 1881, p. 127, Pl. ix., f. 9-14.

Hab.—Sydney Harbour (Challenger).

HYPSELODORIS VERRUCOSA, Crosse.

Goniodoris verrucosa, Crosse, Journ. de Conch. xii., 1864, p 56, Pl. v., f. 4. *Chromodoris verrucosa*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1108.

Hab.—Sydney Harbour (Angas).

Hypselodoris erinaceus, Crosse.

Goniodoris erinaceus, Crosse, Journ. de Conch. xii., 1864, p. 57, Pl. v., f. 5. *Chromodoris erinaceus*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1108.

Hab.—Sydney Harbour (Angas).

Hypselodoris bennetti, Angas.

Goniodoris bennetti, Angas, Journ. de Conch. xii., 1864, p. 51, Pl. iv., f. 10. *Chromodoris bennetti*, Bergh, Verhandl. k.k. zool.-bot. Ges. Wien, 1893, p. 415, Pl. iv., f. 12-17.

Hab.—Sydney Harbour (Angas).

Hypselodoris festiva, Angas.

Goniodoris festiva, Angas, Journ. de Conch. xii., 1864, p. 53, Pl. iv., f. 12. *Chromodoris festiva*, Bergh, Verhandl. k.k. zool.-bot. Ges. Wien, 1893, p. 417, Pl. iv., f. 18-22.

Hab.—Sydney Harbour (Angas).

Hypselodoris loringi, Angas.

Goniodoris loringi, Angas, Journ. de Conch. xii., 1864, p. 52, Pl. iv., f. 11. *Chromodoris loringi*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1109.

Hab.—Sydney Harbour (Angas).

Hypselodoris splendida, Angas.

Goniodoris splendida, Angas, Journ. de Conch. xii., 1864, p. 55, Pl. v., f. 2. *Chromodoris splendida*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1109. *Id.*, Eliot, Proc. Zool. Soc. 1904, i., p. 390.

Hab.—Sydney Harbour (Angas).

Hypselodoris daphne, Angas.

Goniodoris daphne, Angas, Journ. de Conch. xii., 1864, p. 54, Pl. v., f. 3. *Chromodoris daphne*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1109.

Hab.—Sydney Harbour (Angas).

Hypselodoris tasmaniensis, Bergh.

Chromodoris tasmaniensis, Bergh, Reis. im Arch. der Phil. vi. (2), 1905, p. 69, Pl. v., f. 12-15.

Hab.—Ulverstone, Tasmania (Miss Lodder).

Hypselodoris epicuria, *spec. nov.*

Hab.—St. Vincent's Gulf (Newland).

Genus **Casella**, H. & A. Adams, 1858.

Casella atromarginata, Cuvier.

Doris atromarginata, Cuvier, Ann. du Mus. iv., 1804, p. 473, Pl. ii., f. 6. *Goniodoris atromarginata*, Angas, Journ. de Conch. xii., 1864, p. 51. *Casella atromarginata*, Bergh, Journ. Mus. Godeff. Heft. vi., 1874, p. 102, Pl. ii., f. 15-29, Pl. iii., f. 21-32. *Id.*, Reis. im Arch. der Phil. ii. (2), 1892, p. 1110. *Id.*, Eliot, Proc. Zool. Soc. 1904, i., p. 399. *Casella gouldii*, H. & A., Ad. Genera ii., 1857, Pl. xliii., f. 5. *Casella philippinensis*, Bergh, Reis. im Arch. der Phil. ii. (1), 1874, Pl. xxxiii., f. 1.

Hab.—Sydney Harbour (Angas).

Obs.—The above references are not exhaustive.

Genus **Albania**, Collingwood, 1881.*

ALBANIA (?) VERCONIS, *spec. nov.*

Hab.—St. Vincent Gulf, S.A. (Verco).

Genus **Ceratosoma**, Ad. & Reeve, 1848.

CERATOSOMA BREVICAUDATUM, Abraham.

C. brevicaudatum, Abraham, Ann. Mag. Nat. Hist. (4), xviii., 1876, p. 142, Pl. vii., f. 6. *C. oblongum*, Abraham, *loc. cit.*, p. 143, Pl. vii., f. 7, 7a, 7b. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1111.

Hab.—Western Australia (Abraham), St. Vincent Gulf, S.A. (Verco), Sydney Harbour (Hedley).

CERATOSOMA ADELAIDÆ, *spec. nov.*

Hab.—St. Vincent Gulf, S.A. (Basedow).

CERATOSOMA TENUE, Abraham.

C. tenue, Abraham, Ann. Mag. Nat. Hist. (4), xviii., 1876, p. 141, Pl. vii., f. 5, 5b. *Id.*, Smith, Zool. Coll. Alert, 1884, p. 90. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1111.

Hab.—Thursday Island, Torres Straits (Alert).

CERATOSOMA LIXI, Rochebrune.

C. lixi, Rochebrune, Naturaliste, 1894, p. 55. *Id.*, Arch. Mus. Paris, 3 ser., vii., p. 134, Pl. vi., f. 6.

Hab.—Dead Island, Torres Straits (Lix).

CERATOSOMA GIBBOSUM, Rochebrune.

C. gibbosum, Rochebrune, Naturaliste, 1894, p. 55. *Id.*, Arch. Mus. Paris, 3 ser., vii., p. 135, Pl. vi., f. 4.

Hab.—Dead Island, Torres Straits (Lix).

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* While these pages are going through the press, and too late to alter the title of Plate iv., we observed that Bergh (Reis. im. Arch. der Phil., ii. (2), 1894, p. 148) reduces *Albania* to a synonym of *Æthodoris*, Abraham, 1877.

Genus **Aphelodoris**, Bergh, 1879.

Aphelodoris luctuosa, Bergh.

A. luctuosa, Bergh, Reis. im Arch. der Phil. vi. (2), 1905, p. 75, Pl. v., f. 26-32, Pl. vi., f. 1-2.

Hab.—Ulverstone, Tasmania (Miss Lodder).

Genus **Miamira**, Bergh, 1875.

Miamira sinuata, van Hasselt.

Doris sinuata, van Hasselt, Bull. d. Sci. Nat. and d. Geol. iii., 1824, p. 239. *Miamira nobilis*, Bergh, Journ. Mus. Godeff., Heft. vi., 1874, Pl. viii., f. 8, Heft. viii., 1875, p. 53, Pl. viii., f. 1-30, Pl. ix., f. 1-4. *Id.*, Reis. im Arch. der Phil. ii. (2), 1876, p. 411, Pl. xxxiii., f. 2, and 1892, p. 1112; vi. (2), 1905, p. 81, Pl. v., f. 33-36. *Id.*, Smith, Zool. Alert, 1884, p. 90. *Id.*, Eliot, Proc. Zool. Soc., 1904, i., p. 405.

Hab.—Port Denison, Queensland (Alert).

Genus **Sphaerodoris**, Bergh, 1877.

Sphaerodoris incii, Gray.

Doris incii (Alder M.S.), Gray, Fig. Moll. An. iv., 1850, Pl. ccxxvi., f. 1, p. 103. *Dictyodoris incii*, Bergh, Reis. im Arch. der Phil. ii. (2), 1880, Suppl. p. 75. *Sphaerodoris incii*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1113.

Hab.—Torres Straits (Ince).

FAMILY DORIOPSIDÆ.

Genus **Doriopsis**, Pease, 1860.

Doriopsis denisoni, Angas.

Doris denisoni, Angas, Journ. de Conch. xii., 1864, p. 45, Pl. iv., f. 2. *Doridopsis gemmacea*, Ald. & Hancock, Trans. Zool. Soc. v., 1864, p. 126, Pl. xxxi., f. 4, 5, 6, 7. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1884, p. 698; 1892, p. 1120. *Doridopsis denisoni*, Eliot, Proc. Zool. Soc., 1904, ii. (1905), p. 277.

Hab.—Sydney Harbour (Angas).

Obs.—Professor Bergh reduces Angas's name to a synonym of *D. gemmacea.* It appears, however, that *D. denisoni* has about six months' priority over *D. gemmacea.*

Doriopsis violacea, Quoy & Gaimard.

Doris violacea, Quoy & Gaim., Voy. Astrolabe, Zool. ii., 1832, p. 264, Pl. xix., f. 1-3. *Doriopsis violacea*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1121.

Hab.—Jervis Bay, N.S.W. (Astrolabe).

Doriopsis australis, Angas.

Actinodoris australis, Angas, Journ. de Conch. xii., 1864, p. 49, Pl. iv., f. 8. *Doriopsis australis*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1122.
Hab.—New South Wales (Angas).

Doriopsis australiensis, Abraham.

Doridopsis australiensis, Abraham, Proc. Zool. Soc., 1877, pp. 243, 263, Pl. xxx., f. 25-26. *Doriopsis australiensis*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1122.
Hab.—New South Wales.

Doricpsis aurea, Quoy & Gaimard.

Doris aurea, Quoy & Gaim., Voy. Astrolabe, Zool. ii., 1832, p. 265, Pl. xix., f. 4-7. *Doriopsis aurea*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1122.
Hab.—Jervis Bay, N.S.W. (Astrolabe), St. Vincent Gulf, S.A. (Verco).

Doriopsis carneola, Angas.

Doris carneola, Angas, Journ. de Conch. xii., 1864, p. 48, Pl. iv., f. 6. *Doriopsis carneola*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1122.
Hab.—Sydney Harbour (Angas), St. Vincent Gulf (Basedow).

Doriopsis nodulosa, Angas.

Doris nodulosa, Angas, Journ. de Conch. xii., 1864, p. 48, Pl. iv, f. 6. *Doriopsis nodulosa*, Bergh, Reis. in Arch. der Phil. ii. (2), 1892, p. 1122.
Hab.—Ccogee, near Sydney (Angas).

Doriopsis (?) pantherina, Angas.

Doris pantherina, Angas, Journ. de Conch. xii., 1864, p. 47, Pl. iv.. f. 5
Hab.—Coogee, near Sydney (Angas).

FAMILY PHYLLIADIDÆ.

Genus **Phyllidia**, Cuvier, 1798.

Phyllidia varicosa, Lamarck.

P. varicosa, Lamarck, Syst. des An. s. vert., 1801, p. 66. *Id.*, Quoy & Gaim., Voy. Astrolabe, Zool. ii., 1832, p. 292, Pl. xxi., f. 25. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1876, p. 380, Pl. xxv., f. 7, Suppl. 1881, p. 8, 1892, p. 1128. *Id.*, Eliot, Proc. Zool. Soc., 1904, ii. (1905), p. 281.
Hab.—Dampier's Archipelago, W.A. (Gazelle).

DORIDIDÆ PHANEROBRANCHIATÆ.

FAMILY POLYCERADÆ.

Genus **Triopa**, Johnston, 1838.

TRIOPA YATESI, Angas.

T. yatesi, Angas, Journ. de Conch. xii., 1864, p. 60, Pl. v., f. 8. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1139.

Hab.—Sydney Harbour (Angas).

Genus **Palio**, Gray, 1857.

PALIO COOKI, Angas.

Polycera cooki, Angas, Journ. de Conch. xii., 1864, p. 58, Pl. v., f. 6. *Palio (?) cooki*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1142.

Hab.—Botany Bay (Angas).

Genus **Ohola**, Bergh, 1884.

OHOLA PACIFICA, Bergh.

O. pacifica, Bergh, Chall. Zool. x., 1884, p. 52, Pl. ix., f. 9-12.

Hab.—Arafura Sea (Challenger).

Genus **Angasiella**, Crosse, 1864.

ANGASIELLA EDWARDSI, Angas.

A. edwardsi, Angas, Journ. de Conch., 1864, xii., p. 49, Pl. iv., f. 9. *Nembrotha (?) edwardsi*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1145.

Hab.—Sydney Harbour (Angas).

Genus **Nembrotha**, Bergh, 1877.

NEMBROTHA VERCONIS, *spec. nov.*

Hab.—St. Vincent Gulf, S.A (Verco).

Genus **Placomopherus**, Leuckart, 1828.

PLACOMOPHERUS IMPERIALIS, Angas.

Plocamophorus imperialis, Angas, Journ. de Conch. xii., 1864, p. 59, Pl. v., f. 7. *Plocamopherus naevatus*, Abraham, Ann. Mag. Nat. Hist. (4), xviii., 1876, p. 139, Pl. vi., f. 4, 4a. *P. imperialis*, Bergh, Verh. Zool. bot. Ges. Wien, xxxiii., 1884, p. 144-9, Pl. vi., f. 10, Pl. x, f. 8-9, Reis. im Arch. der Phil. ii. (2), 1892, p. 1146.

Hab.—Sydney Harbour (Angas).

Placomopherus insignis, Smith.

Plocamophorus insignis, Smith, Zool. Coll. Alert, 1884, p. 91, Pl. vi., f. l., li.

Hab.—Albany Island, Queensland (Alert).

Genus **Acanthodoris,** Gray, 1857.

Acanthodoris metulifera, Bergh.

A. metulifera, Bergh, Reis. im Arch. der Phil. vi. (2), 1905, p. 98, Pl. vii., f. 3-6.

Hab.—Ulverstone, Tasmania (Miss Lodder).

UNCLASSIFIED SPECIES.

Doris arbutus, Angas.

Journ. de Conch. xii., 1864, p. 47, Pl. iv., f. 4. *Id.*, Read, Proc. Linn. N.S.W., iv., 1879, p. 291, Pl. xvii.

Hab.—Coogee.

Doris chrysoderma, Angas.

Journ. de Conch. xii., 1864, p. 46, Pl. iv., f. 3.

Hab.—Sydney Harbour.

Doris collatata, Abraham.

Proc. Zool. Soc., 1877, p. 205, 255, Pl. xxix., f. 25-26.

Hab.—Port Essington.

Doris peculiaris, Abraham.

Proc. Zool. Soc., 1877, p. 211, 258, Pl. xxx., f. 15-17.

Hab.—Port Lincoln, S.A.

Doris analampulla, Abraham.

Proc. Zool. Soc., 1877, p. 205, 254, Pl. xxix., f. 8-10.

Hab.—Australia.

Doris obtusa, Stimpson.

Proc. Acad. N. Sc., Philad., vii., 1855, p. 389.

Hab.—Sydney Harbour.

Doris excavata, Stimpson.

Proc. Acad. N. Sc., Philad., vii., 1855, p. 389 (not *D. excavata*, Pease).

Hab.—Sydney Harbour.

Doris, sp.

W. S. Kent, Great Barrier Reef, 1893, p. 362, pl. xiii., f. 6.

Hab.—Queensland.

DORIS, sp.

W. S. Kent, Great Barrier Reef, 1893, p. 362, pl. xiii., f. 7.

Hab.—Queensland.

ANCULA, sp.

W. S. Kent, Great Barrier Reef, 1893, p. 362, pl. xiii., f. 9.

Hab.—Queensland.

NUDIBRANCHIATE MOLLUSC.

W. S. Kent, Great Barrier Reef, 1893, p. 362, pl. xiii., f. 8.

Hab.—Queensland.
Obs.—Perhaps a *Phyllidia.*

SUB-ORDER ASCOGLOSSA.

FAMILY ELYSIIDÆ.

Genus **Elysia,** Risso, 1818.

ELYSIA AUSTRALIS, Quoy & Gaimard.

Actæon australis, Quoy & Gaim., Voy. Astrolabe, Zool. 1832, p. 317, Pl. xxiv., f. 18-20. *E. coogeensis*, Angas, Journ. de Conch. xii., 1864, p. 69, Pl. iv., f. 9.
Hab.—Sydney Harbour (Astrolabe), Coogee (Angas)

TO BE EXCLUDED.

ALLPORTIA EXPANSA, Ten.-Woods.

A. expansa, Ten.-Woods, Proc. Roy. Soc., Tas., 1876, p. 28
Hab.—Southport, Tasmania.
Obs.—In a paper read (June 10, 1902) to the Royal Society, Tasmania, but still unpublished, Hedley points out that this name was based on a Planarian worm, *Polycelis australis*, Schmarda.

REMARKS ON SOUTH AUSTRALIAN SPECIES, INCLUDING DESCRIPTIONS OF NEW SPECIES

Scyllæa pelagica, Linné.

Plate ix., figs. 1 and 2.

S. pelagica, Linn. Syst. Nat. x., 1875, i., p. 644, 656. *Id.*, Cuvier, Ann. du Mus. vi., 1804, p. 424, etc., etc.

Several divergent forms lie before us, but after consulting Bergh's criticisms on the species, and its variations, we do not hesitate to include them all under the one widespread species. The main differences are in the length of the dorsal lobes and the colouration, the former feature depending largely upon the degree of contraction, and the latter, no doubt, upon the colour of the seaweed upon which the animal lived.

Dim.—The largest individual that has so far been found in South Australia measures 42 millimetres in length, the length of the lobes being 16, and height of body 21, making a total height of 37 mm.

Hab.—Dredged in 20 fathoms, off Antechamber Bay, Kangaroo Island, January, 1903 (Verco); thrown up on Port Willunga beach (Newland).

Pleurophyllidia cygnea, Bergh.

Plate x., figs. 1 and 2; Plate xi., figs. 1-3; Plate xii., figs. 1-6.

P. cygnea, Bergh, Malakol, Blätter xxiii., 1876, p. 9, Pl. i., figs. 1-7. *Id.*, Semper's Reisen im Arch. der Phil. ii. (2), 1892, p. 1063.

With some confidence we apply Bergh's name to a species which we have obtained from St. Vincent Gulf and Sydney Harbour respectively. The species appears to be rare and not to inhabit the beach zone. Since the original description of the animal from the Swan River, Western Australia (whence it takes its name), it has not been re-taken by any collector. That description was based on an old spirit specimen. We add the following account drawn from a living animal:—

Body elongate, oblong; sides nearly parallel, terminating in a blunt point posteriorly: dorsal surface flat, sloping towards the posterior extremity. Mantle (nothæum) fairly ample, slightly waved along the edge, and extending from behind the rhinophores: ornamented longitudinally, with a series of roughly parallel, black and yellowish, undulating ridges, the medial of which extending throughout the whole length, the lateral passing out at the sides, bordered with yellow. The lobe-like veil is colourless, edged with yellow, and with a few yellow spots in its centre. Foot dilated laterally in front, tapering behind; the edge waved and extending to beyond the sides of body; it is flat, grooved longitudinally along the centre posteriorly, and does not project appreciably behind the mantle. Rhinophores longitudinally laminate, pink, contractile. Branchiæ pink, on the under side of the lateral projection of the mantle. Mouth prominent. Genital orifice and anus prominent on the right side, the latter 19 mm. behind the former. The entire under-surface a uniform light crimson.

Radula pale yellow. Lateral spines numerous, about 70, of equal size, except the most central, which are smaller than the rest. Average length of lateral spines, ·27 mm. The minutely denticulated margin was not observed. Between the lateral spines and central plate, with its cuspidated edge, an irregularly triangular, plane plate.

Dim.—Length 82, breadth 34 mm.

Hab.—Dredged in 20 fathoms, off Antechamber Bay, Kangaroo Island, January, 1903.

Obs.—The mollusc was kept alive for several days in a glass of sea water, and it was still alive when transferred to the preservative. It has retained its colour remarkably well in a weak solution (3 per cent.) of formaline.

Archidoris varia, Abraham.

Plate v., figs. 1-5.

Doris variabilis, Angas, Journ. de Conch. xii., 1864, p. 44, Pl. iv., fig. 1 (not *Doris variabilis*, Kelaart, Ann. Mag. Nat. Hist. (3), iii., 1859, p. 300). *Doris varia*, Abraham, Proc. Zool. Soc., 1877, p. 209. *Doris praetenera*, Abraham, Proc. Zool. Soc., 1877, p. 258, Pl. xxx., fig. 10-12.

This species is as abundant in South Australian waters as in Sydney Harbour.

In addition to the characters indicated by Angas we note that the skin is soft, and, in preserved specimens, has a flabby appearance. In dead examples the rugosities of the back sometimes disappear. The rhinophora arise from elevated conical sheaths, and are ornamented with about 24 lamellæ. Oral tentacles, with a deep longitudinal groove on the exterior side. Branchial plumes five, tripinnate. In colour the species ranges from pale yellowish (St. Vincent Gulf) to dark reddish-brown (Port River). The wrinkles on the back are outlined and exaggerated by a mesh-work of dark lines. The sole of the foot is white, edged with rich orange, and through the thin skin the liver is visible. Along the edge of the mantle muscle-fibres are discernible as short, white, radiating lines.

Radula amber yellow. Lateral spines hamate, numerous, about 70 on either side of each transverse row, decreasing very gradually in size inwardly. Average height of spines, ·3 mm. No central spine. Twenty-three rows of spines in specimen examined. $\infty \cdot 0 \cdot \infty$.

Hab.—Dredged in 20 fathoms, St. Vincent Gulf, January, 1903, and Spencer Gulf (Verco); Port River, in 4 fathoms, April, 1902 (Field Naturalists); taken at low water, Port Noarlunga (Ashby); Port Noarlunga (Newland).

Obs.—This species has hitherto been classified in *Doris*. On account of the general form, grooved tentacles, and radula. we propose to include it in *Archidoris*.

Archidoris staminea, *spec. nov.*

Plate vi., figs. 3 and 4.

Body irregularly elliptical, very slightly narrower posteriorly, convex. Cloak ample, frilled along the border; colour, a uniform tint of yellow; roughened by very numerous small tubercular elevations and depressions, which cover the skin as separate, stellate, or radiate groups of notches; the underside of the mantle, of a similar yellow colour, is marked with vein-like threadlets, multiply dividing and branching towards the outer edge. Foot rounded anteriorly, sides almost parallel, terminating in a blunt point, slightly channelled: colour yellow, darkened somewhat in the centre by the appearance of the liver through the skin. Dorsal tentacles clavate, situated rather far anteriorly. Oral tentacles linear, prominent. Eyes visible in small examples as little black specks behind the rhinophores.

Dim.—Length 32, breadth 19 mm.

Hab.—Dredged in 20 fathoms, Backstairs Passage, January, 1903 (Verco).

Staurodoris pustulata, Abraham.

Plate ix., fig. 3.

Doris pustulata, Abraham, Proc. Zool. Soc., 1877, p. 205, Pl. xxix., figs. 18, 19. *Staurodoris (?) pustulata*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1093.

The species before us corresponds well with that described by Abraham, but as that description was taken from spirit specimens, we add the following account of the live animal:—

Body elliptical, moderately convex. Mantle ample with a slightly waved margin: of an uncommon greenish-grey ground colour, covered with numerous opaque, yellow, warty tubercles of various sizes, standing out prominently from the darker background like golden beads. Foot tapers posteriorly to a blunt point, well within the mantle-margin; colour of the entire under-surface, a light flesh-red. Rhinophores completely retractile within cavities, the openings to which are surrounded with a circlet of nodulations. Branchial plumes, seven, tripinnate, of a deeper shape of grey.

Radula straw-yellow. Lateral spines numerous, about 68 on either side, increasing in size from centre outwards, no central spine, from 25 to 30 rows in specimen examined. $\infty \cdot 0 \cdot \infty$.

Dim.—Length 20, breadth 11 mm.

Hab.—Dredged in 20 fathoms, Backstairs Passage, January, 1903 (Verco).

Alloiodoris marmorata, Bergh.

Plate viii., figs. 1 and 2.

Alloiodoris marmorata, Bergh, Reis. im Arch. der Phil. vi., 1904, p. 42, Pl. iii., figs. 12-19.

The identification of an unfigured species must always be a matter of some misgiving. None of the South Australian examples attain the size given by the author for Tasmanian specimens. In other respects the description harmonises so well with the animals before us that we have preferred to use Dr. Bergh's name for them. We were unable to detect the denticules on the lateral teeth. The following account was prepared from living specimens:—

Body elliptic, symmetrically rounded at both ends, moderately convex. Colour yellowish-white to greyish-brown, covered with minute spiculose elevations on the dorsal surface, which impart to it the brownish tint; also, with less numerous, larger elevations, surrounded by irregular circles of deep brown. The latter occasionally have a centre of opaque white, surrounded by a ring of reddish-brown, the whole giving the impression of miniature craters. Ventral surface translucent, white; irregularly sprinkled over with asymmetrical brown spots, either isolated or arranged in small groups. Mantle considerably broader than the foot, with a slightly undulating margin; fairly thin along the border, so that the colour-markings of the dorsal surface are visible from the under-side. Foot white, with few scattered spots of brown. Rhinophores and branchiæ brown, the latter seven or eight in number. Larger individuals have come under our notice since this description.

Dim.—Length 22·5, breadth 10 mm.

Hab.—Dredged in four fathoms, Port River, December, 1901 (Field Naturalists); taken at low water on rocks, covered with seaweed, off Edithburg, Yorke's Peninsula, January, 1903 (Basedow).

Halgerda graphica, *spec. nov.*

Plate iii., figs. 1-4.

Body squat, of elliptic form, symmetrically rounded at both ends, strongly convex. Colour opaque white, liver faintly visible through the mantle. Ornamented in the following remarkable manner:—The surface of the mantle is divided somewhat regularly into quadrilateral figures, on either side of a distinct central line, by slightly elevated ridges of a rich orange-yellow colour; within these divisions are similar elevated curves and lines, in places semi-symmetrical with regard to a dark central spot, almost invariably present in the centre of each division, but easily detachable by slight abrasion. Under side of mantle white, sparsely dotted with large and small black spots, irregularly spaced. Foot rounded in front, sides approximately parallel and slightly frilled, ending posteriorly in an obtuse point, much narrower than mantle; colour opaque white, fringed with a deep orange-yellow border. Dorsal tentacles comparatively small, truncated, retractile within low sheaths, brown at the summit, white at the base. Oral tentacles, fairly long, linear, rounded in front. Genital aperture inconspicuous, situated about one-third the whole length from anterior end. Branchial plumes six, small, black, finely laciniated.

Radula light straw-coloured. Lateral spines numerous, about 40 on either side; hooked, smooth, rapidly increasing in size outwards, the three most lateral, however, small. Average height of spines, ·38 mm. No central spine. About 40 curved rows in specimen examined. Formula, 40·0·40.

Dim.—Total length 45, breadth 30, length of foot 42 mm.

Hab.—Dredged in 20 fathoms, off Antechamber Bay, Kangaroo Island, January, 1903 (Verco). Dr. Verco has dredged two individuals of this peculiar form on two separate occasions. In the Australian Museum, Sydney, there is a single specimen, collected on the beach at Middle Harbour after a gale, which is probably identical.

Obs.—Bergh's definition of *Halgerda* mentions that the lateral teeth of the radula are furnished with fine denticules, but as Eliot finds (Proc. Zool. Soc., 1903, p. 373) that this is not a constant feature, we have not considered the simple teeth of our species a bar to its admission in this genus.

The remarkable and artificial appearance presented by the ornamentation of this species resembles the hieroglyphic markings of primitive man, and suggests the species-name.

Hypselodoris epicuria, *spec. nov.*

Plate vii. figs 1-3.

Body elliptic, oblong, fairly convex, highest in region anterior to branchiæ. Mantle spiculose, of a rich red colour and covered with numerous silvery-white spiculose elevations, of a lighter shade, with a single row of dark red dots. Foot laterally expanded and slit in front, with a median groove, tapering behind; border waved; colour white, with a single row of largish yellow dots along the upper edge, and the upper surface of the tail with a faint tint of violet or rose. Both the rhinophoral and anal cavities are encircled with a stellate coronation of opaque white. Rhinophores surmounted on a white stalk, with 17 or 18 laminæ and non-retractile. Branchial plumes five, non-retractile, mono-pinnate, with indication of bipinnation at the summit; colour white.

Oral tentacles linear, projecting considerably beyond the mantle border when in motion.

Radula. Lateral spines numerous, about 30; hooked, the inner edge denticulated; surmounted on a strong base.

Dim.—Length 34, breadth 8 mm.

Hab.—Thrown up during a gale on Port Willunga beach (Newland).

Albania (?) verconis, *spec. nov.*

Plate iv., figs. 1-4.

Body oblong-ovate, rounded in front, moderately flattened on top; sides elevated; a strongly acute tail with a distinct central dorsal ridge, extends beyond the mantle edge when in motion; on death this tail curled up. Colour, exquisitely tinted dorsally, with faint, semi-transparent, reddish-violet near the border, fading imperceptibly to a light brown in the central region, which is further traversed by a fine network of opaque white lines, not discernible nearer the margin; ventrally of a uniform pale violet. Mantle serrated along the sides, and in parts upturned, produced frontally. Head, large, distinct. Foot acutely pointed, with a border frill. Rhinophores small, clavate, laminate, with about twelve laminæ, non-retractile. Genitalia large, situated about one-fifth the whole length from the anterior end. Branchial plumes ten, simply pinnate, completely surrounding the vent, non-retractile; colour, opaque white.

Radula. Colour, brownish-yellow, deepest in shade at the dilated end of odontophore. Lateral spines, about 22 on either side, stout, hooked, the central four or five trifidated. No rachidian. About 42 straightish rows in specimen examined. 22·0·22.

Dim.—Length 27, breadth 11, height 9 mm.

Hab.—A single individual dredged in 20 fathoms, off Antechamber Bay, Kangaroo Island, January, 1903 (Verco).

Obs.—With considerable hesitation we have referred this species to *Albania*. The general appearance, branchiæ, and serrate edge of the mantle suggest this genus. Dr. Collingwood describes a frontal veil in the type-species; this was not observed in the living animal. The only specimen that was found has so shrunk that we cannot now decide on its absence or presence.

Ceratosoma brevicaudatum, Abraham.

Plate i., figs. 1-4

Ceratosoma brevicaudatum, Abraham, Ann. Mag. Nat. Hist. (4), xviii., 1876, p. 142, Pl. viii., fig. 6. *Ceratosoma oblongum*, Abraham, *loc. cit.*, p. 143, Pl. vii., figs. 7, 7a, 7b. *Id.*, Bergh, Reis. im Arch. der Phil. ii. (2), 1892, p. 1111.

Dr. Bergh brackets this species with *C. caledonicum*, Fischer, *C. tenue*, Abraham, and *C. oblongum*, Abraham. It seems to us that Fischer's description indicates a species in which the lobes of the nothaeum are more developed; the colour scheme of the New Caledonian species is quite unlike that of the Australian. The difference between *C. brevicaudatum* and *C. oblongum* seems to us merely a matter of preservation. Out of a parcel resulting from the same dredging we have seen individuals, some of which shrunk to the shape of *oblongum* and others assumed in contraction the form of *brevicaudatum*. The following description was drawn up from living specimens:—

Body large, elongate, dorsally flat, rounded in front, sides nearly parallel, except along a slight lateral enlargement in the centre, and tapering to an obtuse point behind; sides much elevated, especially in the region of the vent. Cloak obsolete, sub-quadrangular, with an undulate margin, and ending posteriorly in a peculiar nipple-like protuberance. Colour, beautifully shaded with tints of buff to light brown, usually of a deeper colour at the border, and gradually fading inwards, leaving along the margin of the dorsal surface a series of alternate light and dark patches, there being in the centre of the former in each case a round, violet-purple spot surrounded by a uniform ring of reddish-purple. The central area of this surface is richly sprinkled with circular spots of varying size, of a light violet-purple colour, with a darker border, and delicately surrounded in some cases by a rim of light lemon-yellow; the larger spots of this series are also rendered conspicuous by being situated within the more faintly tinted patches of the cloak. The "post-branchial flesh protuberance" is neatly decorated by a series of brown circles, placed contiguously so as to produce a regular network with meshes of different dimensions. The sides are somewhat similarly marked to the cloak, being lightly tinted and richly sprinkled with three irregular, longitudinal rows of spots, the two outer rows of rich purple, the inner of a lighter violet-purple. The median row does not extend to beyond the length of the cloak, and thus leaves the dorsal portion of the tail marked with deep purple spots only. The spots are in this portion irregularly scattered, and often appear as small groups of two or three; they are more numerous and smaller in size than those upon the cloak. Foot linear, tapering posteriorly to a blunt point; colour white. Dorsal tentacles clavate, obliquely laminated; the number of lamellæ varying from 16 to 30 or more; colour rich orange yellow. Sheaths very slightly elevated. Oral tentacles stout, sub-conical, tapering towards the points. Genital aperture prominent. Branchial plumes twelve, intergrown at the base, and rather difficult to separate, incompletely surrounding the tubular anus in horseshoe shape, the posterior portion being bare; they are retractile with the anus into a common cavity; the five posterior plumes on either side terminate in the same foot stem respectively, the remaining two plumes are unequal in size. Colour, rich reddish-yellow.

Radula. Deep yellow to brown in colour. Lateral spines numerous, about 140 on either side; simply hooked, with an average length of ·2 mm.; about 80 rows in specimen examined. No central spine. The shape of the odontophore and the arrangement of the spines are similar to the corresponding features of *Doris adelaidæ, spec. nov.* Formula, $\infty \cdot 0 \cdot \infty$.

Dim.—Length 111, breadth 25, height 31 mm.

Hab.—Dredged in 20 fathoms, Gulf of St. Vincent, and off Antechamber Bay, Kangaroo Island, January, 1903 (Dr. Verco); taken at low water, Port Noarlunga (Dr. Torr and L. Ashby); and Salt Creek Bay, Yorke Peninsula (E. H. Matthews).

Obs.—This fine species appears to be fairly plentiful and well distributed within our gulf. Dr. Verco has dredged it on various occasions. Though specifically identical, the littoral specimens are nowhere nearly as large as the deep-water forms. The specimens from Antechamber Bay, in particular, deserve mention for their large size and fine colouration.

Ceratosoma adelaidæ, *spec. nov.*

Plate x., fig. 3-4.

Body small, flattened on top, elongate, a little wider at the head than further posteriorly, terminating in a small tail. Mantle sparingly developed. Foot rounded in front, attenuated behind, projecting to no considerable extent beyond the mantle. Colour white underneath, scantily spotted with light lilac along the sides: the dorsal surface, for the most part of a pale buff colour, is bordered on either side by somewhat regularly spaced deep reddish-violet spots (about eight on either side), which are made the more pronounced by being surrounded each by a whitish space, the interspaces between these spots being of a somewhat deeper shade of brown than the rest; the central area is decorated with rows of light bluish spots. Dorsal tentacles club-shaped, obliquely laminated, orange-red in colour. Branchial plumes coherent at their base, apparently six, non-retractile, of the same tint as the rhinophores.

Dim.—Length 8, breadth 3 mm.

Hab.—Taken at low water off Marino Rocks in December, 1901; and also off Edithburg, Yorke Peninsula, in January, 1903.

Obs.—The species appears to live on the under side of rocks covered with seaweed, and partially buried in soft mud.

Doriopsis aurea, Quoy & Gaim.

Plate vii., fig. 4.

Doris aurea, Quoy & Gaim., Voy. de l'Astrolabe, Zool. ii., 1832, p. 265, Pl. xix., figs. 4-7. *Doriopsis aurea,* Bergh, Reisen im Arch. der Phil. ii. (2), 1892, p. 1122.

The type of this species was dredged in deep water in Jervis Bay, New South Wales. Except that the French authors describe their species as over two inches in length (ours is only 15 mm. long and 6 mm. broad), the original account harmonises well with that of South Australian examples. The white dots on the back are more regularly disposed in Quoy & Gaimard's figure, and the foot in South Australian specimens is white; whereas, in the figure quoted, it is red.

Examples from New South Wales are not accessible to us at present, but in view of the close correspondence between our material and Quoy & Gaimard's description we are unwilling to differentiate our form.

Hab.—Dredged in 5½ fathoms, off Orontes Shoal, Yorke Peninsula; also in 9 fathoms on weed, opposite the American River, Kangaroo Island, January, 1903 (Verco).

Doriopsis carneola, Angas.

Plate vi., figs. 1 and 2.

Doris carneola, Angas, Journ. de Conch. xii., 1864, p. 48. Plate iv., fig. 7. *Doriopsis carneola,* Bergh, Reisen im Arch. der Phil. ii. (2), 1892, p. 1122.

A species has been taken by one of us at Marino, South Australia, which, neglecting slight locality variations, must be regarded as Angas's *Doris carneola.* It measures 29 mm. in length, 17½ in breadth, as against Angas's data of 28 and 17 mm. respectively. The colouration of one South Australian example was identical with that of the Port Jackson type, while another individual from Marino had quite a different colour scheme. It was of a dirty greyish-white on the dorsal surface, speckled with silvery-white dots, which were connected by a faint network of white lines, the central space in the region of the liver appearing pinkish or brown; ventral surface white. The under side of the mantle of both individuals is marked with delicate vein-like, multiple branching lines. The mantle is ample, hard, thick, and fortified with numerous calc-spicules. The foot is large, and terminates bluntly. The rhinophores are clavate, with about 10 laminæ; situated rather far anteriorly; colour yellow or white. We do not note the projecting sheaths of these tentacles, that are apparently represented in Angas's sketch. Branchial plumes, four, tripinnate; colour, light orange or white.

Hab.—Marino, taken from under the rocks, at low water, March, 1902 (Basedow).

Nembrotha (?) verconis, *spec. nov.*

Plate ii., figs. 1-3.

Body large, linear, oblong, swollen in centre, and tapering behind. Colour, rich lemon-yellow, with large disconnected blunt tubercles of deep prussian blue arranged very indistinctly parallel to the edge of the foot. The skin is very delicate, and peels off easily on abrasion; it is noticeably wrinkled, the pits of the folds thus produced appearing of a deeper shade than the rest. Cloak almost entirely wanting. Frontal margin (veil) small, of deep prussian blue colour, composed of three semi-circular dilations, the two lateral of which arch laterally around the dorsal tentacles on either side, then gradually fading to *nil* posterior to them. Foot square in front, dilated outwardly at the anterior end, sides slightly frilled, approximately parallel, passing posteriorly to a bluntish point, colour light sea-blue, with a deep blue border; liver visible as a faint brown patch in the centre. Dorsal tentacles sub-clavate, tapering, laminated; about 30 slightly oblique laminæ, non-retractile; colour deep prussian blue, with a yellow stalk. Eyes not visible. Genital aperture prominent, situated one-fourth the whole length from the frontal margin; of a lighter (greenish) blue colour than the tubercles. Branchial plumes five, tripinnate, almost completely surrounding the anus; colour dark yellow at the base, passing into a rich blue along the stems and delicately fringed with small purple tufts.

Radula. Marginal plates four, subquadrate, curved over in front, the most remote very small or wanting; lateral spines one, large, hooked, bifidated: possessing a peculiar spiral twist. Central plate subquadrate-ovate. Colour light straw to amber yellow. About 18 rows. Formula, $4 + 1 \cdot 1 \cdot 1 + 4$.

Dim.—Length 55, breadth 12 mm.

Hab.—Dredged in 20 fathoms, off Newland Head, Backstairs Passage, January, 1903 (Verco).

Obs.—The indications of the existence of a cloak are almost entirely wanting, beyond the slight continuation of the frontal margin past the dorsal tentacles and the somewhat linear arrangement of the tubercles. This species seems clearly separated from co-generic forms by its vivid primrose colour. A large specimen is in the Australian Museum collection; it measures 40 mm. in length, whereas the contracted body of our type barely reaches 30 mm. We have much pleasure in dedicating this beautiful species to Dr. J. C. Verco.

EXPLANATION OF PLATES.

Plate I.

Fig. 1. Ceratosoma brevicaudatum, *Abraham*—Deep-water form. Dorsal view. Slightly enlarged.

Fig. 2. Ceratosoma brevicaudatum, *Abraham*—Deep-water form. Side view. Slightly enlarged.

Fig. 3. Ceratosoma brevicaudatum, *Abraham*—Shallow-water form. Natural size.

Fig. 4. An enlarged branchia of *C. brevicaudatum*, Abraham.

Plate II.

Fig. 1. Nembrotha verconis, *spec. nov.*—Side view. × 2.

Fig. 2. Nembrotha verconis, *spec. nov.*—Ventral view. × 2.

Fig. 3. A single row of teeth from the radula of *N. verconis*, *spec. nov.*

Plate III.

Fig. 1. Halgerda graphica, *spec. nov.*—Dorsal view. × 1⅓.

Fig. 2. Halgerda graphica, *spec. nov.*—Ventral view × 1⅓.

Fig. 3. Teeth from the radula of *H. graphica.*

Fig. 4. Enlarged teeth from the radula of *H. graphica.*

Plate IV.

Fig. 1. Albania verconis, *spec. nov.*—Dorsal view. × 3.

Fig. 2. Albania verconis, *spec. nov.*—Ventral view. × 3.

Fig. 3. Teeth from the radula of *A. verconis.*

Fig. 4. Radula of *A. verconis*, the cross lines representing transverse rows of teeth.

Plate V.

Fig. 1. Archidoris varia, *Abraham*—Dorsal view. × 1⅔.

Fig. 2. Archidoris varia, *Abraham*—Ventral view. × 1⅔.

Fig. 3. Teeth from the radula of *A. varia.*

Fig. 4. An enlarged branchia of *A. varia.*

Fig. 5. Radula of *A. varia.*

Plate VI.

Fig. 1. Doriopsis carneola, *Angas*—Ventral view. × 1⅘.

Fig. 2. Doriopsis carneola, *Angas*—Dorsal view. × 1⅘

Fig. 3. Archidoris staminea, *spec. nov.*—Ventral view. × 2⅓.

Fig. 4. Archidoris staminea, *spec. nov.*—Dorsal view. × 2⅓.

Plate VII.

Fig. 1. Hypselodoris epicuria, *spec. nov.*—Dorsal view. × 3.

Fig. 2. Hypselodoris epicuria, *spec. nov.*—Ventral view. × 3.

Fig. 3. An enlarged branchia of *H. epicuria.*

Fig. 4. Doriopsis aurea, *Quoy & Gaimard*—Dorsal view. × 5 3-5.

Plate VIII.

Fig. 1. Alloiodoris marmorata, *Bergh*—Dorsal view. × 3½.

Fig. 2. Alloiodoris marmorata, *Bergh*—Ventral view. × 3½.

Plate IX

Fig. 1. Scyllæa pelagica, *Linné*—Side view. Lobes contracted. × $3\frac{1}{2}$

Fig. 2. Sycllæa pelagica, *Linné*—Side view. Lobes expanded. × $2\frac{2}{5}$.

Fig. 3. Staurodoris pustulata, *Abraham*—Dorsal view. × $3\frac{3}{4}$.

Plate X.

Fig. 1. Pleurophyllidia cygnea, *Bergh*—Dorsal view. Animal fully extended. Slightly enlarged.

Fig. 2. Pleurophyllidia cygnea, *Bergh*—Ventral view. Animal partially contracted. Slightly enlarged.

Fig. 3. Ceratosoma adelaidæ, *spec. nov.*—Dorsal view. × $10\frac{3}{4}$.

Fig. 4. Ceratosoma adelaidæ, *spec. nov.*—Dorsal view. × $3\frac{1}{2}$.

Plate XI.

Fig. 1. Pleurophyllidia cygnea, *Bergh*—Side view. Animal contracted. Natural size.

Fig. 2. Pleurophyllidia cygnea, *Bergh*—Front view. Animal contracted. Natural size.

Fig. 3. Pleurophyllidia cygnea, *Bergh*—Ventral view Animal contracted. Natural size.

Plate XII.

Fig. 1. Radula of *Pleurophyllidia cygnea*, Bergh, showing arrangement of transverse rows of teeth.

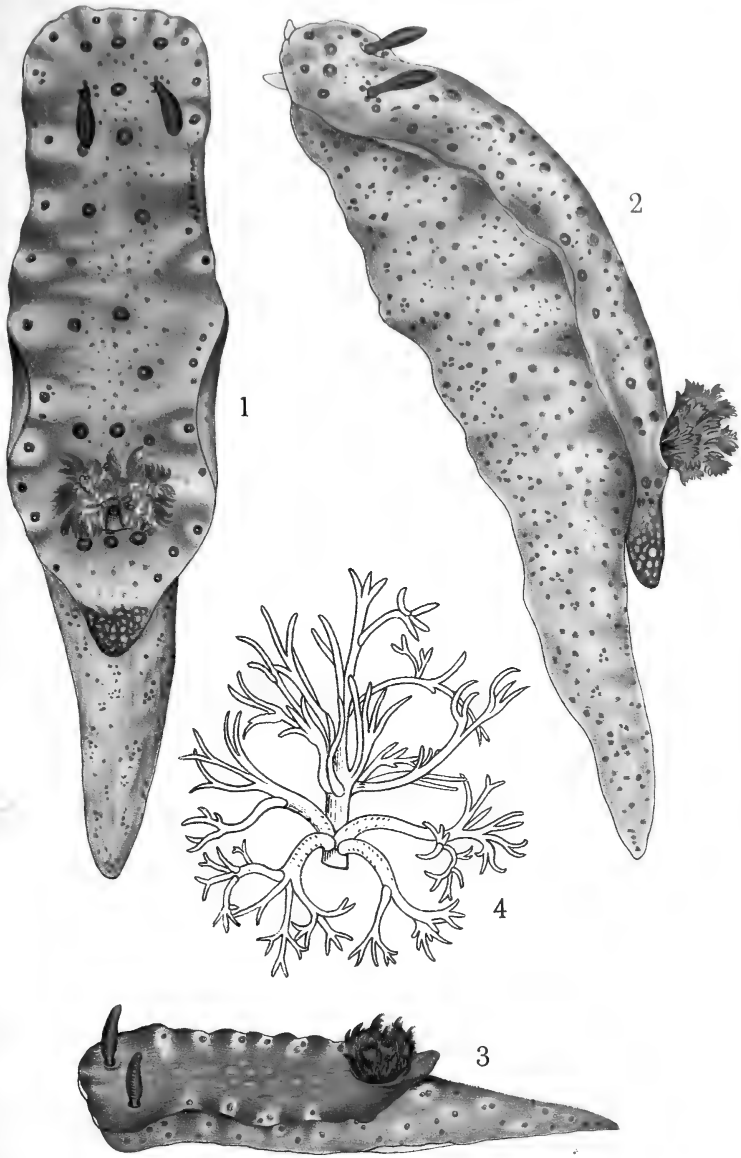
Fig. 2. Rachidian cusp with its denticles, of the radula of *P. cygnea*

Figs. 3 and 3a. Accessory plates connecting the rachidian with the laterals of the radula of *P. cygnea*.

Fig 4. Lingual spines of *P. cygnea*—Exterior aspect.

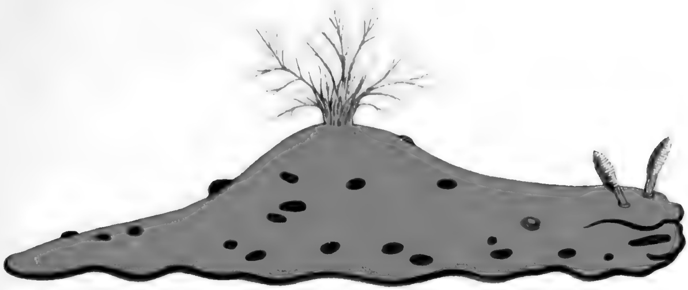
Fig. 5. Lingual spines of *P. cygnea*—Interior aspect.

Fig. 6. Mandible of *P. cygnea*.



H. Basedow del. et pinx. ad nat.

CERATOSOMA BREVICAUDATUM, Abraham.



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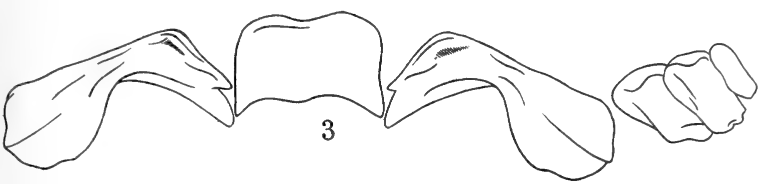

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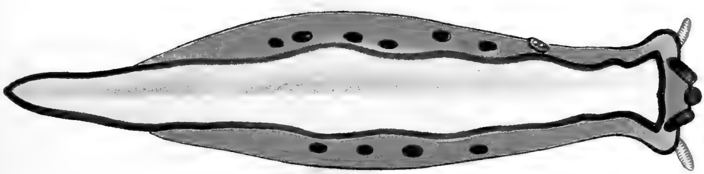

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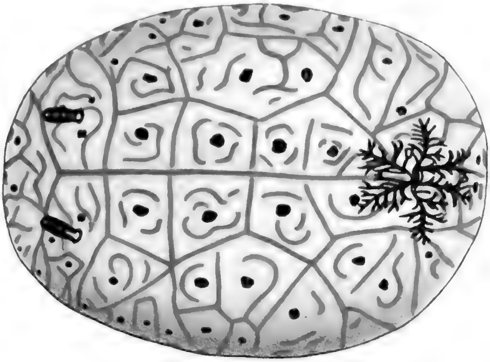
H. Basedow del. et pinx. ad nat.

NEMBROTHA VERCONIS, Basedow & Hedley.



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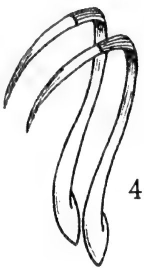

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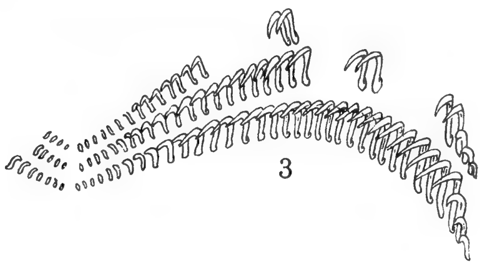

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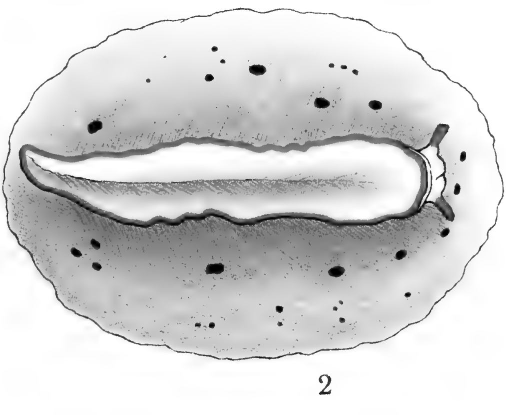

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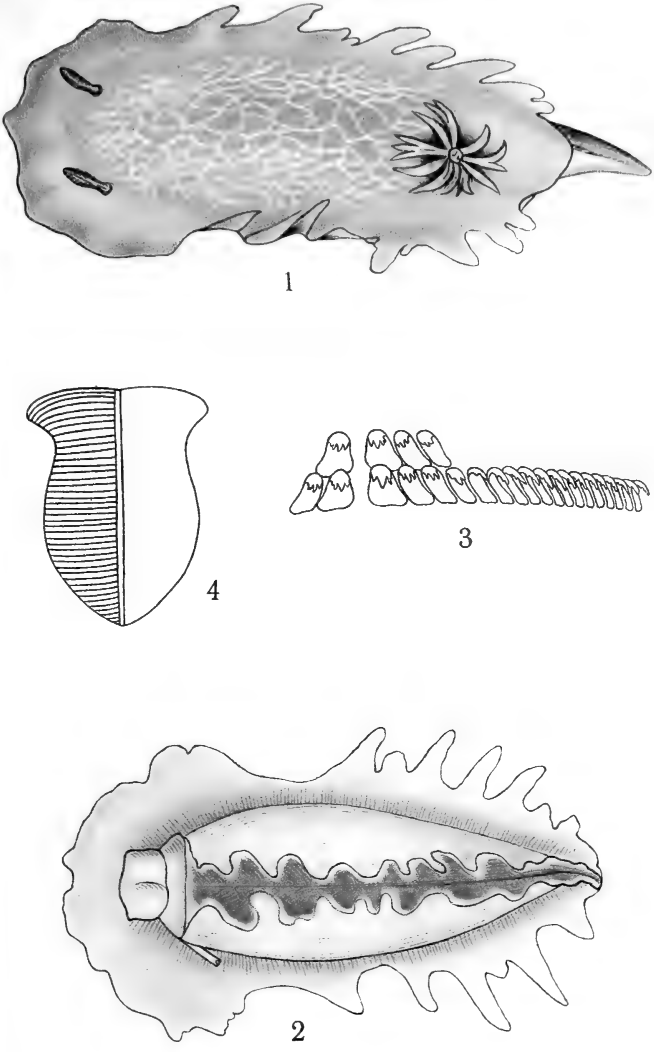
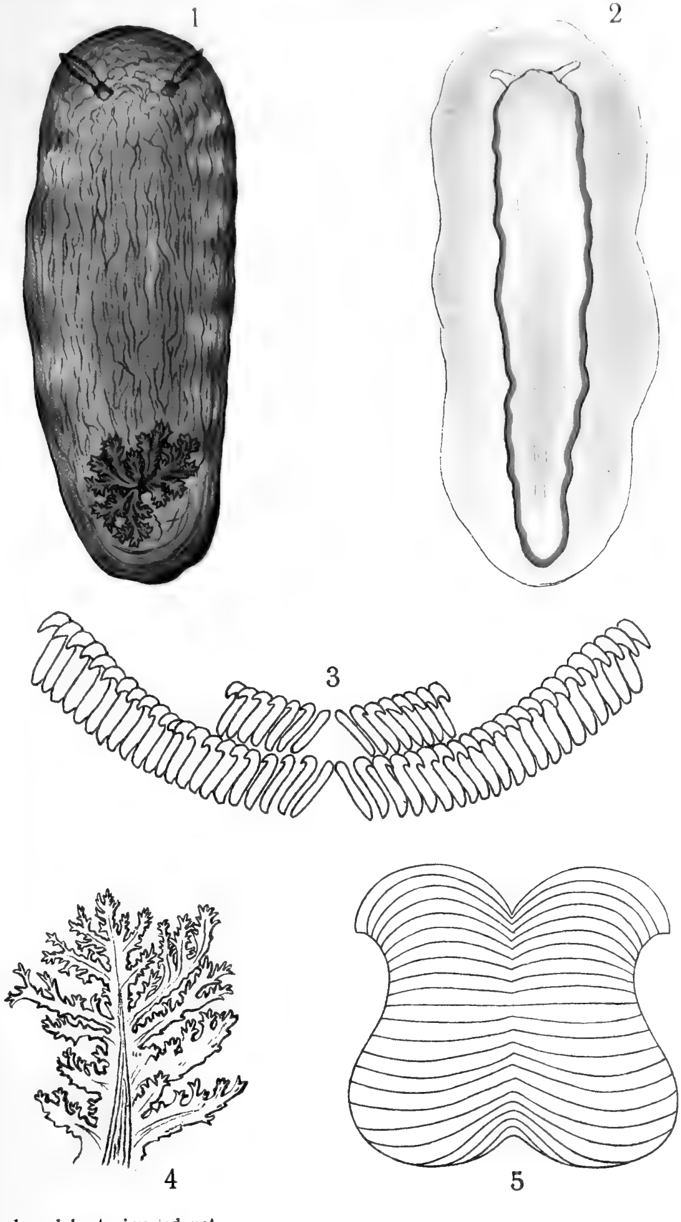
H. Basedow del. et pinx. ad nat.

HALGERDA GRAPHICA, Basedow & Hedley.



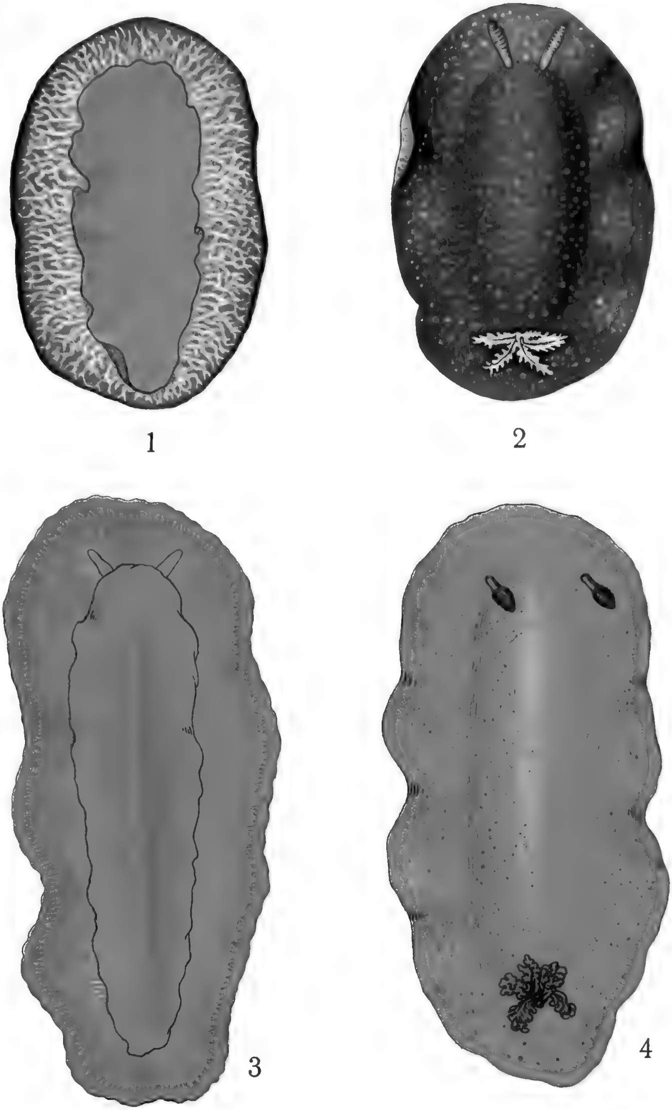
H. Basedow del. et pinx. ad nat.

ALBANIA VERCONIS, Basedow & Hedley.



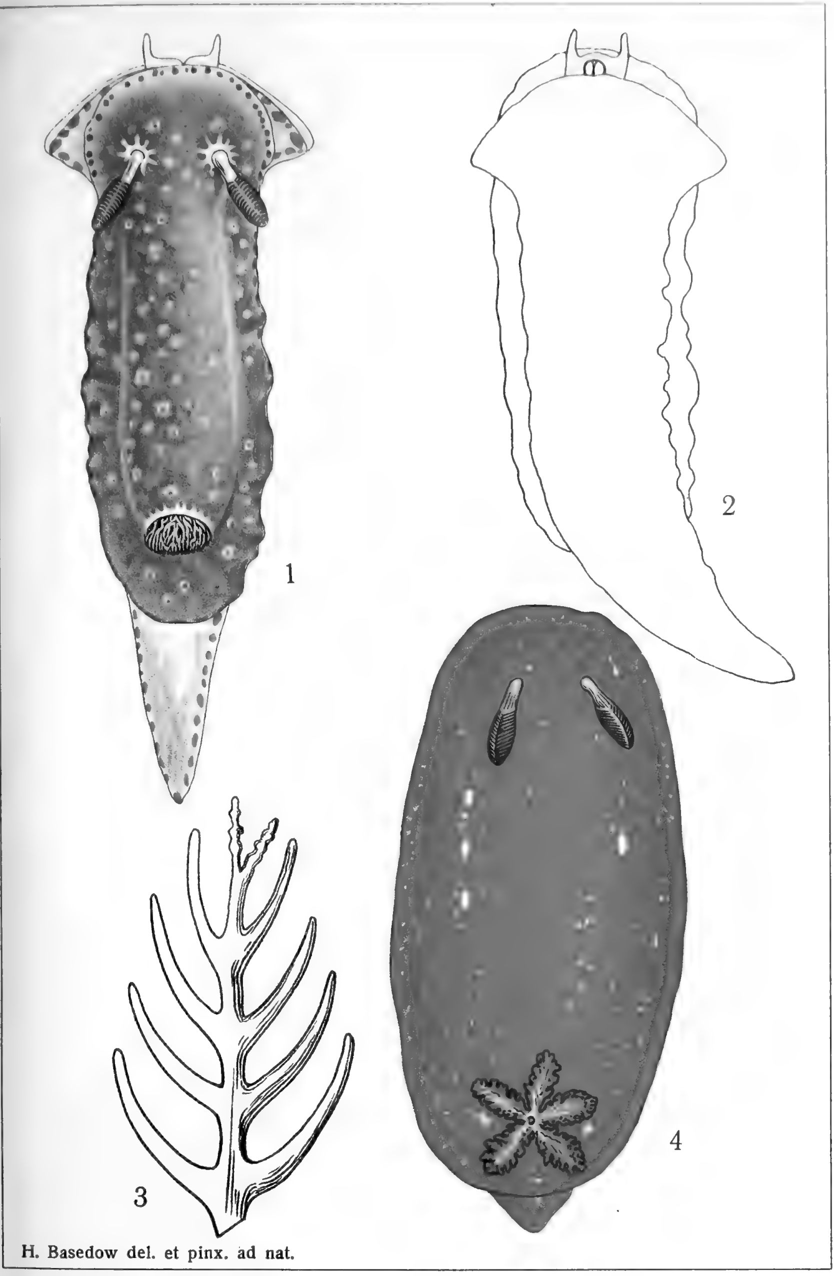
H. Basedow del. et pinx. ad nat.

ARCHIDORIS VARIA, Abraham.

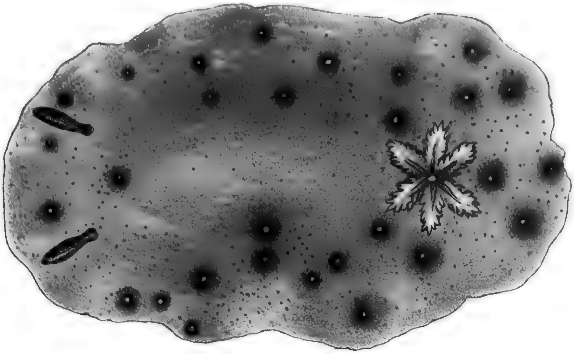


H. Basedow del. et pinx. ad nat.

1 & 2. DORIOPSIS CARNEOLA, Angas.
3 & 4. ARCHIDORIS STAMINEA, Basedow & Hedley.



1, 2 & 3. HYPSELODORIS EPICURIA, Basedow & Hedley.
4. DORIOPSIS AUREA, Quoy & Gaimard.



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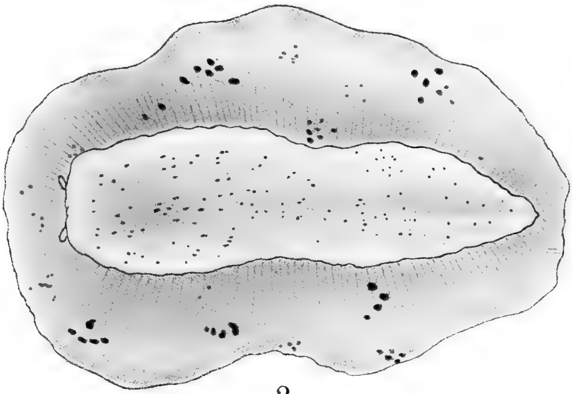

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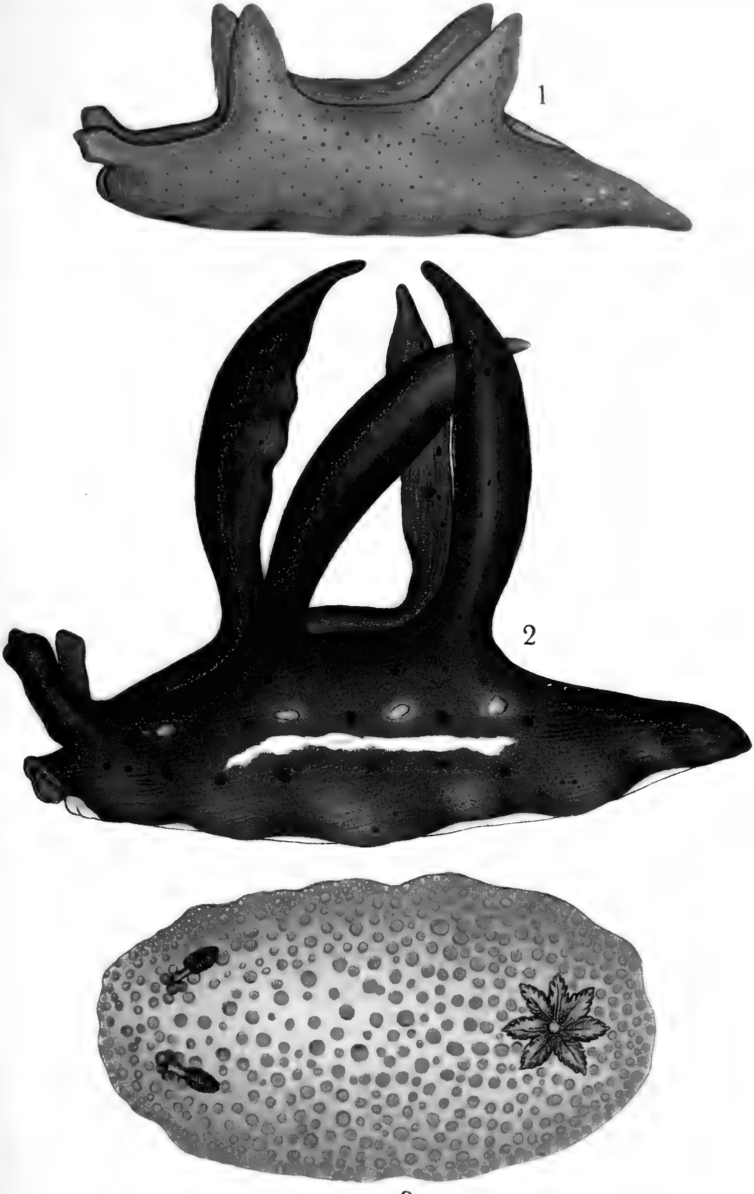
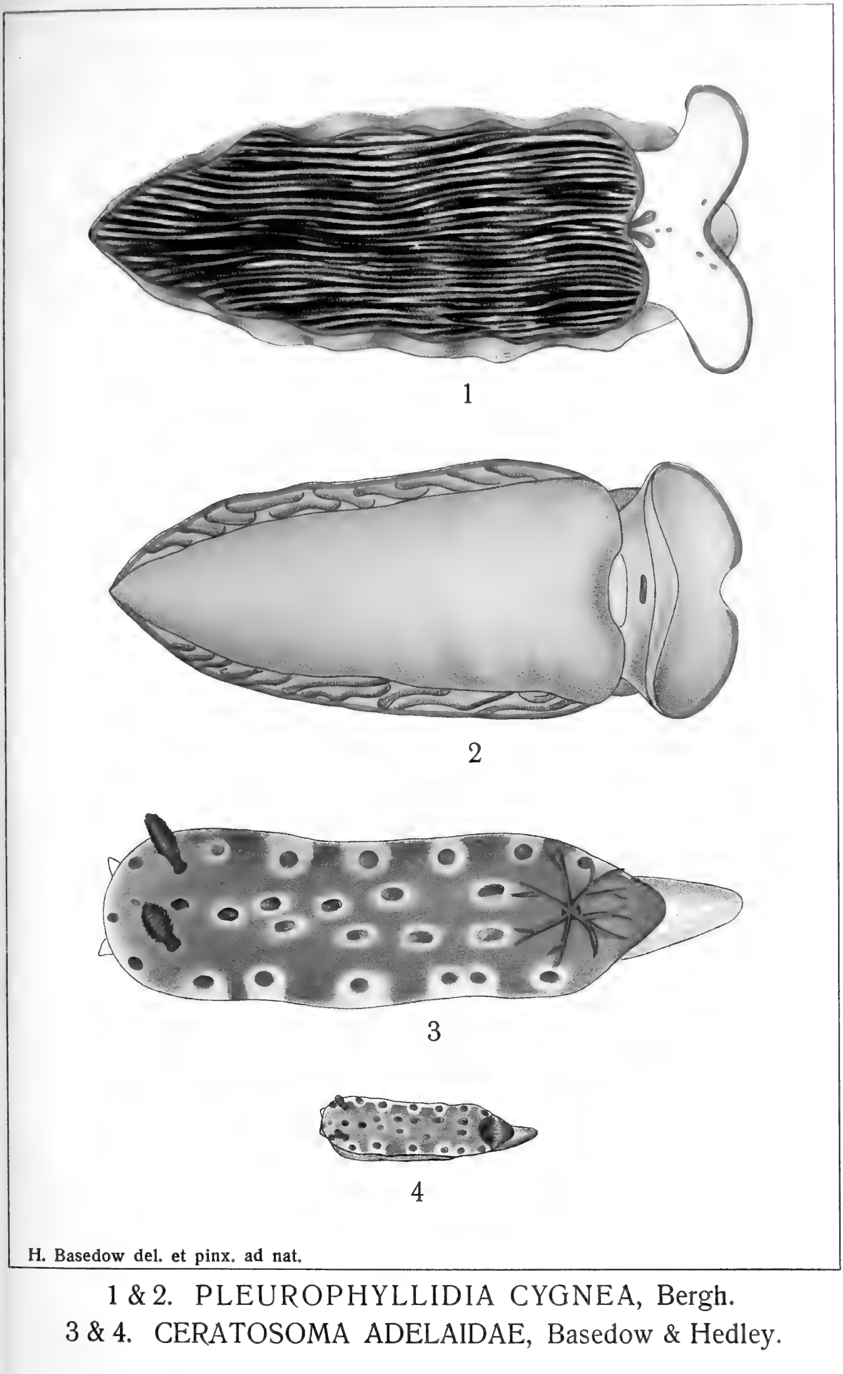
H. Basedow del. et pinx. ad nat.

ALLOIODORIS MARMORATA, Bergh.

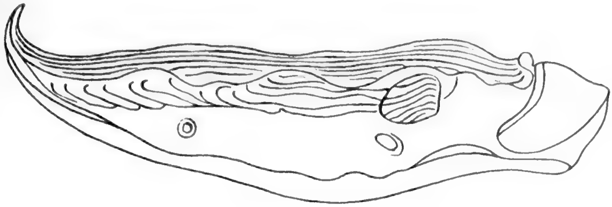


H. Basedow del. et pinx. ad nat.

1 & 2. SCYLLÆA PELAGICA, Linne.
3. STAURODORIS PUSTULATA, Abraham.



1 & 2. PLEUROPHYLLIDIA CYGNEA, Bergh.
3 & 4. CERATOSOMA ADELAIDAE, Basedow & Hedley.



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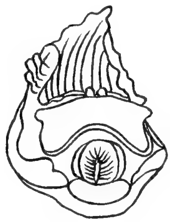

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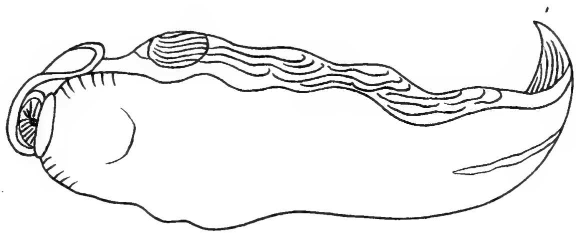
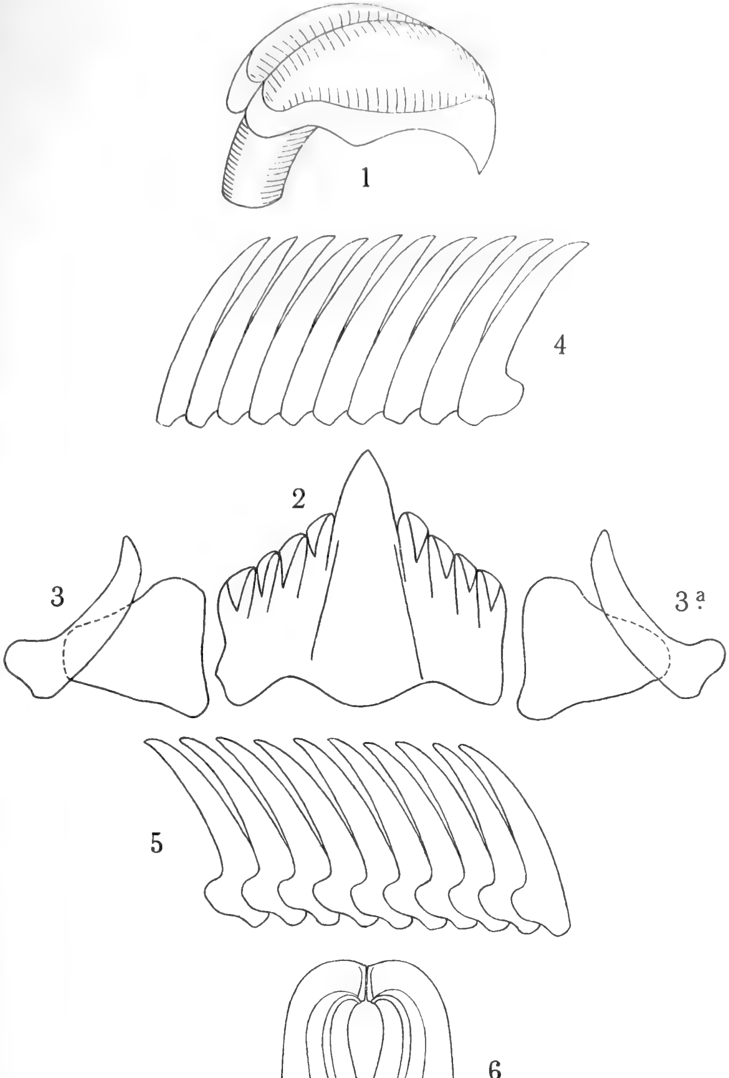


3

H. Basedow del. et pinx. ad nat.

PLEUROPHYLLIDIA CYGNEA, Bergh.



H. Basedow del. et pinx. ad nat.

PLEUROPHYLLIDIA CYGNEA, Bergh.

Report on the Mollusca collected by Mr. Herbert Basedow on the South Australian Government North-West Expedition, 1903.

By Charles Hedley.

[Communicated by Herbert Basedow.]

Plate XXX.

[Read April 4, 1905.]

The Eremian Region has been shown by the investigations of the Horn Expedition to possess a considerable and varied snail population. Desert influence has left its stamp on the larger snail shells. Though quite unrelated to the forms that people the arid regions of Asia, Africa, or America, these Australian shells repeat in their chalky texture and rough sculpture the features of foreign species subjected to similar environment.

The collection which Mr. Basedow kindly invited me to examine has both added to the list of known forms and enlarged the range of those previously described.

I am indebted to Dr. J. C. Verco for an opportunity of examining the types of several species described by the late Professor R. Tate.

Mr. Basedow has generously deposited in the Australian Museum the collection here discussed.

Diplodon wilsonii, Lea.

For bibliography see Simpson, Proc. U.S. Nat. Museum xxii., 1900, p. 893.

Hab.—Algebuckinna Waterhole and Warrungudinna Waterhole, in the bed of the Alberga River.

Isidora newcombi, Adams & Angas.

For a discussion of this Eremian species, see Tate, Rep. Horn. Exped. ii., Zool., 1896, p. 213.

Hab.—Day's Gully and Hector Pass, Mann Ranges: Indulkanna Creek, Warrungudinna Waterhole, on the Alberga.

Thersites basedowi, n. sp.

Plate xxx., figs. 1, 2, 3.

Shell discoidal, of thin and light substance, spire almost flat, umbilicus broad and shallow. Colour buff. Whorls four, parted by sharply impressed sutures. Last whorl acutely keeled at the periphery, rising at the last half-turn above the level of the coil, previous to plunging deeply below it, freed at the aperture from the adjoining whorl. Sculpture: irregular, distant growth lines, and close-set microscopic grains (fig. 2). Aperture very oblique, nearly horizontal; lip entire, a little curled back, broadly expanded. Maj. diam., 19 mm.; min. diam., 15 mm.; height, 6 mm.

A smaller, less sharply keeled specimen from the Mann Range is regarded for the present as a variety.

Compared with its nearest ally, *T. howardi*, Angas, the novelty is smaller, flatter, without colour bands, but with more decided granular sculpture. A specimen which I dissected containing a generative system characteristic of *Thersites*, and comparable to that of *T. setigera*, Tate, Horn Exped., Zool., p. 222, fig. **F**.

Hab.—Musgrave Ranges.

Xanthomelon sublevatum, Tate.

Plate xxx., figs. **7**, 8, **9**.

Thersites sublevata, Tate, Rep. Horn Exped., Zool. ii., 1896, p. 196, Pl. xvii., fig. 5.

A specimen from the Musgrave Ranges extends the known distribution of this species. It was identified by comparison with examples named by its author. As the figure quoted is unsatisfactory, others are now presented.

Xanthomelon perinflatum, Pfeiffer.

Apparently this snail is both most numerous individually and widest spread in this region. Its range is discussed by Professor Tate (*op. cit.*, p. 198).

Hab.—Musgrave Ranges.

Xanthomelon flindersi, Ad. & Angas.

Hab.—Musgrave Ranges.

Xanthomelon angasianum, Pfeiffer.

Hab.—Musgrave Ranges.

Xanthomelon clydonigerum, Tate, var.

Plate xxx., figs. 10, 11, 12.

Thersites (Glyptorhagada) clydonigera, Tate, Rep. Horn Exped., Zool. ii., 1896, p. 195, Pl. xix., fig. 24.

The type of this species, now in the possession of Dr. J. C. Verco, is bleached, and, through a malformation of the later whorls, is subscalar. Compared with Mr. Basedow's examples the unique type is, therefore, more elevated; it is also smaller and rather more coarsely sculptured. As the type is not only in poor condition, but distorted, I have hesitated in regarding the apparent difference as of specific value, and have compromised by offering a description and figures of the shell obtained by Mr. Basedow under this title.

The reproductive system, a partial dissection of which is here shown, demonstrates that the species is included in *Xanthomelon*, as opposed to *Thersites*.

Shell depressedly globose, narrowly perforate, substance rather light and thin. Colour cinnamon-brown, paler on the base. Whorls five, parted by sharply impressed sutures. Periphery rounded, but the flattening of the whorl above suggests an incipient keel. The last whorl descends at the aperture deeply and abruptly with a wavering suture. Sculpture: the first two whorls are smooth to the eye, but under the lens fine vermiculate etchings appear. The adult sculpture commences suddenly, and consists of close, fine, irregular, backwardly curved riblets, which grow lamellate near the aperture. During their traverse of the whorls the riblets sometimes unite, divide or end untimely, while fresh threads may be intercalated. At the periphery the riblets are especially prone to anastomose, on crossing the base they become finer and more regular. Umbilicus very narrow, deep, with a furrow entering spirally from under the columellar expansion. Aperture oblique ovate, outer lip broadly expanded, margins united by a callous ridge, columella partly arching over the umbilicus.

Maj. diam., 22 mm.; minor diam., 18 mm.; height, 15 mm.

Hab.—Musgrave Ranges.

Xanthomelon wilpenense, Tate.

Hadra wilpenensis, Tate, Trans. Roy. Soc., S.A., 1894, p. 193.

Hab.—Musgrave Ranges.

Xanthomelon radiatum, n. sp.

Plate xxx., figs. 4, 5, 6.

Shell lenticular, solid, narrowly perforate, spire slightly elevated. Last whorl bluntly angled at the periphery, rather swollen, and then much contracted behind the aperture. Colour uniform isabelline. Whorls four, parted by an impressed suture. Sculpture: First two whorls microscopically granose-vermiculate, remainder radiately ribbed. Ribs regular, prominent, increasing in strength with the growth of the shell, interstices deeply gouged, in breadth equalling the ribs, on the last whorl numbering about 45. Umbilicus oblong, narrow, and deep. Aperture oblique, lunate-ovate, lip expanded and reflected, margins united by a notched, callous film.

Maj. diam., 12 mm.; min. diam., 10 mm.; height, 6 mm.

The nearest relation to this seems to be *Angasella papillosa*, Tate, which is larger, with fainter radial sculpture.

Hab.—Mount Davies, Tomkinson Ranges, and Musgrave Ranges.

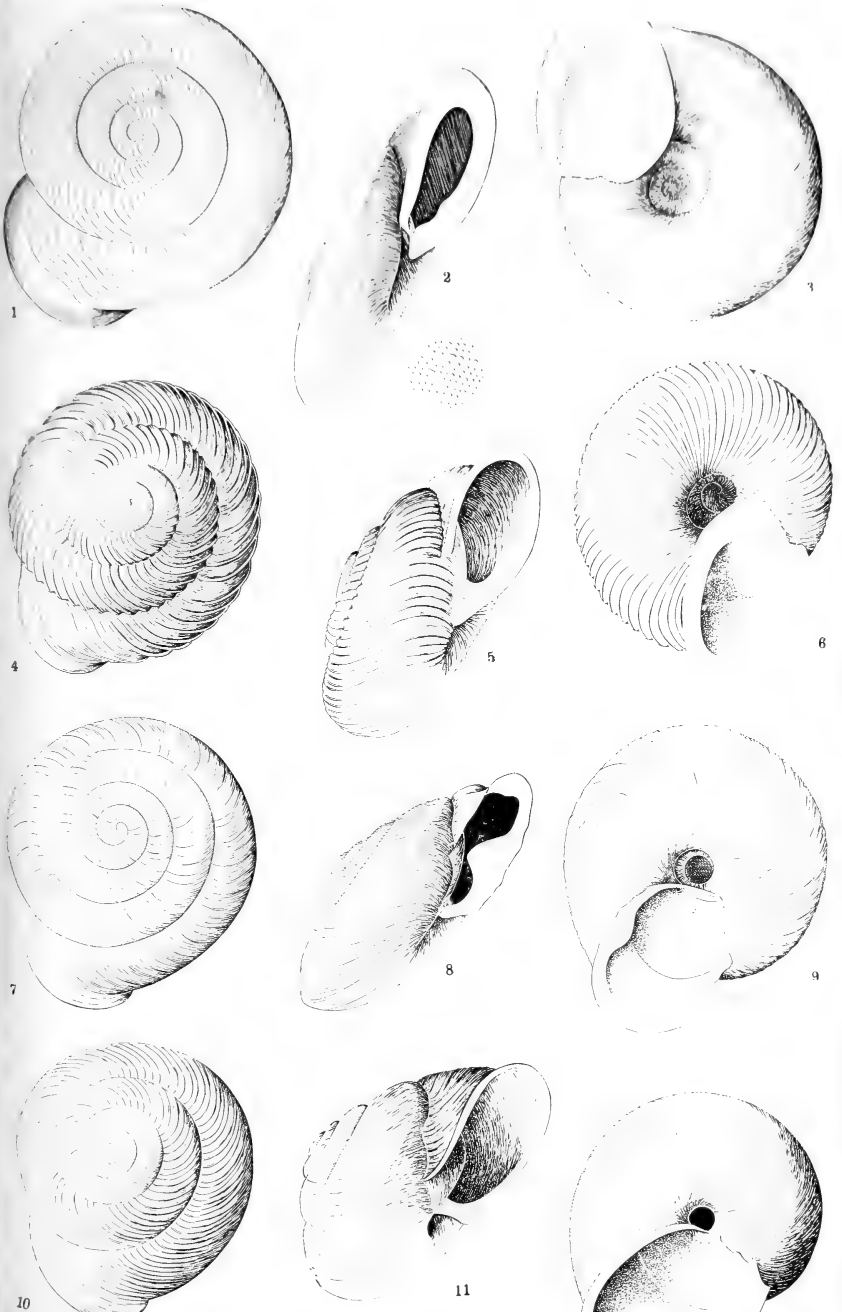
Xanthomelon asperrimum, n. sp.

Shell depressed, acutely carinated, narrowly perforated, thin, dull. Colour, uniform chalk white. Whorls four, flattened above, spire plane or elevated. Suture wound under the peripheral shelf of earlier whorls. Last whorl descending in front. Sculpture: The first whorl and a half finely shagreened, on the rest of the shell large and prominent grains are thickly set in anterior and posterior curves, which intersect each other at right angles. At the periphery the shell is pinched into a broad projecting keel. Base inflated. Umbilicus deep and narrow. Aperture oblique, lip sharp and thin, a little expanded, columella arching over part of the umbilicus. Margins united by a callus band.

Maj. diam., 20 mm.: min. diam., 16 mm; height, 9 mm.

The peculiar form of this species amply distinguishes it from its congeners. The influence of desert conditions on the sculpture of the shell, such as are shown by this species, has been lucidly discussed by Dr. Dall (Proc. Acad. Philad., 1896, p. 411).

Hab.—Mann Ranges.



C. Hedley del.

Hussey & Gillingham, Printers, Adelaide.

EXPLANATION OF PLATE.

Figs. 1, 2, 3. Various aspects and magnified sculpture of *Thersites basedowi*, Hedley.

Figs. 4, 5, 6. Various aspects of *Xanthomelon radiatum*, Hedley.

Figs. 7, 8, 9. Various aspects of *Xanthomelon sublevatum*, Tate.

Figs. 10, 11, 12. Various aspects of *Xanthomelon clydonigerum*, Tate var.

Notes on South Australian Marine Mollusca, with Descriptions of New Species.—Part II.

By Jos. C. Verco, M.D. (Lond.), F.R.C.S. (Eng.), etc.

[Read April 4, 1905.]

Plate XXXI.

Calliostoma zietzi, *spec. nov.* Pl. xxxi., figs. 1, 2, 3.

Shell small, conic, imperforate, moderately solid. Whorls 8, including protoconch of one smooth turn. First two spire whorls rounded and slightly mammillate, next three straight-sloping, last two rather convex. Suture moderately deep, slightly overhung by peripheral lira. Penultimate whorl with 6 spiral cinguli and 2 inter-liral threadlets. Body whorl with 6 cinguli, rather narrower than the interspaces, and 5 threadlets; barely angulated below its centre by a somewhat stouter cord; base rounded, with 8 concentric liræ, flat, and much wider than the interspaces. Spire and base finely obliquely incised with growth lines, which cut the liræ less than the interspaces. Aperture roundly quadrate. Columella nearly straight, slightly oblique and excavated, subtruncate below; outer lip simple crenulated by cinguli. Height, 8 mm.; diameter of base, 5; aperture, 2·5.

Ornament.—Horn-coloured, peripheral band white. Main cinguli on the spire and those on the base obscurely dotted with light chestnut; peripheral band with larger and plainer spots.

Hab.—Backstairs Passage, St. Vincent Gulf, at 12, 17, and 20 fathoms; 9 dead.

It is named after Mr. A. Zietz, F.L.S., of the Adelaide Museum.

Gena terminalis, *spec. nov.* Pl. xxxi., figs. 4, 5.

Shell minute thin oblong-oval, sides parallel. Whorls 4, spire terminal inconspicuous. Surface smooth and polished but for miscroscopic accremental lines; no spiral striæ or incisions, except microscopic, on the base of the body-whorl. Colour white, with crowded spiral bands of crescentic white and dark and reddish-brown spots and blotches. Length, 5·75 mm.; width, 3 mm. Radula, ∞.1.(5.1.5.).1.∞., 36 rows.

Hab.—Dredged alive, Wallaroo Bay, Spencer Gulf 15 fathoms; also alive and dead in deep water, St. Vincent Gulf.

Obs.—The ornament varies greatly. The shell may be blotched pink and white, and there may be numerous fine spiral, hair-like, dark lines.

Diagnosis.—From *G strigosa*, A. Adams. It is smaller, comparatively narrower, the spire is terminal, the aperture is more oblong, the columella is straighter, the outer lip joins the columella almost at a right angle. A juvenile *G. strigosa*, equal in size to an adult *G. terminalis*, has been drawn in Plate xxxi., fig. 6, for comparison.

It very closely resembles *Gena nigra*, Quoy & Gaimard, Voy. de l'Astrolabe, Zool., Vol. iii., p. 307, Plate lxvi. (bis), figs. 10, 11, 12: but their species, as figured, has its spire less terminal, and rests more upon its two ends, and, according to the dimensions given, is three times as large.

Astele calliston, *spec. nov.* Pl. xxxi., figs. 7, 8.

Shell conical, thin. Spire of nine whorls, including two smooth apical turns: gradated. Whorls straight-sloping, with crowded spiral liræ, about 24 on the penultimate; crossed by oblique crowded accremental striæ, producing sub-lenticular pitting. Suture linear, immediately beneath the prominent peripheral cord which gradates the spire. Body whorl with suture slightly descending at the aperture; spiral threadlets about 24; crowded fine sinuous oblique accremental striæ: periphery acutely angular, with a projecting rounded carina, spirally closely engraved on its upper surface, axially crossed by rounded striæ, much more distant than the accremental striæ, provided at somewhat irregular intervals with 16 rounded invalid tubercles. Base very flatly rounded with 7 concentric narrow liræ, the inner 4 closer than the rest, which are separated by 4 to 6 inter-lirate striæ. Umbilicus narrow, minutely axially incised. Aperture oblique, roundly quadrate: outer lip slightly convex, thin, smooth within, margin sinuously convex below the suture, concave towards the periphery; basal lip convex, slightly effuse, smooth within. Columella, upper third concave, the rest straight, obliquely truncate below; callus at the base partly bordering the umbilicus and attached to the columella along a vertical groove.

Ornament.—Shell purple-brown, with somewhat oblique, axial, creamy, rhomboidal flames, extending from suture to suture, and nearly equalling the foundation colour in area. On the peripheral carina, and hence above the sutures, they are replaced by two or three creamy spots, while two or three less marked white spots occupy the intervals, and thus pick out the tubercles of the carina. Every whorl is encircled by four articulated colour bands, which in the white areas are of a more opaque white than the rest of these areas, and extend slightly beyond them, and are crossed by narrow vertical or oblique red lines, while in the purple areas they are of a deeper purple tint, and are crossed by narrow axial white lines. The base is of a lighter tint, the outer 6 cinguli of a rose pink, minutely dotted with creamy white. The columella and umbilicus are white, bordered outside with green, which tints the inner two basal cinguli, and curls around the columella into the throat. The inner edge of the outer lip is golden-brown and white, interior shining and nacreous. Operculum horny multispiral, nucleus central, a radial cellular fringe-like film over the inner three-fourths of each spiral. Height, 11·75 mm.; diameter, 9·75; aperture, 4.

Radula, ∞.1.5.1.5.1.∞. Central rachidian heart-shaped, narrow free end surmounted by small, slightly serrated denticle; the other rachidians with trilobed cusps, which gradually enlarge outwards; a single lateral with one cusp trilobed at its base: marginals many unicuspidate, not serrated.

Hab.—Spencer Gulf, 20 fathoms; 32 alive and dead.

Variations.—Some individuals are uniformly pinkish-brown, with white peripheral tubercles, and four pink cinguli on each whorl articulated with white, the larger white spots lying vertically between the supra-sutural tubercles, while narrower, oblique white spots alternate in groups with them.

Clanculus leucomphalus, *spec. nov.* Pl. xxxi, figs. 9, 10, 11.

Shell depressed conic, rather thin. Protoconch one turn and a half smooth. Whorls 6, rapidly increasing, sloping convex. Penultimate with 8 close-set spiral rows of smooth ovate granules. Body-whorls with ten spiral rows of granules above the acutely angled periphery, the granules of the infra-sutural row are much larger and placed axially, the rest spirally ovate; and ten rows on the base of flatter, more quadrate, and more close-set granules. Oblique axial striæ crowd between the granules on the spire, but are obsolete on the base.

Aperture quadrate oblique: outer lip crenulate, toothed just within the margin opposite each spiral lira, within this thickened and wrinkled, and in the throat lirate and nacreous; basal lip crenulate, thickened within with 5 teeth gradually enlarging towards the columella; columella oblique, nearly straight, ending below in a prominent, obliquely furrowed but not bifid tooth, with a large tubercle at the junction of its upper and middle third, and with a flange throughout its whole length bent towards the umbilicus. The umbilicus is wide and deep, with a funicle winding up its outer side to the tubercle on the columella. The umbilical border overhangs, and has 6 medium-sized tubercles, and is margined by a flat, axially incised, spiral lira, with a threadlet on either side.

Colour light ashen-grey, with obscure flames of deeper grey or buff, and with numerous small pink dots on the second and third whorls. The umbilicus and its margin are pure white, the throat nacreous green.

Height, 8 mm.; diameter of base, 9·75 mm.

Hab.—Backstairs Passage, St. Vincent Gulf; dredged alive in 20, 22, 23 fathoms, dead in 6 to 23 fathoms.

Diagnosis.—The type from Gray's collection of *Trochus clangulus*, Wood, in the Natural History Museum, London, differs from our species in having a more sinuous columella, due to a large tubercle at each end, and a median bulge, only 6 liræ on the penultimate whorl, stouter and fewer liræ in the throat, a less rounded periphery, its colour light pink, with pink spots on the base, and articulated deep pink just above and below the suture, and green and red tints instead of light ashen-grey with darker buff flammules.

Crassatellites ponderosus, Gmelin.

This is the name suggested by Mr. Hedley, in P.R.S. of N.S.W., 1904, Part 1, page 198, for *C. castanea*, Reeve, as also for *C. kingicola*, Lamk.; *C. donacina*, Lamk.; *C decipiens*, Reeve; *C. errones*, Reeve; *C. pulchra*, Reeve; and *C. cumingi*, A. Adams, which E. A. Smith and Brazier had previously united under the name of *C. kingicola*, Lamk. Gmelin's shell, which was first defined in pre-Linnean times by Chemnitz, is cited by von Martens in Malak. Blat. xix., 1872, page 30, as from New Guinea. In Syst. Naturæ, C. Linné, vi. Vermes, page 3280, it is given as *Venus ponderosa*, No. 54, as inhabiting the Southern Ocean.

Some 40 specimens have been dredged by me in South Australian waters, of which 26 are single values. Living individuals were found at 20 fathoms, off Normanville, at 19 fathoms off Eastern Cove, Kangaroo Island, and at 15 fathoms off Wallaroo. These form the material on which the following observations were based.

All the species above-named, except *C. castanea*, are validly corrugated by sub-distant concentric ribs. Not one of my forty examples is so corrugated. It is, therefore, least like *C. kingicola*, Lamk. But I only possess one cabinet specimen of each of them. Perhaps a large series would show examples with smooth surfaces near the umbos.

Size.—The largest measures 115 mm. antero-posteriorly, 90 mm. umbo-ventrally, and 49 mm. in section, and weighs ten ounces.

Shape.—This varies a good deal, as is noted in Conch. Cab., Band x., Abtheil i., page 2; Taf. i., fig. 1; Taf. vi., fig. 1, 1886, where two figures are given, one of a shell 88 mm. by 75 by 42, and another much produced posteriorly, 98 by 73 by 50. One from Port Lincoln, a rounded form, is 112 mm. by 93, while another very produced behind is 115 mm. by 90. This is not merely a senile tendency, for the difference in contour is found in young shells, and also in those of equal size and apparently of similar age. In the produced individuals the ventral outline, instead of being uniformly convex as far as the postero-inferior angle, may be somewhat concave in front of this.

Thickness.- It is very solid; the heaviest shell we have on our coast; it may weigh 10·75 ounces. Often growth in superficial area ceases after a time, and then the thickness greatly increases. Thus a shell only 3·7 inches long and 3·1 deep is 2·05 in section, and weighs 10·75 ounces, whereas another 4·25 inches long and 3·5 deep is only 1·9 inches in section, and weighs but 8 ounces. The volume of the contained mollusc actually diminishes, the thickening taking place at its expense. The muscular impressions appear deeply excavated then, owing to the heaping up of shelly material around the adductor muscles beneath the mantle. The ventral margin, instead of being sharp, is flattened for as much as an inch, nearly at right angles to the external surface, and is in some cases even incurved.

Periostracum.—This is very durable, and even in dead and decaying valves is frequently present, and allows very fair cabinet specimens to be prepared from very unpromising material by a little careful scraping. It disappears sometimes first at the umbos and the subjacent surface, then erodes deeply. My largest individual, taken alive, has only a little of its epidermis remaining along the ventral and posterior borders, and its face value has been thus greatly depreciated.

Interior.—This is smooth down to the pallial line, which is slightly crinkled, and thence on there are radial striæ which fade out towards the ventral margin. The older the shell the deeper is the pallial line, and wider posteriorly, and more markedly crinkled, and the more rugose become the radial striæ beyond.

Colour.—The interior is white, with a beautiful glistening chestnut or burnt-umber colouring of certain parts. The frequency and depth of tinting of these parts is in the following order: —The posterior adductor scar, the posterior part of the pallial line, the anterior portion of the anterior adductor scar, the posterior margin, the ventral margin, and the posterior part of the cartilage pit and hinge plate. Sometimes the colour is a very deep, almost blackish-brown, with a delicate flesh tint, and one is tinted a pretty purplish-pink.

Carinaria australis, Quoy & Gaimard.

Quoy & Gaimard, Voy. de l'Astrolabe, Zool., vol. ii., page 394, Pl. xxix., figs. 9, 13, 1833. The type specimen was dredged between New Holland and New Zealand in January, 1827. Mr. Hedley supplied me with the following quotation from Voy. de l'Astrolabe, Histoire du Voyage ii., 1830, page 27:—"January 2, 1827, the zoologists collected some living carinarias, the shells of which attained a length of eight to ten lines." The next day the vessel was 130 leagues from Port Jackson, on the way to Cook's Straits, New Zealand. Allowing about a hundred to a hundred and fifty miles for the day's run, we can fix the locality of the haul of *Carinarias* at about 158° E. longitude and 40° S. latitude. My single specimen was taken in January, 1905, in 104 fathoms, in sandy ooze, 35 miles south-west of the Neptune Islands, below the entrance to Spencer Gulf, in E. longitude 135·40°, and S. latitude 35·25°. So its *habitat* is extended some 22 or 23 degrees to the west. It measures 10 mm. in length and 3·75 in width. Several characters can be added to those given by the authors. The transverse ridges spreading fan-like from the posterior part to the carina increase in number by intercalation of secondary and tertiary ridges. The carina is undulated in its proximal part, where it springs from the shell, but its distal edge is straight, not corrugated, and only at the back part, where the distal border has been worn or broken away, is it actually undulated at the margin. The aperture is oval, and is about twice as wide towards the posterior part as at the anterior. From within a portion of the protoconch can be seen projecting through the posterior wall of the shell somewhat obliquely and slightly to the right of the middle line. The record of this shell adds not only a new species and a new genus to the South Australian list of marine molluscs, but a new order of Gasteropods; the Nucleobranchiata. Atlanta, another genus of this order, is also represented by an undetermined species taken in the same haul.

Gibbula lehmanni, Menke.

Turbo lehmanni, Menke, Moll. Nov. Holl., page 18; *Trochus lehmanni*, Philippi, Conchyl. Cab. Band ii., Abth. iii., page 185, t. 28, fig. 15; Fischer, Coq. Viv., page 362, t. iii., fig. 3; *Gibbula pulchra*, A. Ads. P.Z.S., 1851, page 187; *Gibbula lehmanni*, Menke, Tryon, Man. of Conch. xi., page 233, Plate xl., figs. 12, 13.

This is a fairly common species. It has been dredged alive at 14 and 25 fathoms in Spencer Gulf, and dead at 15 fathoms in Wallaroo Bay. It has hitherto been confused in South Australia with *G. Coxi*, Angas, so I give the following diagnostic characters:—*G. Coxi* is more solid, slightly less depressed, rather more concave between the carinæ, with sharper spiral liræ, and a much smaller umbilicus. This last character is the easiest diagnostic. The radial flames are much fewer, the colour elsewhere is irregularly stippled instead of spirally articulated, and there are fewer colours in the same shell. Mr. J. H. Gatliff has sent me this shell as *G. sulcosa*, A. Adams, P.Z.S., 1851, page 186, recorded in his Catalogue of the Marine Shells of Victoria, P.R. Soc. of Vict. xiv. (N.S.), Part ii., 1902, page 132. Adams's name is given in Tryon's Man. of Conch. xi., page 243, "unfigured and undetermined species," with the *habitat*, Sir C. Hardy's Island, North Australia.

Astele subcarinatum, Swainson.

Astele subcarinatum, Swns., 1854, P.R.S., Van Diemen's Land, vol. iii., page 36, Plate vi., figs. 1, 2; *Eutrochus perspectivus*, A. Adams, P.Z.S., Lond., 1863, page 506; *Calliostoma (Eutrochus) Adamsi*, Pilsbry., Man. Conch. xi., page 402.

It has been dredged alive at 16, 19, 20, 22, 23 fathoms, in Backstairs Passage, and off Newland Head.

Zizyphinus subgranularis, Dunker, Malak. Blätt, 1871, page 170, No. 56, unfigured, from Bass Straits; *C. subgranulatum*, Dunker, Man. Conch. xi., page 403, is a half-grown individual of the same species. This identification was referred to Mr. Hedley, who says he had arrived at the same conclusion.

EXPLANATION OF PLATE.

Plate XXXI.

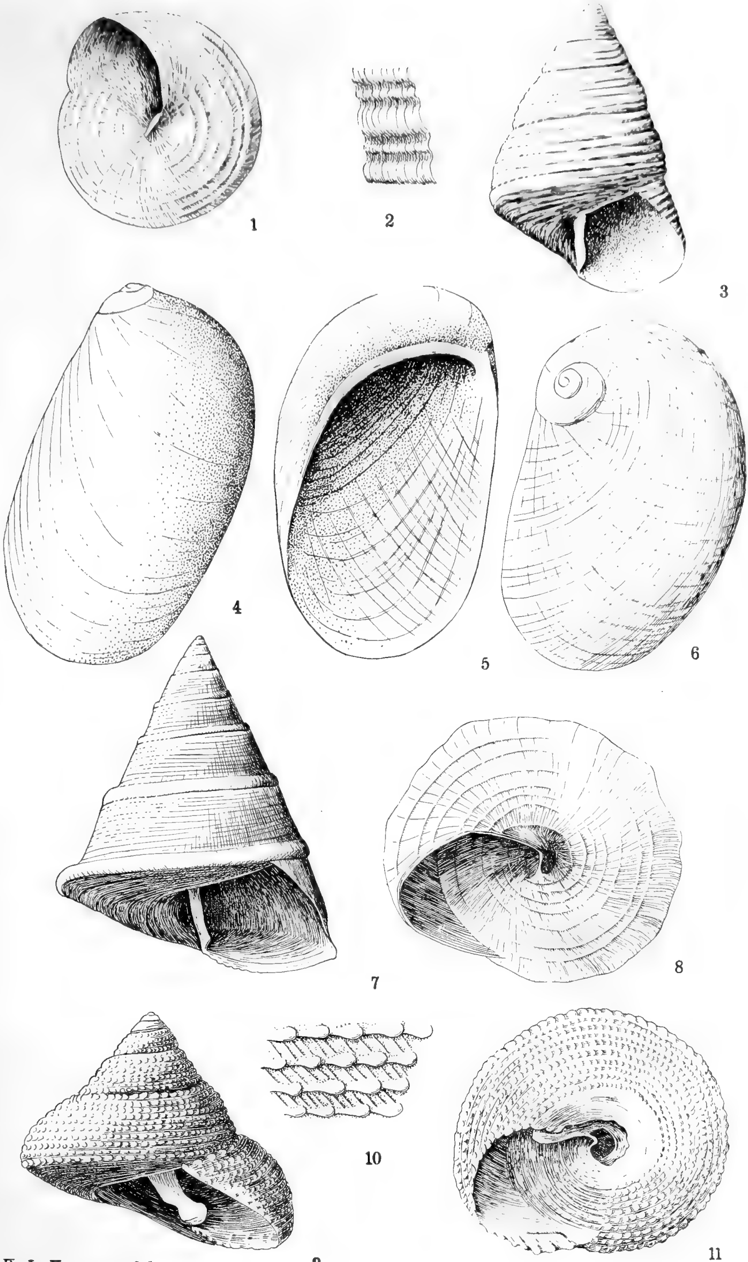
Figs. 1, 2, and 3. *Calliostoma zietzi*, Verco—Basal and profile views, and magnified sculpture.

Figs 4 and 5. *Gena terminalis*, Verco.

Fig. 6. *Gena nigra*, Quoy & Gaimard.

Figs. 7 and 8. *Astele calliston*, Verco.

Figs. 9, 10, and 11. *Clanculus leucomphalus*, Verco.



H. L. Kesteven, del

Hussey & Gillingham, Printers, Adelaide.

Descriptions of New Australian Lepidoptera with Synonymic Notes.—No. XXIII.

By Oswald B. Lower, F.E.S. (Lond.), etc.

[Read August 1, 1905.]

SYNEMONIDÆ.

Synemon monodesma, n. sp.

Male, 38 mm. Head, antennæ, and legs dark fuscous; face and palpi white. Thorax and abdomen whitish beneath. Legs white, mixed with fuscous. Forewings elongate - triangular, costa gently arched, termen obliquely rounded; deep fuscous - ochreous, faintly iridescent; a moderate, very oblique white fascia from below costa in middle, extending towards anal angle, but only reaching two-thirds across wing, almost separated by ground colour in middle; a suffused, whitish, short, oblique fascia below costa at about four-fifths, about half the length of previous fascia; some whitish scales on upper half of termen; cilia fuscous-whitish. Hindwings with termen rounded; blackish-fuscous, with bright orange markings; a broad crescentic fascia at end of cell; a similar fascia, from below costa at three-fourths, running towards anal angle, but not reaching it, deeply excised on upper edge above middle; an irregular row of more or less obscure orange spots along termen; cilia whitish.

Differs from the other described species by the single fascia of forewings.

Mount Darling Range, Western Australia. In November; two specimens.

CARADRININA.

CARADRINIDÆ.

Ectopatria virginea, n. sp.

Male, 36 mm. Head, palpi, thorax, and abdomen snow-white, legs snow-white. Antennæ ochreous. Forewings elongate, moderate, costa nearly straight, termen oblique, hardly rounded; snow-white, without markings; cilia snow-white. Hindwings snow-white, slightly iridescent; cilia snow-white. A distinct species, well characterised by the wholly white colour; at first sight it is not unlike *Caradrina gypsina*, Low., but is without markings of any kind.

Adelaide, South Australia. One specimen; in October.

Euplexia signata, n. sp.

Male, 48 mm. Head, thorax, and abdomen fuscous, thorax with ochreous fuscous posterior crest, palpi ochreous.

Antennæ and legs fuscous. Forewings elongate-triangular, costa hardly arched, termen waved, oblique; light fuscous, markings dark fuscous; posterior two-thirds of cell filled in with dark fuscous; a moderately large sub-triangular blotch below posterior edge, extending beyond end of cell, only separated from cell by intersecting vein; an elongate patch above dorsum, from base to just beyond one-third; a somewhat quadrate spot beyond posterior extremity of cell, indented on posterior edge; an irregular, triangular blotch on costa at five-sixths; orbicular indistinct; reniform in middle of dark fuscous patch in cell, light fuscous, well defined; a row of small lunate marks along termen, hairs of dorsum reddish-fuscous throughout; cilia fuscous, with an ochreous line at base. Hindwings with the termen waved; dark fuscous; cilia as in forewings.

Hobart, Tasmania. One specimen; in October.

CATOCALINÆ.

Niguza anisogramma, n. sp.

Male, 30 mm. Head, palpi, and antennæ ochreous. Thorax fuscous. Legs ochreous. Abdomen greyish, segmental margins ochreous. Forewings elongate; triangular, costa faintly sinuate, termen rather strongly and obliquely rounded; fuscous; a broad, nearly straight, white fascia from one-fourth costa to one-fourth dorsum; a similar fascia, gently curved inwards, from costa at four-fifths to dorsum at three-fourths, edged posteriorly by a line of darker ground colour; a large black ring at two-thirds of wing, edged externally by a line of yellow, and containing two blue metallic spots, one above the other, and externally by an incomplete ring of white; a somewhat elongate oviform ring, below and considerably before the ring, filled in with yellow, and edged above with yellow; a transverse row of somewhat triangular yellow spots, parallel to limiting line of second white fascia, and again followed by a small and more indistinct parallel row of similar spots; a dentate black line along termen, anteriorly edged by a whitish line of similar shape; cilia fuscous, imperfect. Hindwings with termen slightly waved; whitish; a suffused fuscous ante-median band, containing a darker fuscous whitish centred ring below costa; a moderately broad fuscous band along termen, containing the yellow spots, etc., as in forewings; (cilia imperfect).

A pretty insect, not like any other Australian species known to me.

Alice Springs, South (Central) Australia. One specimen, received from **Mr. S. Angel.**

ACRONYCTINÆ.

Sesamia albicostata, n. sp.

Male, 28 mm. Head, palpi, thorax, and legs light ochreous-grey, antennæ whitish, pectinations ochreous. Abdomen shining grey Forewings elongate, moderate, costa slightly arched towards base, apex somewhat rounded, termen obliquely rounded; pale ochreous; veins somewhat outlined with white; a rather suffused broad white costal streak throughout, edged below by darker ground colour; cilia greyish-ochreous. Hindwings and cilia white.

Ocean Grange, near Sale, Victoria. One specimen, taken in January.

LYMANTRIADÆ.

Anthela niphomacula, n. sp.

Male, 46 mm. Head, palpi, thorax, abdomen, and legs dull reddish-carmine. Antennæ carmine-whitish, pectinations 10, dark fuscous. Forewings elongate-triangular, termen nearly straight; dull carmine-pink; a moderate white spot in cell at one-third from base of wing; a similar spot at end of cell, both faintly edged with fuscous; cilia reddish-ochreous. Hindwings with colour as in forewings, basal two-thirds lighter and somewhat ochreous-tinged; cilia as in forewings. Underside of hindwings with a single white fuscous-edged spot at end of cell.

Allied to *Rubescens*, Walk., but distinguished at once by the white spots.

Duaringa, Queensland. One specimen; in November.

Anthela callispila, n. sp.

Male, 46 mm. Head and thorax ochreous-fuscous, face ochreous, palpi ochreous beneath, fuscous above. Antennæ whitish, pectinations 10, dark fuscous. Abdomen ochreous-fuscous, anal tuft ochreous. Legs ochreous-fuscous. Forewings elongate-triangular, termen rounded; dark ochreous-fuscous, irrorated with fine ochreous hair scales along costa; markings snow-white, very distinct; a moderately large elliptic spot at anterior end of cell; a large one, rounded, at posterior end of cell; cilia ochreous-yellow. Hindwings with termen moderately straight; colour as in forewings; a moderately defined whitish spot at posterior end of cell; cilia as in forewings. Forewings beneath more ochreous, especially in cell; spots as above reproduced. Hindwings similar in colour, but an additional round white spot in cell at one-sixth from base.

A very distinct species, easily recognised by the white spots on the ochreous ground colour.

Broken Hill, New South Wales. One specimen; in April.

Anthela pyromacula, n. sp.

Male, 48 mm. Head, thorax, abdomen, and antennæ dark fuscous, antennal pectinations, 10; dark fuscous. Forewings shaped as in *Callispila;* dark fuscous, very minutely irrorated with obscure whitish scales, and more or less appearing to be streaked with dark fuscous along veins towards termen; a moderate black line along vein 2; a somewhat cuneiform orange-red, black-edged spot at anterior end of cell; a rather large, round, similar coloured spot in cell, at posterior extremity; cilia dark fuscous, faintly barred with darker. Hindwings with termen moderately straight; colour and cilia as in forewings: basal half of wing clothed with long fuscous hairs. Forewings beneath with spot at posterior end of cell reproduced in dull white. Hindwings with a dull whitish spot at posterior end of cell.

Not very near any other, probably allied to *Clementi,* Swin., but widely distinct.

Broken Hill, New South Wales. One specimen; in September.

Orgyia hemicalla, n. sp.

Male, 20 mm. Head, thorax, and antennæ blackish, antennal pectinations, 8. Face, palpi, and legs orange. Abdomen blackish, anal tuft orange. Forewings elongate-moderate, costa nearly straight, termen strongly rounded, oblique; dark fuscous; costal edge from two-thirds to apex narrowly orange; cilia orange. Hindwings bright orange; basal half dark fuscous, suffused and irregular; cilia orange.

Melbourne, Victoria. One specimen; in November.

Orgyia retinopepla, n. sp.

Male, 24 mm. Head, antennæ, and legs dull white, face and legs mixed with ochreous-fuscous; antennal pectinations, fuscous, 8. Thorax and abdomen ochreous-fuscous, beneath grey-whitish. Forewings elongate-triangular, costa slightly arched, termen gently rounded; light ochreous-fuscous; markings somewhat darker fuscous; two suffused fascia; first from one-third costa to one-third dorsum, curved outwards, anterior edge moderately defined; second from costa at three-fourths to dorsum at three-fourths, becoming triangular on costa, curved inwards below middle, and edged throughout by a narrow dull whitish line; a moderate discal spot above middle, midway between the two fascia; cilia light ochreous-fuscous, with a darker basal line. Hindwings light ochreous-fuscous, paler towards base, dorsal hairs whitish-ochreous; cilia as in forewings.

Broken Hill, New South Wales. One specimen: in October.

SPHINGIDÆ.

Hopliocnena brachycera, Low.

Coemotriche brachycera, Low., T.R.S.S.A., page 50, 1897.
Hopliocnena melanoleuca, Roths. (1902).

I have taken this species at Broken Hill, New South Wales, and have seen specimens from Roeburne, Western Australia, and Alice Springs, (Central) South Australia.

NOTODONTIDÆ.

Cerura (?) melanoglypta, n. sp.

Female, 40 mm. Head, palpi, and thorax cinerous-grey. Antennæ fuscous. Abdomen silver-grey-whitish. Forewings elongate, moderate, termen slightly waved, rounded, oblique; cinerous-grey, minutely irrorated with black scales; a well-marked, narrow, waved, black line starting on costa at one-sixth, thence becoming sub-costal for a short distance, thence curved and becoming thrice sinuate, and terminating on dorsum at about one-third; a second, nearly straight waved black line from costa at three-fourths to dorsum about anal angle, gently curved inwards below, and with a short outward angulation immediately above dorsum; a moderate, well-defined, somewhat reniform discal spot above middle; midway between the two lines; cilia cinerous-grey, faintly barred with fuscous at extremities of veins. Hindwings with termen gently waved; white; a broad black band along termen, mixed with obscure whitish spots along edge of termen, better defined beneath; cilia whitish.

Mount Pleasant, South Australia. One specimen; in October.

GEOMETRIDÆ.

BOARMIANÆ.

Amelora anthracica, n. sp.

Male, 30 mm. Head, palpi, and thorax black, face rounded, prominent. Antennæ ochreous, pectinations 5. Abdomen grey-whitish. Legs grey-whitish, anterior and middle tarsi infuscated. Forewings elongate-triangular, costa nearly straight, termen gently bowed, oblique; black, with blacker markings; markings thick, well defined; a basal fascia; a dentate fascia from one-fourth costa to one-fourth dorsum; a more strongly dentate fascia from costa at five-sixths to dorsum at five-sixths, more pronounced and somewhat angulated in middle; a large linear discal spot; cilia black. Hindwings with termen gently waved, rounded; whitish, becoming fuscous on posterior two-thirds; discal dot and second line as in forewings, fuscous; cilia dark fuscous.

Probably nearest *Milvaria*, Gin., but abundantly distinct from any other described species.

Mount Darling, Western Australia. One specimen; in November.

Orsonoba (?) euryscopa, n. sp.

Male, 44 mm. Head, thorax, palpi, and abdomen yellow, abdomen speckled with fine fuscous scales. Antennæ fuscous, bipectinated, pectinations 2. Legs ochreous-yellowish, posterior pair spotted with fuscous. Forewings elongate-triangular, costa gently arched, apex acute, termen faintly waved, strongly bowed in middle; sinuate beneath apex; yellow-ochreous, becoming broadly paler along costa, from one-third to apex; a narrow blackish waved line from costa before one-third to just above dorsum at two-fifths; a well-defined, oblique, fuscous line, edged posteriorly by its own width of white, which colour is again edged suffusedly by a similar width of dull purple, from apex to dorsum in middle; a round pale whitish-yellow spot lying on upper edge of fuscous line, just below middle; cilia ochreous. Hindwings faintly waved, more or less strongly near angle; colour and cilia as in forewings; a moderate waved fuscous streak, from one-fifth costa to one-fifth dorsum; a similar parallel streak before middle of costa to before middle of dorsum; a fine waved fuscous line from costa at three-fourths to dorsum before anal angle, obscure on lower half. Wings beneath pale yellowish, finely irrorated with fuscous, all markings, except streak of forewings from apex, obscurely reproduced.

Mackay, Queensland. One specimen; in November.

MONOCTENIANÆ.

Homospora rhodoscopa, Low.

Onychodes (?) rhodoscopa, Low., Tr. Roy. Soc., page 228, 1902.

Homospora procrita, Turn., *l.c.*, page 229, 1904.

I am sorry that Dr. Turner has re-named this species, as I pointed out to him when in Brisbane that I had already given it a MS.S. name. However, the discovery of the male has made it necessary to erect a new genus to receive it, and has borne out my conclusions that it is allied to *Onychodes*, Gin., the female of both genera having the antennæ very shortly pectinated; it differs, however, from that genus, as Dr. Turner points out, by the frontal projection of head and different neuration.

Systatica xanthastis, Low.

Dr. Turner has formed this new genus (Tr. Roy. Soc., S.A., page 231, 1904), to receive this species; but I am strongly of opinion that my type is a female; the antennæ are unipectinated, the pectinations being 1. Should my surmise prove correct, the character of the new genus will require to be altered in accordance with the above character.

DREPANIDÆ.

Oreta hypocalla, n. sp.

Male, 32 mm. Head, face, and palpi scarlet. Thorax and abdomen fleshy-ochreous, paler anteriorly. Antennæ and abdomen dull ochreous, fillet reddish. Abdomen beneath scarlet. Legs scarlet, anterior coxæ more brilliant. Forewings elongate-triangular, costa slightly sinuate, arched on posterior third; termen nearly straight, slightly sinuate beneath apex; dull ochreous-fuscous, finely and obscurely strigulated with darker, especially on median third, where it forms a broad, transverse fascia, anterior edge curved inwards from middle of costa to one-fifth dorsum; posterior edge oblique, from just before apex to two-thirds dorsum; faintly edged with whitish on upper third; cilia chestnut. Hindwings with termen gently rounded; colour and cilia as in forewings, the central fascia faintly indicated. Forewings beneath reddish-orange, suffused with fuscous; posterior edge of fascia reproduced in blackish. Hindwings beneath brilliant scarlet. Allied to *Miltodes*, Low, but differs in shape of forewings and other details.

Mackay, Queensland. One specimen; in November.

ADDENDA.

Deilephila euphorbiæ, Linn.

I recently received a living specimen of this beautiful Sphinx from Mr. J. Fairhead, who caught the insect in the sorting room of the post-office at Broken Hill in April. I feel pretty confident that up to the present it has not been recorded from Australia, and I am very pleased to be able to add it to our fauna. I have also taken in Broken Hill the following *Sphingidæ*:—

Hemaris hylas, Linn.
Hemaris kingii, Macl.
Chærocampa scrofa, Bdv.
Chærocampa celerio, Linn.
*** *Chærocampa erotus*, Cr.**

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* A single poor specimen.

Protoparce { *abadonna*, Fab.
distincta, Lucas.

Protoparce *convolvuli*, Linn.

Deilephila { *lineata*, Fab.
livornica, Esp.
livornicoides, Lucas.

CARADRINIDÆ.

Amaloptila ptilomela, Low.

Metaptila (?) ptilomela, Low, T.R.S.S.A., page 31, 1900; *Amaloptila triorbis*, Turn., T.R.S.S.A., page 6, 1903.

ERASTRIANÆ.

Homodes erizesta, Turn.

(P.L.S.N.S.W., page 110, 1902.)

I have seen this species standing in some collections as *Homodes gemmifera*, Moore, but can find no reference to this in Coates & Swinhoe's Catalogue of the Indian Moths, 1889.

PYRALIDINA.

ENDOTRICHINA.

Endotricha baryptera, n. sp.

Male, 16 mm. Head, thorax, palpi, antennæ, legs, and abdomen dark fuscous; thorax ochreous-whitish in middle; legs more or less banded and ringed with whitish. Forewings elongate, moderately dilated posteriorly, costa nearly straight, termen oblique, slightly bowed; dark fuscous-chocolate; a broad transverse whitish fascia, anterior edge sharply defined, from just before middle of costa to middle of dorsum, with a sharp curve inwards on lower one-third, posterior edge moderately straight, suffused into ground colour; a fine undulating, whitish, sub-terminal line, with a projection outwards, just beneath costa; a few small white spots on costa between fascia and line; a dark fuscous discal spot at end of cell; a few obscure black dots along termen; cilia dark fuscous. Hindwings with colour as in forewings; a fine, well-defined, dentate whitish line from one-third costa to one-third dorsum; a similar line from costa, just beyond middle, to dorsum near anal angle, with a sharp projection outwards in middle; ground colour between the two lines much lighter; cilia as in forewings.

Mackay and Brisbane, Queensland. Two specimens; in January.

On Naticoid Genera Lamellaria and Caledoniella from South Australia.

By Herbert Basedow.

[Read April 4, 1905.]

Plates XXVI. to XXIX.

The Naticidæ include a sub-family known as the *Lamellariinæ*, the members of which are characterised by possessing a thick dorsal shield (reminding of the mantle of the *Doridæ*), partly or wholly enclosing a fragile shell. Five genera have now been established, and of these two have their shell completely enveloped by the animal. They are *Lamellaria* and *Caledoniella*.

The genus *Caledoniella* was founded in 1869 by Souverbie on the shell of an unknown animal It was consequently very doubtfully placed among the *Naticidæ*, and has maintained its uncertain position ever since.

Among other genera that came under my notice on Dr. J. C. Verco's marine dredging excursion were included a number of molluscs with internal shells, and of these I have separated several forms which I unhesitatingly refer to this little-known genus.

After an examination of the dentition and general structure of the animal I am fully convinced that *Caledoniella* is correctly included under the *Naticidæ*, in the sub-family *Lamellariinæ*.

An unfigured species of *Lamellaria*, the internal shell of which was originally described in 1849 from New Zealand, by Gray,* has been reported to occur in South Australia. It goes by the name of *L. ophione*. Dr. Verco has dredged a shell, measuring 8 mm., in Backstairs Passage, in 22 fathoms, which, as near as determination will permit, is *L. ophione*. An additional new species is described in this paper.

Genus Lamellaria, Montagu, 1815.

Lamellaria australis, *spec. nov*

Animal.—Dorsal shield elliptic, with a waved outline and notched in front; soft, smooth, or minutely granular; appreciably broader than the foot, over the sides of which it folds very loosely and imperfectly (differing in this respect considerably from *Caledoniella)*; under side obliquely striated (muscle fibres), around the foot. Body depressed, more con-

* Proc. Zool. Soc., Lond., 849. p. 169.

vex over the shell. Foot flat, straight and dilated in front, sides approximately parallel, terminating in a blunt point, the free tail nearly one-half the whole length; projects beyond the mantle border anteriorly when in motion; it is horizontally slit in front. Eyes, distinctly discernible as little black beads on the outer bases of tentacles, which are not retractile. Genitalia, situated far anteriorly on the right, immediately adjacent to the trunk of the head. Colour: The dorsal shield of the unique specimen is of a uniform, dull, brick-red or vermilion colour, with an imperfectly stellate, four-lobed, opaque white crown in its centre, and three additional white blotches on the right side, all of the white markings being easily removed by abrasion; its under surface is yellow at the border, grading to vermilion, thence to an impure white in the region adjoining the foot. Head and foot shaded brownish yellow. Dentition: Formula |:|:|: central plate sub-trigonal; laterals large, their spines overlapping in the central line. Dimensions: Length, 33; breadth, 25; height, 12 mm.

Shell.— Auriform, moderately convex, about three and a half whorls: margin of lip with a shallow concavity anteriorly: ornamented with distinct incremental striae and very faint spiral incisions, the latter hardly recognisable with the unaided eye: open underneath, exposing the whorls; invested with a thin, transparent yellowish epidermis. Colour shining white, spire and inside nacreous. Dimensions: Major axis, 21½; minor axis, 16½; height, 9 mm.

Hab.—Backstairs Passage, St. Vincent Gulf. Dredged in 25 fathoms.

Obs.—The shell of *L. ophione*, Gray, is much like that of *L. australis*, though smaller, with its body whorl more convex, spire smaller and apex less central: no authentic description or figure of the animal has, however, come to hand. Professor F. W. Hutton has taken a mollusc in New Zealand which he considers in all probability to be *L. ophione*, of Gray.* It clearly differs in one respect from my species. Whereas the dorsal shield of *L. australis* is smooth or minutely granulated, that of the specimen taken by Profesor Hutton is smooth, but much wrinkled, resembling convolutions of the brain.

Genus Caledoniella, Souverbie, 1869.

Animal.—Body ovoid. Dorsal shield thick, ample, verrucose, with its edges tucked in along the sides, and, in a contracted state, completely enclosing the foot: notched anteriorly and produced to an imperfectly closing siphon, re-

* Manual New Zealand Mollusca, p. 59.

ceiving the inhalent current. Head differentiated; eyes distinct, on outer bases of tentacles, which are flattish cylindrical. Foot truncated, horizontally slit, and dilated laterally in front; bluntly pointed behind; tail free. Renal aperture on the right, the mantle-border slightly grooved outward from this spot. Dentition, 2·1·1·1·2. Mandibles corneous, strong.

Shell.—Internal, "heliciform, imperforate oval, orbicular, thin, invested by a thin epidermis, which extends beyond the lip;* spire much depressed, sub-lateral: whorls few, rapidly increasing; aperture oblique, rather large, the extremities of the simple lip united by a callus extending widely upon the whorl."

Hab.—New Caledonia and South Australia.

Caledoniella contusiformis, *spec. nov.*

Plate xxviii., fig. 1, and Plate xxix., figs. 1 to 8.

Animal.—Body ovoid, large. Dorsal shield soft, verrucose, and wrinkled; drawn in along the sides, the head and foot being unprotected when in motion, but capable of being retracted under the shield, which closes over them securely. Foot flat; extended laterally, and slit horizontally in front; the tail and head being free to move, and connected to the main body by a comparatively narrow trunk. Mouth large, from underneath the strong muscular rim of which the serrated edges of the jaws are visible. Dentition, formula 2·1·1·1·2.; central tooth sub-quadrangular, minutely and multicuspidated, laterals at least bicuspid, marginals noticeably narrower than the laterals, strongly hamate. Mandibles strong, elongate, wing-shaped, horny; obliquely striate; outer edge sharply serrate; a prominent ridge marking off the serration, beneath which a narrow band of setæ. Colour: The wrinkled dorsal shield is of an impure white to light brown ground-colour, which in the valleys of the wrinkles appears of a deeper hue. Large black, easily detachable blotches cover the surface, without system in their arrangement; they are each surrounded by a rim of deeper brown, and, at some distance from their edge, by a ring of similar colour: the underside of the shield is light flesh-red. Foot and head brownish-red, the edge of the dilated front of the former, and the tips of the tentacles of the latter, black. Dimensions: Length, 40; breadth, 30; height, 25 mm.; length of foot, 25 mm.

Shell.—Very thin, globose, ellipsoid, heliciform; about three whorls, rapidly increasing in size; spire small, depressed;

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* As a generic character I do not attach much importance to this feature.

covered by a colourless epidermis, which projects beyond the shell-lip; suture channelled; aperture oblique, border with a wide, shallow depression in the anterior; widely open so as to display the winding columella up to the apex. Ornamented by faint accremental striæ; the epidermis has raised, branching lines, radiating from the apex. Colour white, semi-translucent. Dimensions: Major diameter, 28; minor diameter, 17 mm.

Hab.—Backstairs Passage, St. Vincent Gulf; in 25 fathoms.

Obs.—I have not been able to trace the existence of a callus over the body whorl of the shell, between the inner and outer lip, although such was described of the only species hitherto known, viz., *C. montrouzieri*, Souverb. The remaining features of that shell correspond so closely with those of my type that a new genus can hardly be proposed, especially as the animal has not been previously seen; but the differences are considered sufficient to warrant the creation of a new species.

The calcareous matter does not completely infiltrate the shell, which in parts is only membranous (see var. *labyrinthina*, below), especially in the earlier and posterior portion of the last whorl. I will, however, point out that, prior to my examination of the shells, the molluscs had been kept in a weak solution of formalin, and it is just possible that this chemical may have had some deteriorating influence on their delicate tests.

Mr. E. A. Smith has described* a mollusc from Port Phillip Bay, closely allied to my new species. No figure of the living animal is given, and it is not a fair criterion to make a comparison from the description of a contracted spirit specimen with the living animals. Mr. Smith's figure of the internal shell is more elongate-bulimoid, and the spire more elevated, than is the case in my specimens.

Varieties of **Caledoniella contusiformis**, *spec. nov.*

I have before me a number of smaller specimens of *Caledoniella*, which in the outer colouration and design of the dorsal shield differ markedly from one another and the type. The head and foot are coloured the same in each case, and the measurements about one-half that of the form described above. The similarity in shape of the internal shells and other features is so close that I feel indisposed for the present to separate them specifically from *C. contusiformis*, for it is a matter of opinion whether, in this strange genus, specific dis-

* Ann. and Mag. Nat. Hist., V. Series, 1886, Vol. xviii., p. 270.

tinction can with justice be made on colour variation alone. For the time being I enumerate them as varieties.

Var. **testudinis.**

Plate xxviii., fig. 2.

This comes nearest to the described type. The dorsal shield is more closely wrinkled, of an earthy-brown colour, with more numerous black blotches, in the centre of the crests produced by the wrinkles; each crest does not necessarily carry a blotch.

Shell calcareous, as described in type above.

Hab.—St. Vincent Gulf; in 25 fathoms.

Var. **pulchra.**

Plate xxviii.; fig. 3.

Dorsal shield comparatively smooth; of a rich yellow ground-colour, with large, circular, or oval lighter blotches surrounded by wreaths of black.

Shell calcareous, as described in type above.

Hab.—St. Vincent Gulf; in 25 fathoms.

Var. **labyrinthina.**

Plate xxviii.; fig. 4.

Dorsal shield wrinkled; of a faint yellowish ground-colour, of which very little remains visible on account of a labyrinthine structure, produced by closely set, black, partly spiral lines, usually more or less concentric to an enclosed nucleus in the form of a black dot, into which the innermost line very often passes.

The internal shell in this case is destitute of calcareous matter, consisting only of a soft, transparent membrane, with the characteristics described in the type above.

Hab.—St. Vincent Gulf; in 25 fathoms.

EXPLANATIONS OF PLATES.

Plate XXVI.

Fig. 1. *Lamellaria australis*, Basedow—Animal; dorsal surface.

Fig. 2. *Lamellaria australis*—Animal; ventral surface.

Plate XXVII.

Figs. 1, 2, and 3. *Lamellaria australis*, Basedow—Internal shell, various aspects.

Fig. 4. *Lamellaria australis*, Basedow—Showing position of internal shell with respect to animal.

Fig. 5. *Lamellaria australis*, Basedow—A lateral tooth.

Fig. 6. *Lamellaria australis*, Basedow—Dentition 1 : 1 : 1. A single row of teeth, unfolded.

Plate XXVIII.

Fig. 1. *Caledoniella contusiformis*, Basedow.
Fig. 2. *Caledoniella contusiformis*, Basedow—Var. *testudinis*
Fig. 3. *Caledoniella contusiformis*, Basedow—Var. *pulchra*.
Fig. 4. *Caledoniella contusiformis*, Basedow—Var. *labyrinthina*.

Plate XXIX.

Figs. 1, 2, and 3 *Caledoniella contusiformis*, Basedow—Various aspects of internal shell.

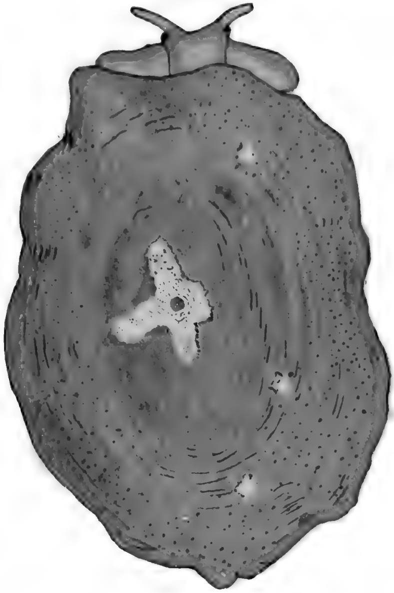
Fig 4. *Caledoniella contusiformis*, Basedow—Showing position of shell with respect to animal.

Fig. 5. *Caledoniella contusiformis*, Basedow—Radula.

Fig. 6. *Caledoniella contusiformis*, Basedow—A single row of teeth. Dentition 2 : 1 : 1 : 1 : 2.

Fig. 7. *Caledoniella contusiformis*, Basedow—Mandible, external aspect.

Fig. 8. *Caledoniella contusiformis*, Basedow—Mandible, internal aspect.



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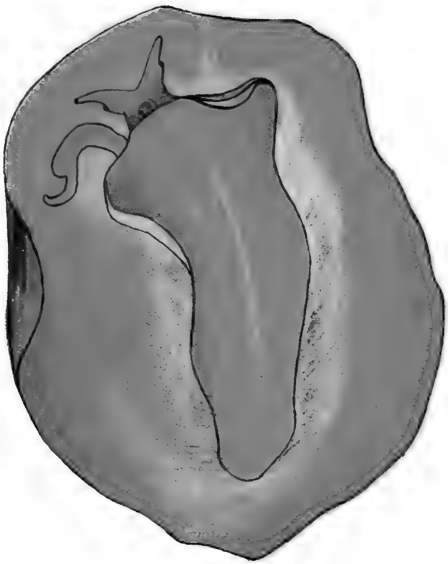

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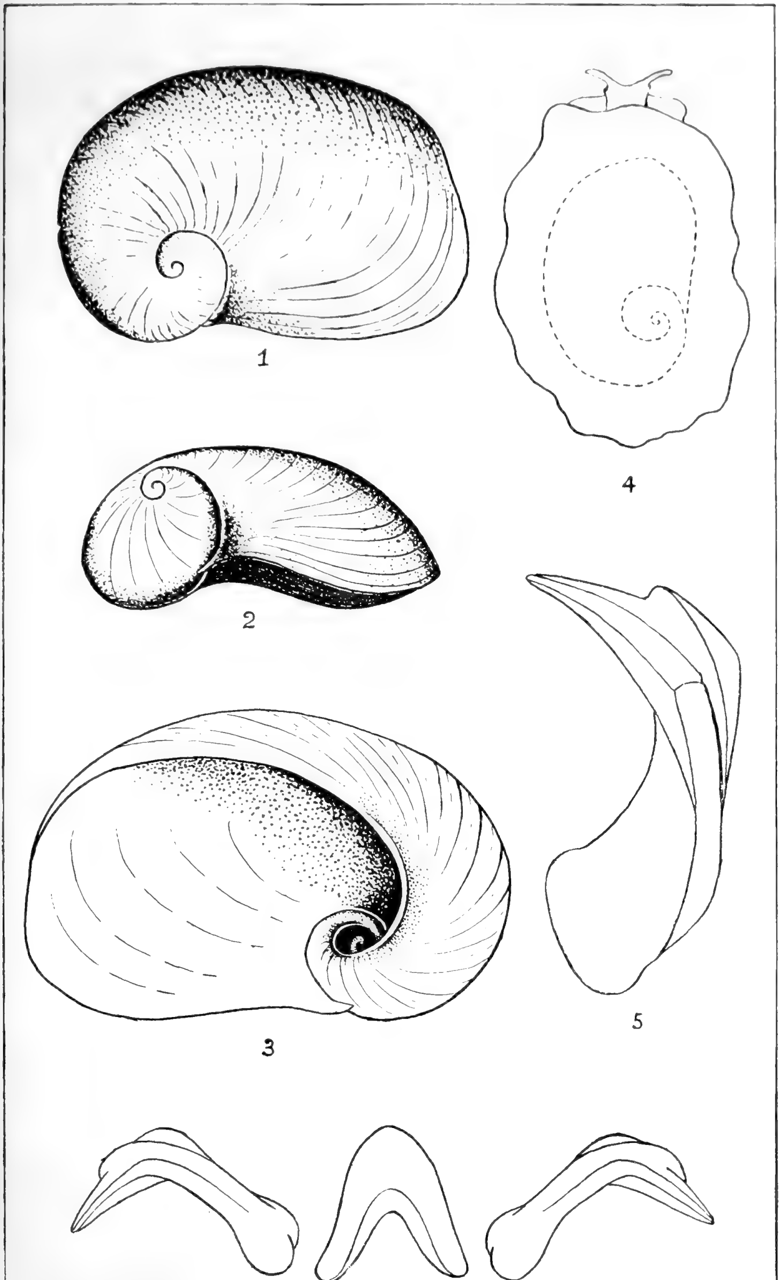
H. BASEDOW DEL. ET PINX. AD. NAT.

HUSSEY & GILLINGHAM. LITH.

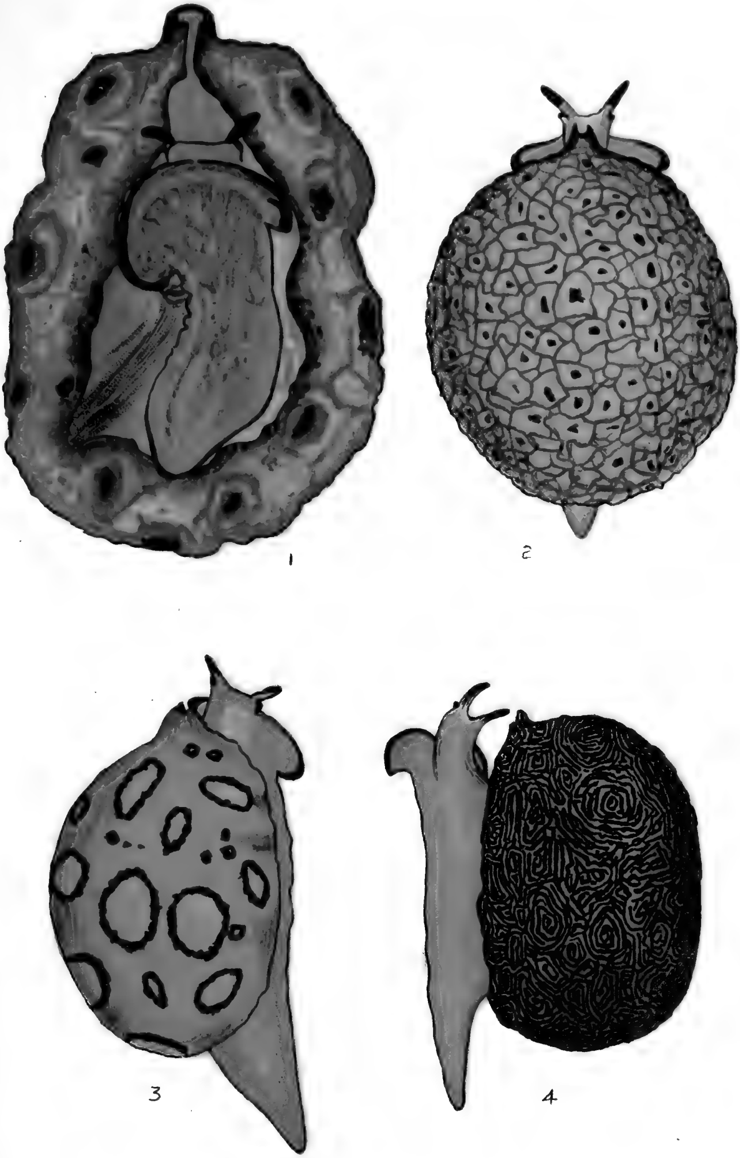
LAMELLARIA AUSTRALIS, Basedow.



LAMELLARIA AUSTRALIS, Basedow.

H. Basedow, del.

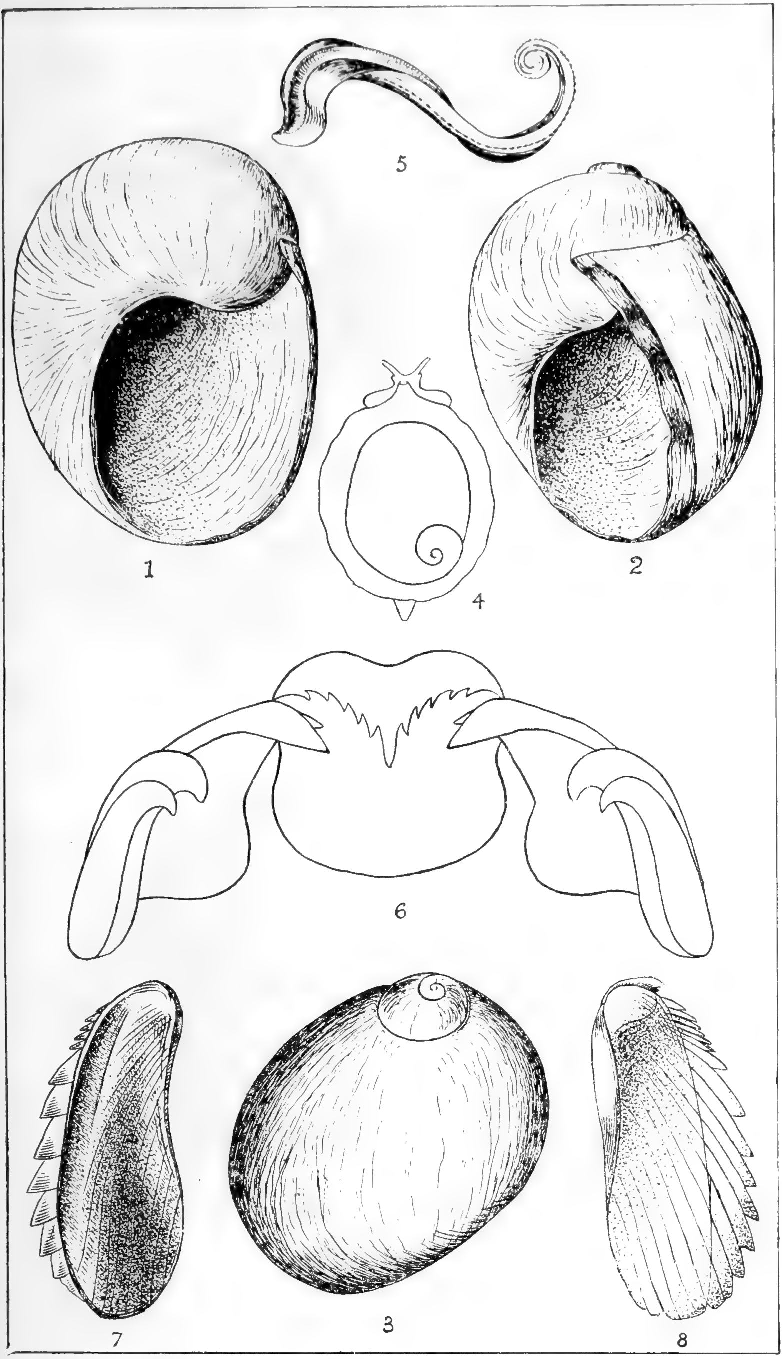
Hussey & Gillingham, Printers, Adelaide.



H. BASEDOW DEL. ET PINX. AD. NAT.

HUSSEY & GILLINGHAM. LITH.

CALEDONIELLA CONTUSIFORMIS, Basedow



CALEDONIELLA CONTUSIFORMIS, Basedow.

H. Basedow, del. Hussey & Gillingham, Printers, Adelaide.

On the Recombination of Ions in Air and other Gases.

By W. H. Bragg, M.A., Elder Professor of Mathematics and Physics in The University of Adelaide; and R. D. Kleeman, B.Sc., Demonstrator.

[Read October 3, 1905.]

It is well known that when positive and negative ions are distributed through a given space a process of combination goes on until ions of one sign only are left. Let there be p positive ions, and n negative ions in each cubic centimetre at any instant, and suppose that the relations of any ion to all those of opposite sign are of the same character. Then the chance that an ion, say, a positive one, will enter into combination before the end of a short time δt is proportional to $n\delta t$; and generally the number of combinations taking place in that time may be denoted by $apn\delta t$ where a is the "co-efficient of recombination." This has been clearly established by the experiments of Rutherford, Townsend, McClung, Langevin, and others.

As a consequence, the current passing between two electrodes in a gas in which ions are being formed by external agents depends on the magnitude of the potential gradient or electric force. The relations between current and force have been carefully studied by many workers, and the observed facts have been compared with the results of calculation based on theory. The comparison is partly, but not completely, satisfactory.

Certain experimental results which we propose to describe in this paper seem to throw light on the reason of the discrepancy. They point to the existence of another cause, distinct from that represented by the expression anp, which prevents ions from reaching the electrodes in the gas in which they are formed. This cause appears to be a process of recombination of newly-formed ions with the atoms from which they have just been separated. The effects of it are proportional to the number of ions formed in a c.cm. in unit time, not to the product of the existing numbers of positives and negatives. They are independent of the shape of the ionisation chamber, and in this they differ from those of general recombination. They depend directly on pressure, and vary greatly from gas to gas.

In order to bring these effects into relief it is only necessary to reduce the number of ions in a c.cm. until the number of those that are lost by general recombination is negligible compared to the number of those that are formed. When this is done it is found that it is still necessary to apply a high potential in order to extract all the ions from the gas. For example, in air at atmospheric pressure an electric force of 25 volts to the cm. will only extract about 80 % of the ions which are obtained when the force is increased to 1,000. The following example will serve as an illustration:—The width of the ionisation chamber is 4 mm., the upper electrode being a metal plate, the lower a sheet of gauze. A thin layer of radium is placed 6·2 cm. below the sheet, and α particles emitted from RaC cross the chamber and ionise the air, which is at atmospheric pressure. The area of the plate on which the rays fall is about 18 cm. The capacity of the electrometer to which the upper plate is connected is about 150 cm, and a potential of ·125 volts applied direct to the electrometer causes a deflection of 722 divisions on the scale; ten divisions = 1 mm. When the lower plate is raised to 400 volts positive, so that the electric force is 1,000 volts per cm., there is a deflection of 982 divisions in 10 seconds, under the influence of the α rays. When a potential of 10 volts is applied, giving a force of 25 volts per cm., there is a deflection of 772 in 10 seconds.

In the latter case the charge Q received per sq.cm. of electrode in one second, measured in electrostatic units, is—

$$\frac{772 \times 150}{10 \times 722 \times 8 \times 300 \times 18} = 3{\cdot}5 \times 10^{-4}$$

The number of ions falling on each sq.cm. of electrode per second is therefore $1{\cdot}2 \times 10^6$ nearly.

The velocity of ions at this potential gradient is nearly $25 \times 1{\cdot}5$, or 37 cm. per second.

Thus, if n be the number of ions in a cubic centimetre, $37n = 1{\cdot}2 \times 10^6$, and therefore $n = 3{\cdot}2 \times 10^4$. Hence, the number of recombinations taking place in a second in the space between two opposing square centimetres of the electrodes is equal to $\alpha \times {\cdot}4 \times (3{\cdot}2 \times 10^4)^2$. If we take the value of α to be $3{,}400 \times 3 \times 10^{-10}$, we find this number to be nearly 420. Finally, therefore, the number of ions recombining in each second is 420, whilst the number received is $1{\cdot}2 \times 10^6$, and thus only 1/3,000th of the ions are lost in this way.

But the current at 25 volts is only 772/982, or about 80%, of the current at 1,000 volts.

It is clear from this example that there is some cause which prevents the current attaining its full value other than general recombination between positive and negative ions.

Now, it is possible that ions newly formed might be specially liable to recombine with each other. Such a possibility has been already suggested by Rutherford ("Radio-activity," p. 33). An electron, which has just been ejected from an atom by a passing α particle, does not go far before encountering a neighbouring atom. The encounter, perhaps, results in a temporary attachment, for we know that ion-clusters are formed in this way. In any case, it is probable that the electron loses much of its velocity of projection. Now, it is still under the attraction of the atom from which it has come. Supposing this atom to have only lost one electron, the strength of the electric force which it exerts at the distance of the mean free path is equal to $e/r^2 = 3 \times 10^{-10}/10^{-10} = 3\ E.S.U.$, or 900 volts per cm. This is large compared to the usual impressed electric forces of experiment. It is by no means improbable, therefore, that the electron may finally slip back into its old place. Such a possibility is not considered in the equations as usually formed. For all writers begin their arguments by the statement:—"Let p be the number of positive ions in a cubic centimetre, and n the number of negative." In doing so they tacitly assume that the relations of any one ion to all others of opposite sign are of the same character. But if a pair of newly-formed ions ran a special chance of recombination until they got away from each other, then the relations of either of these two to the other would be quite different from its relation to all other ions.

Let us, then, for the moment suppose that there is a special form of recombination, which we may call "initial," as distinguished from general recombination, and let us consider the nature of its effects, in order that we may find means of testing the correctness of the supposition.

Now, it is clear that the effects of initial recombination do not depend upon the shape of the ionisation chamber, and this at once differentiates them from those of general recombination. For the special or initial recombination concerns only the ion and its parent atom. But general recombination depends on the chance of an ion meeting others of the opposite sign, which chance depends on the number in a c.cm., and this, again, on the shape of the chamber. If, for example, α particles cross a chamber 3 mm. wide, and a sufficient potential gradient is applied, most of the ions will be carried to the electrodes. If the width of the chamber is increased to 6 mm. the magnitude of the stream of ions is doubled, each positive meets twice as many negatives as before, and therefore the chance that any one ion enters into recombination is twice as great. Suppose the saturation current for a 3 mm. chamber were 100, using any arbitrary system of units, and the actual current for a moderate potential were 90, then for the 6 mm. chamber, under an equal potential gradient, the current would be 160, not 180: the saturation current being 200. This is recognised in the usual formulæ. For example, Langevin finds that—

$$\frac{\epsilon Q}{\sigma} = \log\left(1 + \frac{\epsilon Q_0}{\sigma}\right)$$

where Q_0 is the saturation current per sq.cm. of electrode, and Q is the current when such a potential is applied that σ is the density thereby caused to exist on each sq.cm. of the electrode. When Q and Q_0 are both small compared to σ, it follows that:—

$$\frac{\epsilon Q}{\sigma} = \frac{\epsilon Q_0}{\sigma} - \frac{\epsilon^2 Q_0^2}{2\sigma^2}$$

$$\therefore \frac{Q_0 - Q}{Q_0} = \frac{\epsilon Q_0}{2\sigma}$$

Thus, the relative lack of saturation, viz. $(Q_0 - Q), / Q_0$, is proportional to Q_0, which itself depends on the depth of the chamber. Other formulæ show the same dependence.

But experiment shows that when the density of the ions is small the depth of the ionisation chamber has very little effect on the degree of saturation. This may be illustrated by the following experiments:—

Five mm.g. of radium bromide were so placed that the α rays passed upwards through an aperture in a lead plate and crossed the gauze of the ionisation chamber. The rays formed a cone whose vertical angle was about 20°. The apparatus used was the same as that of the previous experiment described, but the currents were so strong that a capacity of 1,070 cms. had to be put in parallel with the electrometer. Determinations were then made of the strengths of the current at various potentials:—(1) When the ionisation chamber was 3 mm. wide; (2) when 6 mm. wide; and (3) when 9 mm. wide. The values obtained were then reduced so that the saturation current in each case was set at the same value. Comparison then showed that the curves were almost identical except at low potentials, and this was in agreement with the hypothesis now put forward. For at all but low potentials an^2 was so small as to be negligible. When the potential was very low, one or two volts per centimetre, then the ions moved so slowly that n was larger, and an^2 was not negligible, and under those circumstances the curve showed a difference of the right kind. That is to say, the 9 mm. curve was further from being saturated than the others. The currents were specially made not too weak in order to bring out this contrast between the effects at low and at high potentials. The figures are given in the following table:—

Relation of current to potential gradient for different widths of the ionisation chamber, the currents being small: potential gradients in volts per centimetre: currents in arbitrary units, reduced to common maximum.

WIDTH OF CHAMBER.

3 mm.		6 mm.		9 mm.	
Potential Gradient.	Current	Potential Gradient.	Current.	Potential Gradient.	Current
1,000	400	1,000	400	1,000	400
34·8	341	35·7	335	36·0	333
11·9	308	12·7	302	16·4	300
8·65	294	9·47	292	9·83	290
6·6	285	7·47	283	7·81	283
4·66	274	5·50	272	5·83	271
2·75	252	2·75	247	3·10	244
1·92	235	1·89	224	2·23	220
1·50	221	·98	169	1·36	174
1·06	196	·51	108	·84	134
·59	147	·02	4	·04	68
·385	106				
·20	47				

These figures are plotted, as far as 36 volts per cm., in curves A, B, and C of Fig. 1. An open scale is chosen so as to show the separation of the curves at low values of the field, when n is not very small.

These figures and curves show that the ratio of the current at any particular strength of field to the saturation current is almost independent of the shape of the ionisation chamber, when the current is small. As this seems an important point, we have made many experimental tests of it. We give below the details of one such test, in order to illustrate the methods employed and their degree of accuracy.

The arrangements were the same as those just described, and the special object of the experiment was the determination of the degree of saturation under a certain moderate potential gradient in the case of chambers of two different depths. The depths were reckoned in turns of the screw, which raised the upper from the lower plate of the chamber; eleven turns = 1 cm. The currents were allowed to run into the electrometer for 10 seconds. The electrometer was not dead beat, and therefore the first and second resting-places on the scale were observed, and the mean taken. For example, the second line, marked †, of the subjoined table, shows that the first deflection was to 57·47 cm., and then back to 54·92, zero being 4,700. The experiment repeated gave 57·42 to 54·92, and again 57·47 to 54·93. The leak was also measured with

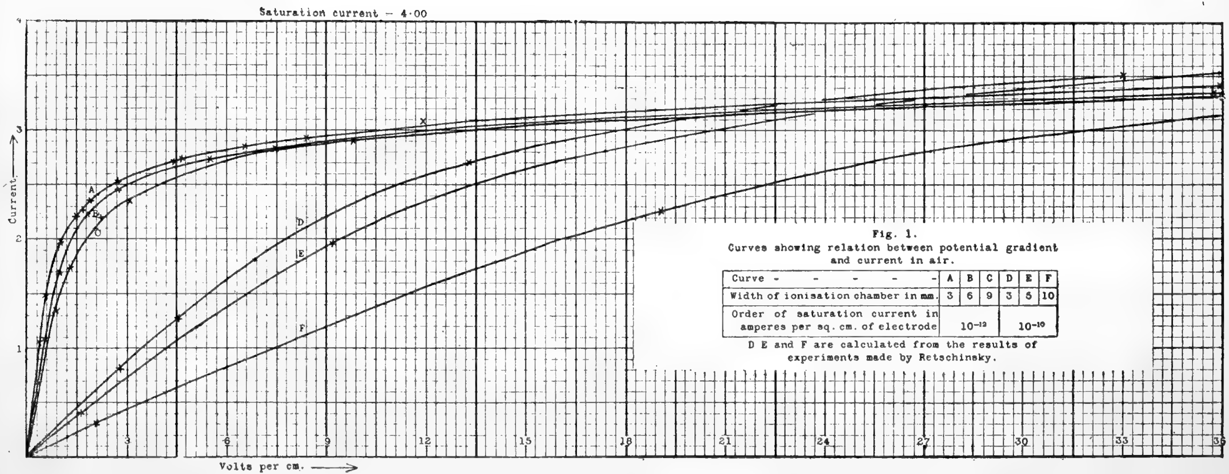


Fig. 1.

Curves showing relation between potential gradient and current in air.

Curve - - - - -	A	B	C	D	E	F
Width of ionisation chamber in mm.	3	6	9	3	5	10
Order of saturation current in amperes per sq. cm. of electrode	10^{-12}			10^{-10}		

D E and F are calculated from the results of experiments made by Retschinsky.

a metal plate over the radium, and the difference taken as the proper value of the leak for that experiment, a small proportion only being due to β rays. The first measurements relate to a chamber of depth 6 turns—(i.) under a potential gradient of 600 volts for the 6 turns: (ii.) a gradient of 20 volts for the same distance; (iii.) under 600 volts again. The difference between (i.) and (iii.), as shown in the table, was due to the variation in sensitiveness of the electrometer. In almost all our experiments this variation has been negligible: in this special case it was not so, because so large an amount of radium was used, viz., 5 mmg. The γ rays penetrated all the metal casings, and caused a leak in the charge of the needle. The leak had an exaggerated influence on the readings because the capacity of the electrometer was increased by the addition, in parallel, of a plate condenser of 1,000 cm. capacity. This disturbed the usual balance of the electrometer, in which leakage of the needle's charge had little effect on the deflection for a given quantity of electricity. To obviate any error from variation of sensibility the results of (i.) and (iii.) were averaged, and compared with the result of (ii.). It will be observed that successive determinations of the same leak were very consistent with each other. This implies that almost all the observed effect was due to the radium: extraneous influences were very small.

6 Turns. Zero = 4700.

600 volts (Metal over Ra)	47 47	75 69 63 59	Mean leak = 67	Nett leak = 852 = I_6 (say)
† 600 volts	57 54	47 42 47 92 92 93	Mean = 919	
20 volts (Metal over Ra)	47 47	50 54 40 46	Mean = 48	Nett leak = 695 = I'_6
20 volts	55 53	49 39 49 43 36 42	Mean = 743	
600 volts (Meta over Ra)	47 47	70 69 61 55	Mean = 64	Nett leak = 829 = I_6
volts	57 54	19 16 13 73 70 66	Mean = 893	

$\therefore$ Mean value of $I_6 = 840$.

Value of $I'_6 = 695$.

3 Turns.

300 volts (Metal over Ra)	47 47	53 53 44 44	Mean = 49	Nett leak = 416 = I_3 (say)
300 volts	52 50	27 30 31 99 00 03	Mean = 465	
10 volts (Metal over Ra)	47 47	41 42 34 36	Mean = 38	Nett leak = 340 = I'_3
10 volts	51 50	26 31 31 23 28 27	Mean = 378	
300 volts (Metal over Ra)	47 47	52 51 45 42	Mean = 48	Nett leak = 396 = I_3
300 volts	52 50	06 07 04 83 83 83	Mean = 445	

∴ Mean value of $I_3 = 406$.
Value of $I'_3 = 340$.

Hence, $I_6/I'_6 = 1{\cdot}208$, and $I_3/I'_3 = 1{\cdot}193$. A repetition of the experiment, in different order, gave $I_6/I_3 = 1{\cdot}947$, and $I'_6/I'_3 = 1{\cdot}897$. These agree well with each other, for we find from the first set that $I_6I'_3/I'_6I_3 = 1{\cdot}013$, and from the second that the same fraction $= 1{\cdot}025$.

The fraction I_6/I'_6 is the ratio of the saturation current in a chamber about 6 mm. wide to the current when the potential gradient is about 35 volts per cm., and I_3/I'_3 is the ratio when the chamber is 3 mm. wide, all other conditions being exactly the same. It ought, perhaps, to be mentioned that the current for the chamber of double width was not quite twice that for the other, because the widening was effected by raising the top plate, and so adding to the chamber a layer of air which was about 3 mm. further away from the radium than the original layer. As a little heap of radium bromide was used, the curve was of the form shown in Plate xviii., "Philosophical Magazine," December, 1904, so that ionisation decreased as distance from the radium increased. These results show clearly the existence of at least one effect which we should expect to find as a result of initial recombination.

Again, we ought to find that variation in current strength, caused by altering the power of the ionising agent, makes little difference to the form of the curve when the current is small. We have made several experiments in this direction also. In Fig. 2, curves A and B show the results

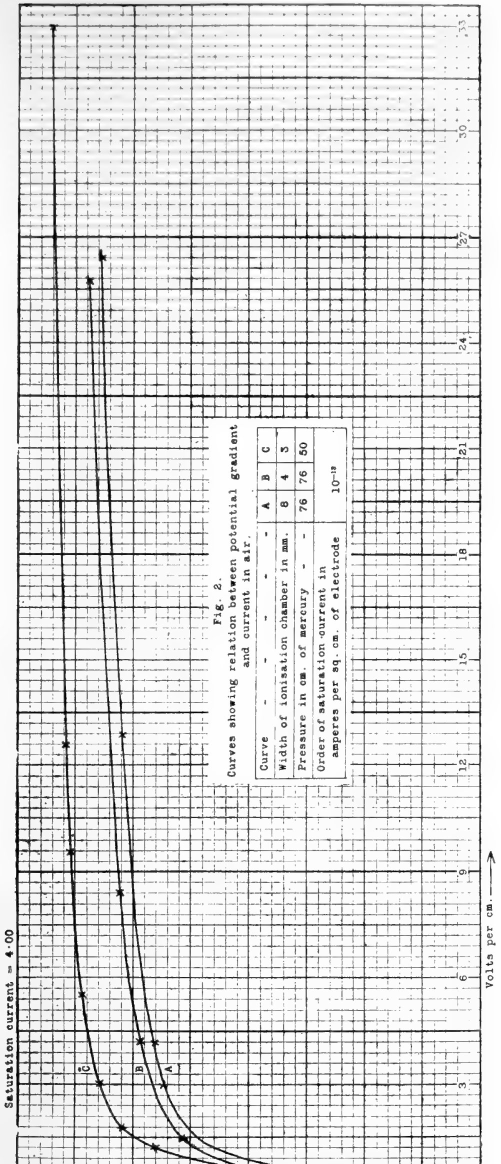


Fig. 2.
Curves showing relation between potential gradient and current in air.

Curve - - - - - -	A	B	C
Width of ionisation chamber in mm.	8	4	3
Pressure in cm. of mercury - -	76	76	50
Order of saturation current in amperes per sq. cm. of electrode	10^{-13}		

of experiments with currents which were of an order ten times smaller than those already described; yet their form is very similar. The curve A shows results with an 8 mm. ionisation chamber; curve B, 4 mm. The ionisation was due to a thin layer of radium, surmounted by a set of vertical tubes, as described by us in the "Philosophical Magazine," September, 1905. Other experimental results may be expressed in terms of I_4, the saturation current for 4 turns of the screw (rather less than 4 mm.), and I'_4 the current for a potential gradient of 25 volts per cm., and the same depth of chamber. On one occasion it was found that $I_4/I'_4 = 1·17$: $I_8/I'_8 = 1·21$; and on another $I_4/I'_4 = 1·18$: $I_8/I'_8 = 1·23$. In these experiments the radium was 5·05 cm. from the gauze. When the distance was 6·25 it was found that $I_4/I'_4 = 1·27$; $I_8/I'_8 = 1·29$; and again $I_4/I'_4 = 1·30$, $I_8/I'_8 = 1·30$. In the latter cases the α rays did not all get across the chamber: possibly the small variation of the ratios with distance may, in some way, be due to this fact.

It might be argued that we ought not to find much variation in the lack of saturation when the current is increased by shooting a greater number of α particles across the chamber in one second, on the following grounds:—Each particle as it flies across makes something like 10^5 ions in a centimetre of its path. If there are only about 10^4 or 10^5 ions in a c.cm. at any one time it is clear that these must be all the work of one particle, and that all the ions it produces are cleared away before the next one comes. Thus, the ions made by one α particle have no chance of combining with those made by another, and recombination cannot be proportional to the square of the number per c.c. But this consideration, though no doubt true, cannot furnish an explanation of the fact that the curves are little altered when the chamber is altered in depth. It was, indeed, in view of this argument that we made the experiments with the varying depths of the chamber.

It is very instructive to compare these figures with the results obtained by Retschinsky, and described by him in a paper contained in "Drude's Annalen," No. 8, 1905. Very careful measurements have been made by this observer of the relation between current and potential gradient in the case when the currents are of an order 100 to 1,000 times greater than those of the experiments described above. Curves D, E, and F, in Fig. 1, are plotted from the table on page 531 in his paper, being reduced to a saturation value 400, so as to be comparable with the other curves in the same figure. It will be seen that in this case the curves for different widths of the ionisation chamber differ very widely at low potential gradients, and this is in accordance with the present hypothesis. For, when the currents are so large, the value of an^2 is great, and the effects of general recombination must be considerable, unless the potential gradient is much increased. In fact, the general characteristic of these curves is that the larger the current the higher the potential gradient must be at the point where the effects of altering the depth of the chamber cease to be visible.

Several observers have determined the form of the curve connecting current and potential gradient, and have calculated therefrom the recombination co-efficient. Let us now consider the result of neglecting the effects of initial recombination in these calculations.

If the currents are very great, the effects of initial recombination may be small as compared to those of general recombination. But they must always be there, and their effect will be of greater relative importance when the current is made smaller, either by using a weaker source of ionisation or by lessening the width of the ionisation chamber. If both effects are ascribed to one cause, whose influence is measured by α, then α must be given a value which is fictitiously large. The smaller the chamber, the greater the apparent value of α must be; and this is actually the case, as found and remarked upon by Retschinsky. For when the chamber is very small the effects of general recombination ought to be small: and if, as is the case, there is still a considerable lack of saturation at moderate voltages, the whole of which is ascribed to general recombination, the value found for α must be very great. It is possible to find any desired value of α in this way, if only the currents are made small enough. This is especially true if we use the first formula employed by Retschinsky, and ascribed by him to Riecke. In this the determination of α depends on the difference between two current-values taken from the upper part of the curve where the slope is due rather to initial than to general recombination. To make this point clear consider the following determinations of α:—

Retschinsky gives the following form of Riecke's equation where the quantities are expressed in electrostatic units:—

$$\alpha = 5{\cdot}52 \times 10^{-4} \frac{(C-c)\ F_0}{c^2\, l}\left(1 - {\cdot}2 \times \frac{C-c}{c}\right)$$

where C = saturation current per sq. cm. of electrode

c = current for a potential gradient F_0

l = depth of chamber.

He has found by experiment that when l is 1 cm., and F_0 is 151 volts per cm., then (in amperes)

$$C = 8{\cdot}03 \times 10^{-8}/200 \text{ (area of electrode} = 200 \text{ sq. cm.)}$$
$$= 4{\cdot}01 \times 10^{-10}$$
$$c = 3{\cdot}94 \times 10^{-10}$$

Therefore,

$$\frac{C - c}{c^2} = 4{\cdot}5 \times 10^7$$

and by substitution in the equation it can be found that

$$\alpha/e = 4434 \quad (loc\ cit., \text{ p. } 530).$$

Now, in a similar experiment, with far smaller currents, we find that when l is 1 cm. and F_0 is 150 volts per cm.

$$C = 4{\cdot}23 \times 10^{-13}$$
$$c = 3{\cdot}90 \times 10^{-13}.$$

Therefore

$$\frac{C - c}{c^2} = 2{\cdot}2 \times 10^{11}$$

and substitution in the equation gives a value of α/e about 5,000 times greater than Retschinsky's, or about 2×10^7.

In the second formula (Stark's) the values of α are more correct, because the current values used are taken, one from the lower part of the curve, and one from the saturation values, so that their difference depends less on the effects of initial recombination. Retschinsky draws attention to these anomalies in his results, but ascribes them to absorption of ions by the electrodes. He argues that in a shallow ionisation chamber this effect must be greater than in a deeper one; and so he accounts for the lack of saturation in the small chamber, a lack which is excessive if attempt is made to explain it as wholly due to general recombination. But we think that a more reasonable explanation is to be found in the hypothesis and results described in this paper, in connection with which Retschinsky's results fall naturally into place. Retschinsky points out that McClung obtained smaller values of α than he himself obtained, and he suggests that, since McClung's apparatus consisted of a series of shallow ionisation chambers, the absorption effects would be considerable. On the hypothesis of this paper McClung's method is so far the more reliable, that it avoids the complications due to the special phenomena which occur in connection with the original forming of the ions, and deals only with a state of things in which ions have been formed and are distributed at random through the gas. All methods in which ions are formed whilst the potential gradient is in existence must be more or less affected by those phenomena, hitherto unregarded, which it is the object of this paper to explain.

When, therefore, the ionising agent is feeble, the only part of the curve which can be altered by varying the current is that where the potential gradient is small: the feebler the agent the smaller the gradient. Let us now consider whether our hypothesis makes it probable that we can alter the shape of the rest of the curve by any variation of the conditions of the experiment.

Now, if initial recombination takes place because the ejected electron does not get far enough away from its parent atom before it is stopped by encountering another atom, then diminution of pressure ought to make it much easier to saturate. But this is a well-known fact (Rutherford, "Philosophical Magazine," vol. xlvii., p. 160). In order to obtain results comparable with those we had already obtained at ordinary pressures, we made several experiments in which all the conditions were the same, except that the pressure was less than that of the atmosphere. Curve C in Fig. 2 shows the results of such an experiment. If this is compared with the other curves in the same figure it will be clear that alteration has taken place in the very portion of the curve where we should have expected it, and where change in the strength of the current has small influence, viz., all along the upper part of the curve up to the high potential end. The saturation current per sq.cm. was about 10^{-13} amp. In further support of our hypothesis it may be pointed out that it gives a ready explanation of an experiment due to Rutherford, and described by him in the "Philosophical Magazine," vol. xlvii., p. 158. He found that the saturation value of the current through a gas could be obtained for a much lower potential gradient when the gas was drawn away from the uranium which ionised it, and treated in a separate vessel. This is to be expected when it is considered that under the circumstances of the experiment initial recombination was wholly absent.

It is now convenient to consider these phenomena as they are manifested in other gases than air. It is well known that the relations between current and potential in carbon dioxide are in some way abnormal. But the peculiarities of this gas are even intensified in ethyl chloride (C_2H_5Cl). The fact is that this effect, which makes it difficult to draw all the ions to the electrodes in the case of air, is far greater in more complex gases, and thus it is extremely difficult to obtain the saturation current unless very high potentials are employed. We find it necessary to use a potential gradient of two to three thousand volts per cm. in the case of ethyl chloride at 60 cm. pressure. In the investigations which were made by us ("Philosophical Magazine," September, 1905), with regard to the ionisation curves in different gases, we found the currents to be unexpectedly small in the case of some gases. We suggested that possibly some of the ions made by the α particles did not get away from their parent atoms. We proposed to make a special investigation of the point, and it was with this purpose that the work described in this paper was undertaken.

It now appears that our suggestion was justified, but it is also clear that we should have obtained larger currents if we had used a higher potential gradient; 500 volts per cm. was insufficient.

Consider the curves in Fig. 3. In A is shown the relation between current and potential gradient up to 3,000 volts per cm. for ethyl chloride at 56 cm. pressure, the saturation current per sq.cm. being about 3×10^{-13}. B shows the same relation in the case of air at atmospheric pressure, the saturation current being rather smaller. Comparison of these two shows how much more difficult it is to obtain the full current in the more complex gas. Again, C shows the results of experiments in which the depth of the ionisation chamber was varied. The crosses refer to a 2 mm. chamber, the dots in circles to a 4 mm. chamber. The currents were of the 10^{-13} order. The two sets of observations lie on practically the same curve. This shows that general recombination is not responsible for the lack of saturation, and that the cause is probably similar to that whose effects in the case of air have been described above. Curves D and E refer to experiments in which the chamber was maintained at the same depth, 2 mm., but the currents were altered by varying the distance of the radium. In the former curve the saturation current is about 10^{-13}, in the latter six times as much. In the case of the results shown in C, D, and E the gas contained a certain proportion of air.

These results all go to show that the form of the curve for ethyl chloride is almost independent, as in the case of air, of strength of current and depth of ionisation chamber, when the ionisation is small. But also, as in the case of air, it depends greatly on the density of the gas. F represents the results of experiments at a pressure of 36 cm., and is to be compared with A. All the conditions, except as regards pressure, were the same for the two curves.

We have also carried out experiments, similar to some of those just described, for a mixture of carbon tetrachloride and air, and obtained similar results. Although there was only 5% (by pressure) of the denser gas in the mixture, yet the current at a potential gradient of 330 volts per cm. was only 82% of the saturation value, whilst in air under similar conditions it was 93%.

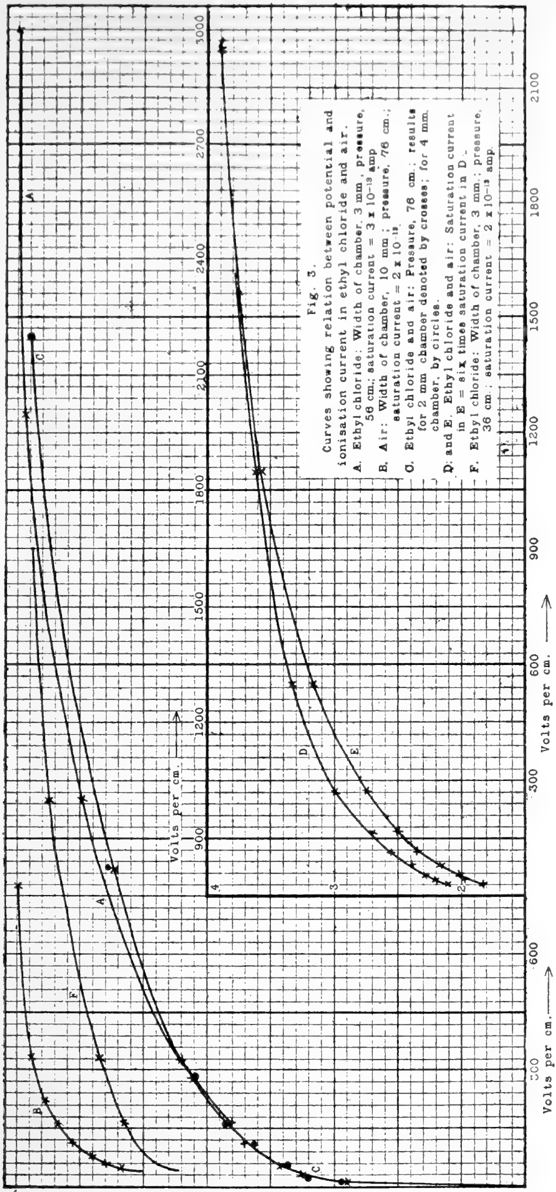


Fig. 3.

Curves showing relation between potential and ionisation current in ethyl chloride and air.

A. Ethyl chloride: Width of chamber, 3 mm., pressure, 56 cm.; saturation current = 3×10^{-13} amp.

B. Air: Width of chamber, 10 mm.; pressure, 76 cm.; saturation current = 2×10^{-13}.

C. Ethyl chloride and air: Pressure, 76 cm.; results for 2 mm. chamber denoted by crosses; for 4 mm. chamber, by circles.

D. and E. Ethyl chloride and air: Saturation current in E = six times saturation current in D.

F. Ethyl chloride: Width of chamber, 3 mm.; pressure, 36 cm.; saturation current = 2×10^{-13} amp.

It is hardly surprising that initial recombination should be more effective in a complex gas than in air. For the molecule contains many atoms, each one of which is just as likely to lose an electron as if it were not associated with other atoms. Perhaps, therefore, the molecule as a whole loses two or three electrons, and its electric field is the more intense. Recombination of this kind must also be easier, the shorter the free path.

It will be clear from the foregoing that certain effects occur which are characteristic of a process of initial recombination, a process which is *a priori* not improbable. The question now arises as to whether any other cause could produce the same effects.

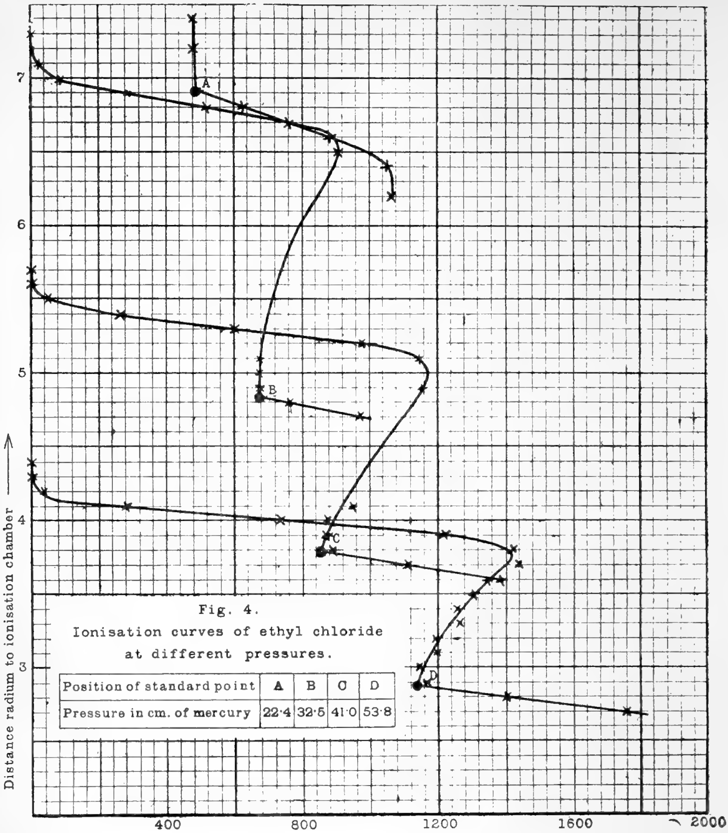
When we consider the great increase of current in a complex gas which is caused by an increase in the electric force applied, we cannot but ask whether any of it is due to the production of other ions by those actually made by the α particle. Could the electric force aid the freed electron to gather speed sufficient to ionise by collision? A process of this kind would be similar in its results to initial recombination, in that it would be independent of strength of current and depth of ionisation chamber. It seems probable, however, that its effectiveness would rather be increased than diminished by lowering the pressure: and also it would be difficult to account for the existence of a saturation value of the current. Nevertheless, it does not seem safe as yet to say that no such process occurs. Probably further light could be thrown on the subject by an investigation into the total number of ions produced in different gases under varying conditions. Some initial experiments of this kind will be described presently.

Rutherford has recently shown that the α particle of RaC has only lost 40% of its velocity when it ceases to ionise. If this fact is considered in conjunction with our investigations into the form of the ionisation curves for gaseous mixtures, it is at once clear that the α particle stops ionising in every gas when its speed has fallen to precisely the same value. For, if not, the ionisation curve for a mixture would show a superposition of simple curves, of which effect there is no trace. This and other considerations seem to show, as we have already said ("Philosophical Magazine," September, 1905), that the α particle performs the same number of acts of ionisation in every gas. If, then, we find the total saturation current to be different in different gases, we must come to the conclusion that either the ions in the gases of higher conductivity produce others by the help of the electric field, or that in the gases of lower conductivity some of the ions made by the α particle do not get free, even under conditions of saturation, from their parent atoms, or that both these effects take place. With the object of helping to a decision on this point we have begun a set of experiments, of which those now described are the first examples.

The method used is to measure the co-ordinates of some standard point on the ionisation curve of the gas investigated, under different pressures. The point chosen is that where the side of the RaC curve is struck by the top of the curve which belongs to the α particles of next velocity to those of RaC. This point in air, at 760 mm. and 20° C., is at a height of nearly 4·83 cm. It is a convenient point to choose, for the following reasons:—Being on a part of the RaC curve, where no great change in the ionisation takes place for a considerable alteration in range, the measurements there are usually pretty consonant with each other, even though they are taken quickly, and if several be taken on the RaC curve they check each other. The ordinate of this point can also be determined with great precision by measuring two or three points along the top slope of the curve of RaA (or emanation, whichever it finally proves to be). Thus, a few readings can be quickly taken in succession which determine the point accurately, and very little leakage of air into the apparatus takes place while the experiments go on. This is a desirable thing, because our apparatus leaks slowly when the pressure within is much reduced, on account of the large number of connecting tubes and mechanical arrangements. We find that this method is very satisfactory. We may mention also that to save time it is not well, in the case of gases like ethyl chloride, which are at first in the liquid form, to admit any of the liquid into the apparatus, as it takes so long to evaporate completely. It is better to let the liquid evaporate in another chamber, which can be quite small, and then to take over gas only.

Fig. 4 shows the results of some experiments with C_2H_5Cl. The curves shown are portions of the ionisation curves in this gas at different pressures. In all cases the apparatus was exhausted of air to about 10 mm. pressure, then partly filled with gas, re-exhausted, and filled again to the desired pressure. The observations were made at once, those in the neighbourhood of the standard point being made first, so that the gas might be as pure as possible whilst the important readings were being taken. A potential of 900 volts was used for the three greater pressures, and of 300 for the low pressure. The chamber was 3 mm. wide, and therefore these potential gradients were, respectively, 3,000 and 1,000 volts per cm.

The results for ethyl chloride and for air are contained



in the following table, where P. denotes the pressure, R. the range, and I. the ionisation on an arbitrary scale:—

Ethyl Chloride.

P.	R.	I.	R. × I.	R. × P.
53·8	2·87	1,140	3,260	154
41·0	3·78	860	3,260	155
32·5	4·83	666	3,220	157
22·4	6·92	476	3,300	155

Air.

P.	R.	I.	R. × I.	R. × P.
75·3	4·72	546	2,570	355
57·9	6·08	432	2,620	352
46·9	7·42	340	2,520	348
38·8	9·00	283	2,540	349

These results relate to two gases only; but so far as they go they show:—(i.) That the range varies inversely as the pressure, which result might have been anticipated; (ii.) that the total number of ions set free in a gas is independent of the pressure, but is different in different gases. The total ionisation is greater in ethyl chloride than in air. This is a contrary result to that which we obtained during our experiments on absorption. We were unaware at that time of the enormous force required to saturate the complex gas.

Finally, the following experiments may be briefly described:—

We have tried the effect of reversing the field on the relation between current and potential, and found a result which was practically negative. We have found a similar result when the α particles were not shot straight across the ionisation chamber in the direction of the lines of force, but in a slanting direction. These experiments were made in the endeavour to find whether there was any relation between the direction in which electrons were projected and the direction of the applied field. We have also tried to alter the range in air by using different potential gradients, with the idea that it might be possible to obtain ions from an atom traversed by a slower α particle, if only enough electric force were applied. But the result was the same, no matter whether the force was 20 volts to the cm. or 2,000; and a variation of ·2 mm. could hardly have escaped detection.

In a paper which we had the honour to lay before this Society on June 6, 1905, we described the results of some investigations into the correct form of the ionisation curve. Assuming that the α particle had lost almost all its energy when it ceased to ionise, we showed that it spent its energy at a rate which was inversely proportional to the square root of its speed. This assumption appeared to us at the time to be reasonable, but Rutherford has shown since then ("Philosophical Magazine," July, 1905), that the α particle of RaC still retains 40% of its initial energy when it ceases to ionise the gas through which it passes. In consequence, the conclusion which we drew from our experimental results needs modification. Recalculation shows that the α particle spends energy at a rate which is inversely proportional to the square of its speed. This is interesting, since this is the rate at which any particle moving with great speed gives up energy to a particle, relatively at rest, which it passes by, it being supposed that a force acts between the two which is a function of their mutual distance (Report of the Australasian Association for the Advancement of Science, Dunedin, 1904. p. 64). Rutherford's remarkable discovery does not affect any other of our conclusions.

We have examined the loss of range of the α particle in passing through several other atoms and molecules, and found that in all cases the square root law is fulfilled at least as accurately as for the atoms and molecules of the original list. The new substances are:—Lead, iron, nickel, oxygen, carbon dioxide, carbon bisulphide, ethyl iodide, chloroform, pentane, and benzene.

During the progress of this work, one of us (R. D. Kleeman) left Australia for England. We wish to acknowledge with gratitude the assistance of Mr. H. J. Priest, B.Sc., in completing the observations.

An Aroid New for Australia.

By J. H. Maiden, Government Botanist and Director of the Botanic Gardens, Sydney, Honorary Fellow.

[Read June 6, 1905.]

Amorphophallus campanulatus, Blume, Pine Creek, Northern Territory of South Australia (J. H. Niemann). Cultivated in the Botanic Gardens, Sydney, where it flowered, October, 1904. Water colour drawings of the flower (October, 1904), and of the foliage (January, 1905), have been executed by Miss Margaret Flockton, and are deposited in the National Herbarium, Sydney.

This species belongs to the section "Candarum," chiefly distinguished from the other sections by the long style.

According to Engler's Monograph of Aroideæ in DC.'s Monographiæ Phanerogarum, vol. ii., p. 308 (1879), the following three species belong to this section:—

A. campanulatus, Blume.
A. dubius, Blume.
A. hirsutus, Teysm.

The measurements of our plant are:—

Height of spathe, $10\frac{3}{4}$ inches.
Breadth of spathe, 8 inches.
Height of spadix, $8\frac{1}{2}$ inches (from base to top of sterile appendage).
Sterile appendage, nearly 4 inches broad, and rather above 3 inches high.

The measurements of *A. dubius* are, according to "Bot. Mag.," t. 5187:—

Height of spathe, 6 inches.
Height of spadix, 4 inches.

It will be seen that the flower is about twice as large as those of *A. dubius*, and are sharply distinguished from that species by the wrinkled appendage of the spadix, which is smooth and almost egg-shaped in *A. dubius*.

The following are actual measurements of the plant of *A. campanulatus*:—

Height of plant, 6 feet 4 inches.
Length of petiole (trunk), 3 feet 10 inches.
Diameter of petiole, $1\frac{3}{4}$ inches.
Length of leaf, 2 feet 6 inches.
Spread of foliage, 4 feet 4 inches.

The leaf does not differ from that of the type of *A. campanulatus.*

The flower differs in colour and shape. In the typical *A. campanulatus* (as figured in "Bot. Mag.," t. 2812, and in Blume's "Rumphia," I. t. 32 and 33) the spathe is broader than high, while in the Northern Territory specimen *the spathe is higher than broad.* The Northern Territory plant is, further, darker inside and more distinctly spotted outside than the type, and the sterile expansion on the top of the spadix is considerably less wrinkled.

I do not think these differences are sufficient to warrant its description as a new species, and, in view of the amount of variation known to exist in the species, I am not altogether free from doubt as to the expediency of giving it a varietal name. But it may be a convenience to distinguish the Northern Territory form, and therefore I propose the name *A. campanulatus*, Blume, var. *australasica*, for it.

Several new species of *Amorphophallus* have been described since 1879 (the date of Engler's Monograph), but none of the species recorded in the Supplement to the "Index Kewensis" come near the Northern Territory plant, so that I have no doubt the plant is unrecorded for Australia.

Mueller mentions *A. variabilis*, Blume, as the only Australian species, and Bailey adds two more species, *A. galbra* and *A. angustiloba*, but all these three species belong to a different section of the genus, and are very different from the plant under consideration.

The geographical range of *A. campanulatus* is from Madagascar to the Malayan Archipelago and the Melanesian and Polynesian Islands, so that its occurrence in Australia is only what could have been expected.

Descriptions of Australian Curculionidæ, with Notes on Previously Described Species.

By Arthur M. Lea.

Part III.

[Read October 3, 1905.]

SUB-FAMILY OTIORHYNCHIDES.

Myllocerus and Allied Genera.

There is a very natural group of the *Otiorhynchides*, of which *Myllocerus* is the leading genus, that is abundantly represented in Australia. The species are all comparatively small, and live on foliage; many of them are clothed with green scales, which to the naked eye are sufficiently beautiful, but which, under the microscope, are almost dazzling; under that instrument also scales apparently the most sober greys and fawns take on a lovely appearance. The species are most numerous in the tropics, and become sparser and more soberly coloured the greater the distance from the equator; from Tasmania the group appears to be entirely absent.* Mr. Pascoe proposed a number of genera allied to *Myllocerus*, but it is very doubtful if they will all be maintained. He regarded the bisinuation of the base of the prothorax as the main distinguishing feature of *Myllocerus*, but this is a variable character, and at least two species (*ignaria* and *bicolor*) have been referred to *Titinia*, in which the base is bisinuate.

I do not know a single external character which alone is sufficient to denote the sex of a specimen; where the sexes are before one they can sometimes be distinguished by the greater size of the females; in some species also the scape is considerably stouter in one sex than in the other; the shape of the prothorax is also not always the same; but these characters are useless for ascertaining the sex of unique specimens.

The scales are usually so dense that the derm cannot be seen; and the shape and positions of the punctures are seldom traceable; consequently, before describing the new species, I have always considered it necessary to partially abrade at least one specimen. By doing this great differences can be seen to exist in the punctures of the prothorax (and to a less extent of the elytra), and of which absolutely no sign was visible before abrasion.

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* It is true that *Myllocerus speciosus* was described as from Western Australia and Tasmania, but I do not believe that it, or any other species of *Myllocerus*, occurs in Tasmania.

Practically any species with green scales, belonging to the allied genera, would fit the description of *Mylloccrus australis*, Boi., so until more information is forthcoming I think this name should be regarded as non-existent.

MYLLOCERUS TREPIDUS. Pasc., and DUPLICATUS, Pasc.

There are four specimens before me, from Port Denison and Endeavour River, which evidently belong to one of these species, but as to which is very doubful if these names really appertain to distinct species. The four specimens appear to agree very well with either of the formal descriptions, but on comparing these together the following apparent discrepancies appear : —

Trepidus	*Duplicatus.*
Second joint of funicle longer than first	Second joint much longer than first
Prothorax short	Prothorax very short
Scutellum oblong	Scutellum less oblong
Elytra with irregular white setæ	Elytra with white setæ in double series.

Duplicatus is also said to be more richly coloured, and the setose scales otherwise arranged.

The four insects have the elytral setæ arranged in places in double and in places in treble series, but the apparent arrangement is subject to alteration according to the point of view. If, however, the character of the antennæ is reliable, the specimens will belong to *trepidus*, as the second joint of the funicle is but very little longer than the first.

MYLLOCERUS DARWINI, Blackb.

I have two specimens from Cairns, one of which agrees exactly with the description of this species, but in the other three very faint infuscate lines can be traced on the prothorax.

MYLLOCERUS SPECIOSUS, Blackb.

A species which appears to be common in North Queensland* agrees with the description of this insect. The dark vittæ of the prothorax are somewhat variable in shape and width, and the scales on the elytra of some specimens have a distinct golden gloss.

MYLLOCERUS LATICOLLIS, n.sp.

Dark reddish brown: appendages somewhat paler. Densely clothed with whitish-grey scales, on the upper surface obscurely mottled with brown; in addition with stout setose scales or setæ; dense on legs, dense and rather fine on antennæ, and subseriate in arrangement on elytra, on the latter they are but little elevated above the general level.

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* Cairns, Endeavour River, Cooktown, etc.

Head not impressed between eyes; these prominent and suboval. Rostrum short, broad, and slightly concave. Scrobes distant. Two basal joints of funicle subequal in length. *Prothorax* strongly transverse, sides strongly dilated to base; base strongly bisinuate and distinctly wider than elytra. *Scutellum* transverse. *Elytra* slightly dilated at shoulders, thence parallel-sided to near apex; striate-punctate. *Femora* feebly dentate. Length, 5½ mm.

Hab.—Queensland: Cairns (Henry Hacker).

The base of prothorax distinctly wider than the elytra will readily distinguish from all previously described species. On abrasion the prothorax is seen to be supplied with rather small, isolated punctures; those on the elytra are fairly large, round, and in distinct striæ, but before abrasion appear to be much smaller and narrowly oblong.

MYLLOCERUS ABUNDANS, n.sp.

Black, appendages in places obscurely diluted with red. Densely clothed with scales, usually more or less green in colour. In addition with numerous setæ, which on the elytra have a tendency to form in double rows on each interstice.

Head narrowly impressed between eyes; these oblong oval. Rostrum short, but rather narrow, slightly constricted in middle, feebly concave along middle. Scrobes deep, large, and approximating behind. Antennæ stout; scape grooved below; first joint of funicle as long as second and third, second as long as third and fourth, seventh slightly longer than sixth. *Prothorax* transverse, apex much narrower than base, and slightly incurved to middle; sides strongly rounded, base trisinuate, the median sinus small and the width of scutellum. *Scutellum* transverse. *Elytra* not much wider than and closely applied to prothorax; striate-punctate. *Femora* feebly dentate. Length, 6½ to 8½ mm.

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

Judging by the numerous specimens before me, the colour of the scales seems subject to alteration after death, either through improper treatment or through oily exudations. When alive the scales are probably of an uniform bright green, but in specimens before me there are patches, varying from single scales to large, irregular areas, in which the process of change appears to be as follows:—From bright green to golden green, then to bright golden, then to dull golden, and finally to ashy, in this stage all lustre having disappeared: the patches are never symmetrical (unless the whole of the scales are changed), but may be confined to one side, and appear in some instances to have been altered through contact with other insects in the bottle in which they were collected. I believe in other species of the subfamily the scales are also subject to alteration.

The elytral setæ are often indistinct, and (except to a slight extent posteriorly) do not rise above the general level, on the prothorax they are more distinct. The eyes are less prominent than in any other here recorded. The emargination of the apex of the prothorax, although of the same nature, is much less distinct than in *Bovilli*. In other species of the genus the scutellar lobe is probably emarginate, but the emargination masked. In the present species, however, it is sufficiently deep to prevent the scales entirely masking it. The scape is narrowly grooved throughout its entire lower surface, a most unusual character in any genus of weevils; there are, however, several of its congeners with traces of this feature. On abrasion, the punctures are seen to be as described in the preceding species, and the rostrum to have two fine costæ marking the inner boundaries of the scrobes.

Possibly close to *aurifex*, but differs from the description of that species in having the elytra without patches or spots of fawn, the rostrum longitudinally impressed (the impression, however, often concealed by scales), the eyes slightly oblong, elytra not much wider than base of prothorax, and the second abdominal segment (at least along middle) much shorter than the first; also in *aurifex* no mention is made of setæ. With the description of *glaucinus* it agrees fairly well, but it cannot be that species, as Pascoe tabulates it as having the "eyes round" and "form more slender," whilst the present species is the most robust of its genus I have seen.

MYLLOCERUS AMBLYRHINUS, n. sp.

Black, appendages reddish. Densely clothed with white (very lightly tinted with blue) scales, on the elytra obscurely variegated with small pale brown spots. In addition with short setæ, which on the elytra are curved and slightly elevated above the general level.

Head convex. Eyes suboval and very prominent. Rostrum very short, subquadrate, concave only at extreme apex. Scrobes distant. First joint of funicle not much longer than second. *Prothorax* strongly transverse, base moderately bisinuate and slightly narrower than apex; sides rounded. *Elytra* much wider than prothorax, striate-punctate. *Femora* minutely dentate. Length, $5\frac{1}{2}$ mm.

Hab.—N.W. Australia: Roebuck Bay (C. French).

The rostrum is unusually short, and the eyes are more prominent than usual. The femoral teeth are so small as to be invisible from most directions. On abrasion the prothoracic punctures are seen to be fairly large, and more numerous than in the two preceding species, but those on the elytra are much the same.

Evidently close to the description of *nasutus*, but smaller, prothorax slightly *narrower* at base than at apex, and with distinctly rounded sides, the elytra without rows of decumbent scales, although on each interstice there is a row of larger scales, but these are nowhere elevated above the others. From the description of *torridus* it differs in the first joint of the funicle slightly longer than the second and the base of its prothorax not very strongly bisinuate.

MYLLOCERUS SORDIDUS, n. sp.

Blackish-brown, appendages in places obscurely diluted with red. Densely clothed with white or whitish scales; on the upper surface largely mottled with rusty brown. In addition with numerous setæ, which on the elytra have a tendency to form in irregular r ws, and are distinctly elevated above the general level.

Head narrowly impressed between eyes; these suboval and not prominent. Rostrum not very short, feebly but regularly diminishing in width to apex, feebly concave. Scrobes rather distant. Antennæ fairly stout; apical half of scape feebly grooved beneath; first joint of funicle distinctly longer than second. *Prothorax* moderately transverse, apex feebly incurved to middle, sides rounded; base rather strongly bisinuate and not at all or but slightly wider than apex. *Elytra* considerably wider than prothorax, very feebly increasing in width to beyond the middle; striate-punctate. *Femora* edentate. Length, 5-6½ mm.

Hab.—Western Australia: Geraldton (A. M. Lea).

On abrasion the punctures of the prothorax are seen to be fairly large and rather numerous, with the minute intervening punctures* rather more distinct than usual.

MYLLOCERUS NIVEUS, n. sp.

Black, appendages reddish. Densely clothed with pure white scales. In addition with numerous stout setæ, which on the elytra are formed into irregular rows and slightly elevated above the general level.

Head narrowly impressed between eyes: these briefly elliptic and prominent. Rostrum not very short, diminishing in width from base but not to extreme apex, gently concave in front. Scrobes rather distant, distinct to eyes. Antennæ thin, all joints of funicle elongate, first slightly longer than second. *Prothorax* moderately transverse, sides rounded, extreme base slightly wider than apex, and srongly bisinuate. *Elytra* much wider than prothorax, parallel-sided to near apex; striate-punctate. *Femora* finely dentate. Length, 6-7½ mm.

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* These minute punctures are evidently for the scales, the larger ones being for the setæ: they are to be seen on all the species on abrasion, both on the prothorax and elytra.

Hab.—Queensland: Cooktown, Endeavour River (C. French).

On abrasion the punctures of the prothorax are seen to be rather large, those on the elytra (although before abrasion apparently no larger than in other species) are almost as wide as the interstices separating them.

Myllocerus elegans, n. sp.

Dark reddish-brown; appendages reddish. Densely clothed with pale-green, golden-green or rosy glistening scales. In addition with fine setæ, which on the elytra are formed into irregular rows, and scarcely rise above the general level. Length, 6 mm.

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

In structure much like the preceding species, but the eyes rather less prominent, the prothorax longer, more convex across middle, the sides more strongly rounded, and base not so strongly sinuous; the antennæ are stouter, and the first joint of the funicle is considerably longer than the second: the scales are greenish instead of dull, dead white, setæ denser, finer, and longer; the punctures (as seen after abrasion) are also larger and more irregular on the prothorax and smaller on the elytra. The setæ on the upper surface are unusually thin. It agrees fairly well with the description of *glaucinus*, but cannot be that species, which Pascoe placed in his table amongst those having "prothorax much broader at the base," whilst in the present species the base and apex are of equal width; *pudicus* (from Nicol Bay, practically the same as Roebourne) is briefly compared with *glaucinus*, and placed beside it in the table, so that it also cannot be the present species.

There are two specimens before me, one having the scales as described, the other having them almost entirely without gleam, and white, except that in places they are lightly tinged with green or gold: on this specimen the elytral setæ (although exactly as in the type) are much more distinct. The species, in fact, appears to be one in which the scales (as in *abundans*) are subject to alteration.

Myllocerus rugicollis, n. sp.

Reddish-brown, appendages paler. Densely clothed with pale, greyish scales, on the elytra very slightly (or not at all) variegated with small spots of pale brown. In addition with fairly stout setæ, but on the elytra these are very sparse and indistinct.

Head feebly convex, very narrowly impressed between eyes: these briefly elliptic and rather large. Rostrum subquadrate, feebly concave. Scrobes distant. Antennæ rather stout; scape grooved on its lower surface at apex; first joint of funicle slightly longer than second, the others all slightly transverse; club rather short. *Prothorax* moderately transverse, apex slightly wider than base, sides rounded, base not very strongly bisinuate. *Elytra* much wider than prothorax, widest at their middle; striate-punctate. *Femora* distinctly dentate. Length, 5-6¼ mm.

Hab.—Queensland: Brisbane (R. Illidge, T. McGregor, and E. J. Turner).

The prothorax has an elevated ridge across its middle, with a slight depression on each side behind it, the depressions being occasionally very distinct. On abrasion the punctures of both prothorax and elytra are seen to be almost exactly as in the preceding species, but the elytral interstices are narrower and more convex.

Close to the description of *modestus*, but all the femora distinctly dentate, instead of the front femora only (at least it is so implied), prothorax no wider at base than at apex and sides quite strongly rounded; for that species also no mention is made of the transverse prothoracic impressions so conspicuous in the present species.

There are two specimens before me from the Endeavour River, which I hesitate to regard as this species, although they have a strong general resemblance to it. They differ in having thinner antennæ, none of the joints of the funicle transverse, and in having the femoral dentition stronger: the transverse impressions on the prothorax are also absent.

Myllocerus echinatus, n. sp.

Dark reddish-brown, appendages (except club) somewhat paler. Very densely clothed with greyish or pale fawn-coloured scales. In addition with numerous stout setæ: long, erect, or suberect on the elytra, shorter on the prothorax and head, and still shorter on the appendages.

Head with the eyes briefly elliptic and rather large. Rostrum moderately long and concave. Scrobes subapproximate. Antennæ stout; first joint of funicle slightly shorter than second. *Prothorax* as long as wide, sides scarcely rounded, and very feebly increasing in width to base, base strongly bisinuate. *Elytra* much wider than prothorax, parallel-sided to near apex; striate-punctate. *Femora* edentate. Length, 4-4½ mm.

Hab.—North Queensland: (H. J. Carter), Cairns (E. Allen).

The elytral setæ or bristles are longer and stouter than in any other species known to me, each is directed at almost or quite a right angle with the derm in which it is set. From behind they can be seen to be in quite regular rows, of which the alternate ones are slightly higher than the others. On abrasion the punctures of the prothorax are seen to be very large (they are fully twice as large as those of any here recorded), close together, and rough; those on the elytra are large (but smaller than those on prothorax), with the interstices separating them narrow and rather strongly convex. The rostrum has two very strong costæ, which are almost or quite concealed by the clothing.

Myllocerus suturalis, n. sp.

Dark reddish-brown, elytra and appendages paler. Densely clothed with whitish scales; on the under surface slightly tinged with blue, on the upper surface largely (and to a variable extent) mottled with rusty brown. In addition with numerous stout setæ, which on the elytra become long and suberect.

Head almost flat, and with a small impression between eyes: these fairly large and briefly elliptic. Rostrum slightly longer than wide, slightly diminishing in width to apex, feebly concave. Scrobes distant. Antennæ rather thin; first joint of funicle slightly longer than second. *Prothorax* about as long as wide, apex just perceptibly incurved to middle, sides slightly rounded, base as wide as apex and feebly bisinuate. *Elytra* much wider than prothorax, almost parallel-sided to beyond the middle; striate-punctate. *Femora* finely but acutely dentate. Length, $3\frac{2}{3}$-$4\frac{2}{3}$ mm.

Hab.—Queensland: Gayndah (Australian Museum).

The white scales clothe the sides, and form a continuous line commencing between the antennæ and terminated at the tip of elytra, they usually clothe the shoulders and form spots (sometimes condensed into more or less oblique fasciæ) between the sides and suture. On several specimens, however, the white scales do not form a median line on the prothorax, and on the elytra no distinct spots or patches are defined. The elytral setæ are almost as long as in the preceding species, but are thinner and less erect, whilst those on the prothorax and head are quite normal. On abrasion the prothoracic punctures are seen to be fairly large and dense, those on the elytra are also fairly large and close together.

Although the base of the prothorax is almost truncate, I have referred this species to *Myllocerus*, despite Mr. Pascoe's contention that all such species should be excluded; to fall in line with Mr. Pascoe it would be necessary to propose a bewildering number of new and highly unstable genera. In general appearance, the present is close to several species of *Myllocerus*, closer still perhaps to several species of *Titinia*, but its dentate femora exclude it from that genus, from *Proxyrus* (also with dentate femora and base of prothorax subtruncate), its prothorax distinguishes it, from *Prosayrodes* it is distinguished by the scape passing the apex of the prothorax.

MYLLOCERUS TRILINEATUS, n. sp.

Dark reddish-brown; elytra and appendages paler. Densely clothed with scales; white on the lower surface, rusty-brown, variegated with dingy white on the upper. In addition with stout setæ, which on the elytra are arranged in regular rows, and scarcely rise above the general level. Length, male 5, female 7 mm.

Hab.—Queensland: Gayndah (Australian Museum).

Decidedly allied to the preceding species, and placed in *Myllocerus* for the same reasons: but differs in its feeble elytral setæ and in its larger size, the base of its prothorax is also slightly more sinuous: the rostrum slightly diminishes in width from base, but not to extreme apex, and is not concave, and the antennæ are rather thin. On abrasion the punctures are seen to be much the same, except that those on the prothorax are somewhat denser and coarser. In all other features of structure, however, the two species are almost identical.

The brown scales are almost absent from the head, form three feeble stripes of variable intensity on the prothorax (of which the median is always narrower than the others), and are condensed into numerous spots on the elytra, these spots (although never eye-like in character) frequently have their centres darker than their margins. I have two pairs pinned as having been taken *in cop.*, but except for the difference in size the sexes appear to be exactly alike.

MYLLOCERUS EXILIS, n. sp.

Brownish-red, appendages of a rather pale red. Densely clothed with white or greyish-white scales (slightly tinged with blue or not); prothorax with three very pale stripes of brown, elytra usually with very indistinct brownish spots. Setæ much as in the preceding species.

Head moderately convex; eyes briefly elliptic. Rostrum shorter than wide, feebly diminishing in width to apex. Scrobes moderately distant. First joint of funicle just perceptibly shorter than second; scape stouter in female than in male. *Prothorax* in male slightly longer than wide, in female very feebly transverse, sides feebly rounded, base the width of apex, and rather feebly bisinuate. *Elytra* much wider than prothorax, widest at about the middle; striate-punctate. *Femora* very feebly dentate. Length, $4\frac{1}{4}$-$5\frac{1}{2}$ mm.

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

A rather thin species; its clothing on the whole is much as in the preceding species, except that it is much paler (on only one specimen before me are the markings at all distinct), but the size of both sexes is distinctly less, and the prothorax is decidedly longer, and on abrasion the punctures are seen to be somewhat smaller and more regular.

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

Prothorax at base wider than elytra ... *laticollis*, n. sp.
Prothorax narrower than elytra.
  Prothorax at base much wider than at apex.
    Apex of prothorax strongly incurved ... *Bovilli*, Blackb.
    Apex of prothorax straight, or almost so.
      Clothing never green ... ... *cinerascens*, Pasc.
      Clothing more or less green.
        Prothorax with two irregular black vittæ ... ... *speciosus*, Blackb.
        Prothorax without vittæ. ... ... *abundans*, n. sp.
  Prothorax at base not at all or very little wider than at apex.
    Elytra with long setæ or bristles.
      Setæ on prothorax and head also long *echinatus*, n. sp.
      Setæ on prothorax and head normal ... *suturalis*, n. sp.
    Elytra never with long setæ.
      Clothing more or less green.
        Elytra wider at middle than at base *trepidus*, Pasc.
        Elytra parallel-sided to beyond the middle.
          Prothorax strongly rounded in middle ... ... *elegans*, n. sp.
          Prothorax at most moderately rounded in middle.
            Prothorax less than once and one half as wide as long ... *usitatus*, Lea.
            Prothorax at least once and one half as wide as long.
              Sutural interstice with distinct setæ throughout ... *carinatus*, Lea.
              Sutural interstice at most setose posteriorly ... ... { *Tatei*, Blackb. / *Darwini*, Blackb. }
      Clothing of upper surface not at all green.
        First joint of funicle shorter than second ... ... *exilis*, n. sp.
        First joint of funicle longer than second.
          Rostrum wider than long.
            Elytra wider at middle than at base ... ... *rugicollis*, n. sp.
            Elytra parallel-sided to beyond the middle ... ... *amblyrhinus*, n. sp.
          Rostrum longer than wide.
            Clothing pure white ... ... *niveus*, n. sp.
            Clothing more or less variegated.
              Narrowest part of rostrum its apex ... ... *sordidus*, n. sp.
              Narrowest part of rostrum before its apex ... ... *trilineatus*, n. sp.

Titinia.

As with many others of Mr. Pascoe's genera, there is really very little to distinguish this genus from *Myllocerus*, the sinuation at the base of the prothorax being practically one of degree only. I have referred but one new species to it, but several placed in *Myllocerus* might have been so referred, only that their femora are dentate, and this character (not that it is a very good one) I have regarded as a bar to the species belonging to *Titinia*.

Titinia eremita, Blackb., and bicolor, Blackb.

Specimens of both of these species were sent to me by Mr. Blackburn (his 469 and 3945); the two are very closely allied, but appear to be distinct on account of the first joint of the funicle being much longer than the second in *eremita* and not much longer in *bicolor;* in the former also there is a median whitish vitta on the prothorax, and that part is more parallel-sided.

In the table Mr. Blackburn supplies* he divides the genus into two sections:—

"A. Rostrum very narrow between the scrobes."

"AA. Rostrum but little narrowed between the scrobes."

These expressions are somewhat misleading, inasmuch as the width of the rostrum *between* the scrobes is much the same in both sections;† in "A," however, the rostrum itself is almost continuously narrowed from the base to the apex, but in "AA" it is narrowed from the base, and then increases in width to the apex. But the upper surface of the rostrum between the scrobes is greatly constricted in both sections.

Titinia ignaria, Pasc.
marmorata, Pasc.
læta, Blackb.

These names appear to appertain to but one species, *ignaria* having been described from a female with the markings but little pronounced; *marmorata* from a male (the male is always smaller than the female in this species, as in most, if not all, of the subfamily). *Ignaria* was described as having the "head (the rostrum presumably included) without any traces of lines or excavations"; *marmorata* as having "*capitis fronte rostroque in medio linea longitudinaliter impressa.*" This apparent difference, however, was probably due to the

* P.L.S.N.S.W., 1892, p. 121.

† At least in *læta, tenuis*, and *brevicollis* of A, and *bicolor* and *eremita* of AA; the appearance of this space, moreover, varies according to whether the scales have been abraded or not.

comparative freshness of the individuals, as when the head and rostrum are densely squamose no line can be seen, but when at all abraded a line can be traced.

The species is a variable and widely distributed one, and is common on various species of acacia. The elytra are sometimes almost entirely pallid, whilst in others they are very decidedly maculate; they always, however, have rows of semi-erect bristles. The prothorax is usually supplied with three infuscate lines, occasionally with but two (it was probably from a female of this form that Blackburn drew up his description of *læta)*, whilst a form is not at all uncommon in which the whole upper surface of the prothorax is clothed with infuscate scales. The size varies from $1\frac{1}{3}$ to 2 mm.

In this species (as in others of the subfamily) the apparent width and shape of the joints of the funicle differ according to whether they are free or clogged with gum, and fresh or abraded.

On one specimen before me the deciduous mandibular processes are present. They are strongly curved, not half the length of the head and rostrum combined, widest and obtusely dentate in the middle, and of a reddish colour.

The species is very close to *tenuis* and *brevicollis* (if these are really distinct), but differs in having the prothorax longer and the elytra with semi-erect bristles.

Hab.—Victoria: Grampians, Ararat, Melbourne; New South Wales: Blue Mountains, Springwood, Forest Reefs; Queensland: Brisbane.

Titinia parva, n. sp.

Black, appendages (except middle of femora) reddish. Densely clothed with dingy whitish and slaty-brown scales, and with sparse, stout setæ.

Head narrowly impressed in middle, the impression continued on to rostrum. Eyes large, almost round. Rostrum gradually narrowing to apex. Scrobes short, deep, and approximating behind. Scape strongly curved: first joint of funicle distinctly longer than second. *Prothorax* feebly transverse, base lightly bisinuate, sides lightly rounded in middle. *Elytra* subparallel on basal two-thirds, much wider than prothorax; striate-punctate. *Femora* edentate. Length, $2\frac{1}{2}$ mm.

Hab.—Victoria (National Museum).

The smallest of the subfamily as yet recorded from Australia. From *ignaria* it differs in being smaller, in the elytra having the setæ sparse, short, and scarcely (usually not at all) rising above the general level (instead of rather dense and sub-erect); the club also is reddish. The prothorax is distinctly longer than in *tenuis* and *brevicollis.*

The white scales in places (but especially on the under surface) are slightly tinged with green, but they are nowhere shining; they clothe the head (on one specimen there is a broad median patch of brown scales extending from the base to between the antennæ), rostrum, scutellum, under surface, and legs; form four lines on the prothorax (two median and two lateral), and are distributed in irregular patches on the elytra; on the latter they cover from one-fourth to one-half of the surface, on the prothorax they cover less than half. The setæ are rather numerous on the legs and antennæ, rather sparse on the prothorax, and very sparse on the elytra; they are nowhere dark in colour. The elytra to the eye appear almost seriate-punctate, the punctures being partially visible,* but the striæ very indistinct.

SYNOMUS ÆRUGINOSUS, n. sp.

Black, appendages reddish. Densely clothed with golden-green scales; abdomen and appendages with white scales (with an occasional golden gleam) and with white setæ. Elytra with long, stiff, upright, whitish bristles, prothorax with similar but shorter bristles, and still shorter ones on head.

Head large and very feebly convex. Eyes almost round. Rostrum slightly diminishing in width from base to apex, with a narrow, impressed line, which terminates posteriorly in a narrow, ocular fovea. First joint of funicle distinctly longer than second. *Prothorax* strongly transverse, base strongly bisinuate, sides lightly rounded. *Scutellum* minute. *Elytra* ovate, widest at about the middle, at base closely applied to and no wider than prothorax: striate punctate. *Femora* minutely dentate. Length, $4\frac{3}{4}$ mm.

Hab.—Queensland: Chillagoe (C. French).

On both specimens before me several obscure patches of greyish scales are to be seen on the prothorax and elytra, but these may be due to an oily exudation. The elytra appear to be rather finely striate only, but on abrasion fairly large punctures are exposed. The green scales will readily distinguish it from *cephalotes*.

The elytra at the base no wider than the prothorax † is practically the only character Pascoe gave as distinguishing *Synomus* from *Myllocerus*, but it appears to be a very good

* These are the only ones that are even partially visible, all the punctures on the prothorax and elsewhere being quite concealed.

† This is due to the narrowing of the elytra to the base, the prothorax being normal: in several species of *Myllocerus* the elytra at the base are no wider (in one species they are narrower) than the prothorax, but this is due to the hind margins of the prothorax being widened out to the base.

one, and, as in other genera having similar elytra, these are partially soldered together, and the wings are rudimentary.

HOMÆOTRACHELUS.

Although this genus* was referred by Faust to the *Tanymecides*, it appears to me to belong to the same subfamily as *Myllocerus*, despite its short scape: the side pieces of the meso- and meta-sternum to which (and with justice) so much importance was attached by Leconte, are identical in both genera, and, in fact, were the antennæ removed, there would be nothing to prevent the species of it being referred to *Myllocerus* itself.

HOMÆOTRACHELUS TRICARINATUS, n. sp.

Black, appendages reddish; apical sides of elytra obscurely diluted with red. Densely clothed with scales—white on the under surface and legs, greyish-white on upper surface; elytra and abdomen in addition with subsetose scales, but which do not (or but seldom) rise above the general level.

Head distinctly impressed between eyes; these large and suboval. Rostrum the length of head, sides parallel and almost vertical, sides and middle carinate, the median carina bifurcate in front, terminated posteriorly in ocular fovea.† Two basal joints of funicle of equal length, and combined slightly longer than scape. *Prothorax* moderately transverse, base not much wider than apex, sides moderately rounded. *Scutellum* subtriangular. *Elytra* much wider than prothorax, each strongly rounded at base, striate-punctate, the punctures large, subapproximate and subquadrate, but more or less concealed. *Femora* unarmed, the hind pair glabrous internally. Length, 6-6½ mm.

Hab.—Queensland: Port Denison (Macleay Museum).

The prothorax, although almost truncate at the base, appears to be rather strongly bisinuate; as in others of the genus the ocular lobes are absent, but their positions are marked by small patches of long yellowish setæ. The punctures are everywhere more or less concealed, but those on the head and prothorax are evidently rather coarse; those on the elytra appear to be large, oblong, and black, but when the scales have been abraded appear of different shape and

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* I cannot be mistaken as to its identification, as I have four specimens agreeing with the description of *H. australasiæ*, and one of which was sent to me with the name by the late Herr J. Faust himself.

† The expression "ocular fovea" refers to the impression which exists between the eyes in almost all weevils, and which appears to correspond with the clypeal suture of other beetles.

much larger. In general outline it approaches *Australasiæ*, but the clothing is more uniform, and the elytral punctures are larger.

SUB-FAMILY CRYPTORHYNCHIDES.

Lybæba acuticosta, n. sp.

Male. Red, club infuscate; base of rostrum, sterna, and abdomen black. Clothed with bright red, variegated with stramineous scales: on prothorax the paler scales form a short median and distinct lateral stripes, on the elytra they are condensed into numerous small spots, which become more or less fasciate in arrangement. Under surface with pale scales; head with red scales continued to near antennæ.

Eyes separated the width of rostrum at base. Rostrum long, moderately curved, thin, parallel-sided to antennæ, thence slightly (but noticeably) decreasing in width and depth to apex: rather strongly punctate, punctures behind antennæ partially concealed, but leaving three acute costæ. Scape inserted one-third from apex, shorter than funicle. *Prothorax* moderately transverse, apex more than half the width of base, with dense, partially-concealed punctures. *Scutellum* round and punctate. *Elytra* subcordate, each gently rounded at base, shoulders gently rounded; striate-punctate, punctures partially concealed: interstices regular, much wider than punctures. *Mesosternal* plate semi-circular, feebly depressed. Abdomen densely and shallowly punctate, third and fourth segments straight, their combined length more than that of second and much more than that of fifth. *Femora* acutely dentate. Length, 4; rostrum, $1\frac{1}{2}$; width, $2\frac{1}{6}$ mm.

Female differs in having the derm entirely red, the rostrum slightly longer, more noticeably curved, feebly punctate, shining, gently decreasing in width from base to apex and clothed only at base: the antennæ inserted less close to apex, and the eyes larger and less prominent.

Hab.—South Australia (Macleay Museum).

Allied to *majorina*, but the rostrum different in both sexes.

Melanterius impolitus, Lea.

I have to thank the Rev. T. Blackburn for calling my attention to a mistake made by me in regard to this species. In my table it is included amongst those having "interstices raised posteriorly," and in the description I say (quite correctly), "elytra nowhere ridged."

Melanterius costipennis, n. sp.

Piceous-black: head, legs, and rostrum piceous-red, antennæ and elytra somewhat paler. Clothed with moderately elongate scales, varying on different specimens from a stramineous yellow to an ochreous red; prothorax with a basal spot and two sublateral stripes; elytra with numerous distinct spots of scales, the interspaces with small and obscure sooty scales. Metasternal episterna each with a distinct row.

Head densely punctate; ocular fovea distinct; eyes ovate, separation less than width of rostrum at base. Rostrum feebly curved, sides very feebly incurved to middle; male densely and strongly punctate, punctures leaving five irregular ridges to antennæ; female less coarsely punctate, and with only the median ridge moderately distinct. Scape the length of funicle; in male inserted one-third from apex; in female two-fifths. *Prothorax* strongly transverse, densely punctate, punctures in places feebly confluent, with or without a feeble median line. *Scutellum* oblong-ovate. *Elytra* about once and one-third the width of and more than twice the length of prothorax; shoulders oblique; seriate-punctate, punctures suboblong, feebly connected; interstices much wider than punctures, the third, fifth, and seventh acutely raised, the ridges shining. *Mesosternal plate* moderately transverse, depressed, and feebly concave. Metasternum rather densely punctate, the episterna each with a single row of punctures. Abdomen with moderately large and shallow punctures on first segment, smaller and sparser on second, smaller and dense on fifth; third and fourth combined, slightly longer than second, each with a single row of punctures. *Legs* moderately long; femora rather strongly dentate; posterior tibiæ with punctures in feeble series. Length, 6 (vix.); rostrum, $1\frac{3}{4}$; width, 3; variation in length, $4\frac{1}{3}$-$6\frac{1}{2}$ mm.

Hab.—Tasmania: Launceston (A. Simson), Hobart (H. H. D. Griffith, in *Acacia* galls; A. M. Lea, under bark).

May be distinguished from all previously described species by the alternate interstices of the elytra being triangularly raised to the base, with the ridges shining; *floridus* has the alternate interstices raised, but not triangularly, nor are they shining; *aberrans* has somewhat similar interstices, but the ridges are not continued to the base, and the antennæ are very different; *vinosus* has all the interstices raised and the eyes widely separated.

Poropterus nodosus, n. sp.

Moderately densely clothed with greyish-brown and small but moderately long scales, becoming ochreous-brown on under surface, base of head and base of prothorax. Ciliation of ocular lobes very distinct, even with head in position.

Convex. *Head* with the ocular fovea rather large and deep; eyes finely faceted. Rostrum with moderately dense subseriate punctures. Funicle slightly longer than scape, first joint slightly longer than second. *Prothorax* slightly transverse, sides rounded, constriction continued across summit, across middle a series of four moderately large and very distinct tubercles, a subobsolete one on each side of apex; with rather numerous large, glossy granules; median line without granules, but with a feeble ridge anteriorly. *Scutellum* subtriangular, distinct *Elytra* ovate, about thrice the length and at widest about once and one-half the width of prothorax; interstices with numerous small and moderately large glossy granules, and with about five or six small tubercles on each side; each side at summit of posterior declivity with a large subconical tubercle; each side of apex with a moderately distinct one. *Abdomen* with second-fourth segments scarcely depressed, and at a glance appearing almost equal in length, but the second encroaches on the first. *Legs* long and rather thin; posterior femora extending to apex of elytra; third tarsal joint wide. Length, 15; rostrum, 4; width, 7 mm.

Hab.—Tasmania (type in Mr. A. Simson's collection).

A very distinct species, belonging to the *succisus* group. Each elytron has the third interstice subtuberculate at base, and with two moderately distinct tubercles between the base and the large tubercle, this is obsoletely granulate and outwardly directed.

POROPTERUS RHYTICEPHALUS, n. sp.

Rather sparsely clothed with small scales, each puncture containing a distinct scale; tubercles feebly setose.

Strongly convex, subcylindrical. *Head* and rostrum roughly punctate; eyes finely faceted; ocular fovea rather large. Antennæ black; funicle longer than scape, its second joint longer than first. *Prothorax* moderately transverse, sides rounded; constriction irregularly continuous across summit; with numerous granules; across middle a series of four large rounded punctate granules; with a distinct median carina, which terminates before base and apex. *Scutellum* subtriangular. *Elytra* oblong-ovate, not much wider than prothorax, and more than twice as long; with moderately large, round punctures, and with numerous subtubercular elevations; second interstice with two tubercles of moderate size; one near base round and slightly larger than those on prothorax, the other just beyond middle, suboblong, and smaller; each side near summit of posterior declivity with a large, obtusely conical tubercle; apex without tubercles. *Abdomen* with third and fourth segments depressed below second and just perceptibly below fifth. *Legs* moderately long and thin; posterior femora just passing elytra. Length, 9½; rostrum, 2½; width, 4 mm.

Hab.—Queensland (Australian Museum).

A very distinct species belonging to the *succisus* group. The (two) specimens under examination are probably partially abraded, but as the species is very distinct I have not hesitated to describe them. The seventh elytral interstice is moderately distinctly ridged in middle, so that it causes an appearance of a slight epipleural fold. Compared with *succisus* it differs in being considerably narrower, the elytra with less numerous tuberosities, the subapical tubercles larger and rounded and by the conjointly rounded apex.

Poropterus listroderes, n. sp.

Moderately densely clothed with stout brownish scales, prothorax with a very distinct complete border of paler scales, and which is continued on sides of elytra to apex, but decidedly incurved at basal third.

Flattened, subelliptic. *Head* flat; ocular fovea indistinct; eyes finely faceted. Rostrum rather short and stout, increasing in width to apex; muzzle moderately densely punctate. Funicle slightly longer than scape, second joint much longer than first. *Prothorax* flat, sides moderately round, strongly narrowed towards apex, apex feebly bifurcate. *Elytra* not much wider than prothorax, and scarcely twice as long; base strongly bisinuate; with series of large, shallow punctures, more regular on sides than on disc; the spaces between the punctures often tuberculiform, and with small, shining granules, second interstice near apex with a subconical tubercle, apex itself without tubercles. *Abdomen* with the third and fourth segments below level of second, but not of fifth. *Legs* moderately long; posterior femora extending to apex of elytra; third tarsal joint moderately wide. Length, 11; rostrum, $2\frac{1}{2}$; width, 5 mm.

Hab.—Queensland: Mount Dryander (A. Simson).

The very distinct pale lateral markings of the prothorax and elytra will readily distinguish this species; it belongs to the *exitiosus* group. The tubercles on the posterior declivity are rather small, and are indistinct when viewed from above, but they are very distinct from the sides.

Poropterus longipes, n. sp.

Moderately densely clothed with muddy-brown scales, interspersed (especially on legs) with rather long blackish setæ and with stouter scales, on the elytra these form a feeble fascicle on each side at summit of posterior declivity.

Strongly convex. *Head* with punctures concealed by clothing; ocular fovea moderately large; eyes finely faceted. Rostrum long, thin, moderately strongly curved; basal portion coarsely, elsewhere finely (very finely in female) punctate; with a feeble median ridge continued to near antennæ. Scape inserted two-fifths from apex of rostrum, almost the length of funicle; second joint of the latter almost twice the length of the first. *Prothorax* slightly transverse, subglobular; without punctures or tubercles. *Elytra* ovate-cordate, widest at about one-third from base, less than thrice the length of prothorax, without tubercles; with series of moderately large (large at sides) punctures, which are partially concealed by clothing. *Abdomen* with third and fourth segments not depressed, their combined length equal to that of second or fifth; without large punctures except for a curved row on intercoxal process, and which, around the coxæ, become compressed into a distinct groove. *Legs* unusually long and thin; posterior femora passing elytra; third tarsal joint wide. Length, $8\frac{1}{2}$; rostrum, $2\frac{3}{4}$; width, 4 mm.

Hab.—Queensland: Cairns (George Masters).

Belongs to the *varicosus* group, but is, nevertheless, a distinct species, and is not close to any known to me.

POROPTERUS CAVERNOSUS, n. sp.

Densely clothed with stout, suberect brownish scales almost uniform in size and colour throughout, except that on the legs they are feebly variegated; on the elytra they are most numerous on the alternate interstices, but even there are less dense than on the prothorax.

Strongly convex. Punctures of *head* and rostrum entirely concealed, but evidently very coarse; eyes coarsely faceted. Rostrum noticeably incurved to middle. Scape inserted almost in exact middle of rostrum, much shorter than funicle; second joint of the latter much longer than first, third joint almost as long as two following combined, none transverse. *Prothorax* as long as wide, or slightly longer than wide, sides rounded; densely and coarsely punctate, punctures entirely concealed. *Elytra* elliptic-ovate; decidedly raised above, scarcely twice the length of and once and one-half the width of prothorax; with nine series of large, regular foveiform punctures; the interstices narrow, not much wider than the transverse ridges between puncture and puncture. *Abdomen* without distinct punctures, third and fourth segments combined slightly shorter than second. *Legs* moderately long; posterior femora extending to apex of elytra; third tarsal joint moderately wide. Length, $6\frac{1}{4}$; rostrum, $1\frac{3}{4}$; width, 3 mm.

Hab.—Queensland: Cairns (Macleay Museum).

Belongs to the *varicosus* group, and with an outline somewhat similar to that of the preceding species; from which, however, it totally differs in the punctures and legs; of the described species it is perhaps closer to *crassicornis* than to any other, but is abundantly distinct from it on account of the absence of large abdominal punctures (one specimen has been abraded to make sure of this point), and by the different punctures of elytra.

POROPTERUS FOVEATUS, n. sp.

Densely clothed with ruddy brown scales, interspersed with numerous long suberect or erect spathulate scales, which are very numerous on legs, and even appear on the apex of the scape.

Strongly convex. Punctures of *head* and rostrum concealed, but evidently coarse. Scape inserted slightly nearer base than apex of rostrum, stout, subclavate, considerably shorter than funicle; the latter with the second joint very slightly (if at all) longer than first, third strongly, fourth-sixth moderately strongly, seventh feebly transverse. *Prothorax* and *elytra* much as in the preceding species, but the former with a feeble median ridge and much larger punctures, the latter with a feeble projection at base of third interstice, and with very much larger and less numerous punctures or foveæ. *Abdomen* with a few large punctures on the two basal and on the apical segments, third and fourth combined considerably shorter than second or fifth. *Legs* moderately stout; posterior femora terminated before apex of elytra: third tarsal joint moderately wide. Length, $5\frac{1}{2}$; rostrum, $1\frac{2}{3}$; width, $2\frac{1}{2}$ mm.

Hab.—New South Wales (J. Faust).

The shape is much the same as in the preceding species, but the elytral foveæ are almost twice as large as they are even in that species, and are very much larger than in any other member of the *varicosus* group. The brevity of the third joint of the funicle is very unusual. The eyes are very coarsely faceted.

POROPTERUS INUSITATUS, n. sp.

Sparsely clothed with small brown scales; prothorax with four fascicles transversely placed in middle, apex feebly bifurcate, each puncture with an elongate scale; elytra with the alternate interstices moderately densely clothed, the third with a feeble, dark fascia beyond middle, suture posteriorly with similar scales, but scarcely fasciculate. Under surface moderately densely, the legs, head, and rostrum densely squamose.

Strongly convex. *Head* and rostrum roughly punctate; eyes moderately coarsely faceted. Rostrum moderately long, noticeably increasing in width to apex. Scape inserted three-sevenths from apex, shorter than funicle; second joint of the latter considerably longer than first, the others slightly longer than wide. *Prothorax* as long as wide, sides rounded, constriction deep, and not quite continuous; with four tubercles transversely placed in middle, of which the two median only are moderately distinct; with rather large round punctures somewhat irregular in size and very irregularly distributed, but more numerous at base than elsewhere. *Elytra* ovate, moderately long, more than twice the length of prothorax, widest at basal third; with series of large punctures, becoming foveæ on sides and very small on posterior declivity; without distinct tubercles. *Abdomen* with a few large punctures (not foveate, however), on the two basal and the apical segments; third and fourth combined slightly shorter than second or fifth. *Legs* moderately long; posterior femora terminated before apex of elytra; third tarsal joint wide. Length, 8½; rostrum, 2¼; width, 4 (vix.), mm.

Hab.—E. Australia (Horace W. Brown).

Belongs to the *varicosus* group, from all the members of which it may be distinguished by the exposed and irregular prothoracic punctures. On a glance the clothing appears as if partially abraded, but I am convinced that the specimen described (which was taken at Orange, in New South Wales, or Rockhampton, in Queensland), is in perfect preservation.

Poropterus lissorhinus, n. sp.

Densely clothed with stout sooty and sooty-brown scales, rather paler on head and under surface than elsewhere; prothoracic scales stouter and less numerous than those on elytra; prothorax with six feeble fascicles; four across middle, and two at apex; elytra with eight moderately distinct fascicles (on the third and fifth interstices) forming two distinct transverse series; one near base and one at summit of posterior declivity.

Moderately convex, subelliptic. *Head* with punctures entirely concealed by clothing; eyes finely faceted. Rostrum long, thin, rather strongly convex; base and sides behind antennæ coarsely punctate; elsewhere shining and very sparsely and finely punctate. Scape inserted slightly nearer base than apex of rostrum, half the length of funicle and club combined; second joint of funicle slightly longer than first, the others transverse. *Prothorax* and *elytra* much as in *bituberculatus*, but the former without carina. *Abdomen* densely and regularly punctate, punctures indistinct, but each carrying a large scale; third and fourth segments combined slightly longer than second or fifth. *Legs* moderately long; posterior femora terminated before apex of abdomen; third tarsal joint wide. Length, 7; rostrum, 2½; width, 3¼ mm.

Hab.—New South Wales: Mount Kosciusko (J. J. Fletcher).

In appearance this species strongly resembles *bitubercu-latus*, and it is remarkable that the two should have exactly similar tubercles at the base of the elytra; the facets of the eye, however, are very much finer (less than half the size) than in that species, and forbid its being regarded as a variety. Many of the prothoracic and abdominal scales appear to be conical in shape.

Poropterus rubus, Pasc.

Two specimens, from Cairns, appear to represent a variety of this species. They differ from typical specimens in having the clothing longer and denser, the apex of the elytra very obtusely mucronate, and all the tubercles more obtuse; of the sutural tubercles the second is almost obsolete, being transformed into a feeble ridge.

Decilaus apicatus, n. sp.

Densely clothed with large soft scales, varying from a dingy white to sooty brown, and causing the upper surface to appear speckled. Under surface with longer dingy-whitish scales; pectoral canal densely squamose.

Head indistinctly but evidently coarsely punctate. Rostrum stout; coarsely punctate, punctures irregular in front of antennæ, behind them evidently in seven rows, the lateral row very distinct. Scape stout, almost the length of funicle, inserted close to apex. *Prothorax* (by measurement) slightly longer than wide, with moderately large, round, shallow punctures, which are entirely concealed. *Elytra* oblong-cordate, scarcely twice the length of prothorax, striate-punctate, both striæ and punctures entirely concealed, punctures moderately large, but not as wide as interstices, these flat and punctate. *Abdomen* with the punctures almost entirely concealed. Anterior *tibiæ* at apex with a glabrous, outwardly rounded, and obliquely flattened plate, from which the terminal hook proceeds. Length, 5; rostrum, $1\frac{1}{6}$; width, $2\frac{1}{2}$ mm.

Hab.—South Australia: Eyre's Peninsula (Rev. T. Blackburn, No. 1492).

The anterior tibiæ are very peculiar. The margins of the elytra in the vicinity of the abdomen are perfectly glabrous in the (two) specimens under examination, this character being invisible from above; it does not appear to be due to abrasion. Each puncture of the rostrum behind the antennæ contains a large scale, which entirely conceals it, but as the scales can be traced in seven rows the punctures are probably also in rows.

Decilaus squamipennis, n. sp.

Prothorax with three feeble whitish lines, each puncture containing a scale, the majority of which are dingy brown, and do not rise to the general level: elytra densely clothed with soft pale brownish scales and with paler scales, giving the surface a slightly speckled appearance. Under surface and legs with brownish-grey scales: head (except between eyes), rostrum, and pectoral canal sparsely squamose.

Head transversely impressed, and with coarse punctures between eyes, with smaller (but not fine) and almost regular punctures elsewhere. Rostrum moderately long; not very coarsely punctate, punctures forming four distinct rows. Scape inserted two-fifths from apex, much shorter than funicle. *Prothorax* transverse, with dense, moderately large, round, clearly cut punctures, which are larger on flanks and smaller on apex than elsewhere; with or without a feeble median line. *Elytra* subcordate, outline almost continuous with that of prothorax; striate-punctate, punctures moderately large, subquadrate, only partially concealed; interstices feebly convex, much wider than punctures, themselves rather densely punctate. Two basal segments of *abdomen*, with punctures which are but little smaller than those on prothorax. Anterior *femora* feebly dentate. Length, 4: rostrum, $1\frac{1}{6}$: width, 2 mm.

Hab.—Australia (J. Faust): Queensland. Gayndah (Macleay and Australian Museums).

The dentition of the femora is more of the nature of a slight lateral extension of the ridge bordering the groove (as in *moluris*), rather than distinct teeth. The difference in the clothing of the prothorax and elytra is very pronounced. Six specimens have a distinct transverse whitish spot on each side of elytra at summit of posterior declivity, on a seventh these spots are continued (running parallel with suture) almost to apex, on an eighth they are not traceable.

Decilaus cuniculosus, n. sp.

Clothed with greyish-white scales, on the prothorax long and setose, and each arising from a puncture, on the elytra softer, and rounded and densely clothing the interstices, each puncture with a thin, indistinct scale. Under surface and legs with moderately elongate, almost white scales; metasternum with very thin setose scales; pectoral canal moderately squamose; head and rostrum with similar scales to those on elytra.

Head coarsely and irregularly punctate. Rostrum moderately stout, coarsely punctate, punctures more or less seriate in arrangement, and leaving a distinct impressed median space. Scape inserted two-fifths from apex, the length of the four following joints; of these the first is longer than the second. *Prothorax* moderately transverse, with dense, coarse, round punctures. *Elytra* subcordate, seriate-punctate, punctures moderately large, oblong or suboblong, sometimes with slightly wrinkled walls; interstices not separately convex, much wider (at base not much wider) than punctures. *Abdomen* irregularly punctate, the punctures of the two basal segments never very large, and not very dense, a few larger than the others on second; third and fourth each with a single row of squamose punctures. Length, 5; rostrum, $1\frac{1}{2}$; width, $2\frac{1}{2}$ mm.

Hab.—South Australia (Rev. T. Blackburn, No. 1493).

The prothoracic punctures are fully as large as in *foraminosus*, but those on the elytra are very much smaller than in that species. The clothing of the under surface shows a slight approach to that of *auricomus* and *tibialis*. Mr. Blackburn informed me that the specimens described were probably taken near Adelaide.

Decilaus irrasus, n. sp.

Sparsely and irregularly clothed with brown and whitish scales, forming in places indistinct spots. Sterna and basal segments of abdomen with elongate whitish scales; pectoral canal almost glabrous.

Head densely and coarsely punctate. Rostrum moderately stout, sides feebly incurved to middle; coarsely punctate, punctures subseriate in arrangement between antennæ and base. Scape inserted three-sevenths from apex, the length of five following joints; of these the first is noticeably longer than the second. *Prothorax* moderately transverse, basal two-thirds almost parallel sided, with rather large, round, clearly-cut punctures, which become smaller towards apex. *Elytra* oblong-cordate, base almost truncate; seriate-punctate, punctures moderately large, deep, oblong, or suboblong; interstices not separately convex, narrower than punctures and rather coarsely punctate. *Abdomen* with the two basal and the apical segment irregularly but not densely punctate; some of the punctures rather large. Length, $3\frac{1}{4}$; rostrum, $1\frac{1}{6}$; width, $1\frac{5}{6}$ mm.

Hab.—Queensland (Australian Museum).

The prothoracic punctures are about the size that they are in *distans*, but those on the elytra are considerably larger.

Decilaus auricomus, n. sp.

Clothed with pale fawn-coloured and whitish scales; prothorax with three feeble lines of rather stout elongate scales; elytra not very densely clothed with soft, almost round scales, a few of which are of an almost pearly whiteness. Middle of metasternum and two basal segments of abdomen and the four posterior coxæ with long, slightly curved, golden setæ or hair: pectoral canal almost glabrous; legs and head densely clothed, the scales feebly variegated.

Head and rostrum coarsely and irregularly punctate, punctures on the latter scarcely seriate in arrangement, but leaving a feeble, longitudinal, impunctate space. Scape inserted two-fifths from apex, slightly shorter than funicle. *Prothorax* moderately transverse, with dense, moderately large, round, clearly defined punctures, which are scarcely smaller at apex and larger on flanks than on disc. *Elytra* subcordate; seriate-punctate, punctures large, oblong, all connected together; interstices gently convex, the width of or slightly wider than punctures, with sparse punctures. *Abdomen* with dense and irregular punctures, none of which is very large, third and fourth segments each with a single row of squamose punctures. Length, $4\frac{1}{2}$; rostrum, $1\frac{1}{3}$; width, $2\frac{1}{4}$ mm.

Hab.—New South Wales: Sydney (at roots of beach-growing plants).

The clothing of the under surface is most remarkable, and, except in the following species, is dissimilar to that of any other; two specimens are under examination, and are probably both males. The colour of the derm is of a brownish-red, the elytra and legs rather less dark than elsewhere. Each prothoracic puncture contains a scale, but along middle and towards sides these scales are stouter and paler than elsewhere, and cause three feeble stripes to appear. The elytral punctures cause an appearance as of deep, continuous striæ, the walls of which are slightly waved. I know of no other species having similar punctures, although there is a slight approach to them in *spissus*.

Decilaus tibialis, n. sp.

Male. Upper surface moderately densely clothed with stout, sooty scales, interspersed with small spots of pale brownish scales. Under surface, legs, head, and rostrum with pale brownish scales, the legs feebly ringed with sooty ones; middle of metasternum and two basal segments of abdomen, and the four posterior coxæ clothed with very long recurved golden setæ or hairs.

Punctures of *head* and rostrum (except in front of antennæ, where they are moderately dense and coarse) concealed, on the latter evidently subseriate in arrangement. Scape inserted one-third from apex, the length of four following joints, two basal subequal; club elongate-ovate. *Prothorax* moderately transverse, base feebly but distinctly bisinuate, apex less than half the width of base; with (for the genus) rather small punctures, less crowded than usual, but entirely concealed (except at sides); an impunctate and slightly depressed median line. *Elytra* cordate, shoulders slightly prominent; seriate-punctate, punctures large and deep; interstices feebly convex, not at all or very slightly wider than punctures, themselves with small and rather numerous, but entirely concealed, punctures. *Abdomen* with punctures entirely concealed, but evidently dense and not very large. Terminal hook of posterior *tibiæ* strongly incurved and outwardly dentate. Length, 7; rostrum, $1\frac{1}{5}$; width, 4 (vix.); variation in length, $6\frac{1}{2}$-$7\frac{1}{3}$ mm.

Female. Differs in being entirely without golden hair on the under surface, the terminal hook of the posterior tibiæ simple, the rostrum squamose only at base, and antennæ inserted more distant from apex of rostrum.

Hab.—New South Wales: Armidale (D. McDonald and A. M. Lea); Tamworth (Lea).

A much less convex species than usual, the male with very remarkable clothing and posterior tibiæ. I believe the species belongs to *Decilaus*, the clothing of the under surface is almost exactly the same as in *auricomus*, an undoubted *Decilaus*. Many of the elytral punctures have a slightly triangular appearance, others are more or less rounded or ovate, each is isolated by a distinct transverse ridge, which is just below the level of the interstice, but which is more or less concealed by the clothing.

Decilaus spissus, n. sp.

Very densely clothed with soft, pale, dirty, fawn-coloured scales, which are larger and more rounded on prothorax and abdomen than elsewhere. Head and rostrum very densely clothed; pectoral canal with a few elongate scales.

Punctures of *head* and rostrum entirely concealed, but those on the latter evidently seriate in arrangement. Rostrum wider at base than apex, and much wider than between antennæ. Scape stout, inserted nearer base than apex, the length of two following joints; these subequal in length. *Prothorax* rather strongly transverse, sides not suddenly narrowed towards apex; with dense, large, round, clearly-cut punctures, which are partially concealed. *Elytra* oblong-cordate, more than twice the length of prothorax; striate-punctate, punctures rather large, subcontiguous; interstices convex, much wider than punctures, fourth widest of all. Two basal segments of abdomen with exactly similar punctures to those on prothorax. Length, 5; rostrum, $1\frac{2}{3}$; width, $2\frac{1}{2}$ mm.

The clothing is so dense that, except where abraded, the sculpture can scarcely be seen.

Hab.—South Australia (Macleay Museum).

DECILAUS NOCTIVAGUS, n. sp.

Black, antennæ and tarsi dull red. Very densely clothed with muddy brown scales, with stouter, suberect, and darker scales, rather thickly distributed, and forming feeble loose fascicles.

Head and rostrum with coarse but concealed punctures, those of the latter evidently in rows. *Rostrum* stout, the length of prothorax. Scape stout, inserted two-fifths from apex of rostrum, the length of five basal joints of funicle. *Prothorax* transverse, sides rounded; with dense but entirely concealed punctures. *Elytra* briefly subovate, not twice the length of prothorax; striate-punctate, punctures large, but entirely concealed, striæ traceable through clothing. *Abdomen* with rather dense and large but entirely concealed punctures. Length, $2\frac{3}{4}$; rostrum, $\frac{3}{5}$; width, $1\frac{2}{5}$ mm.

Hab.—New South Wales: Forest Reefs (A. M. Lea).

With the exception of *hispidus*, the smallest of the genus. I could only take it (at dusk and night time) crawling over old "cockatoo" fences, but it was rather numerous on them. The surrounding "post-and-rail" fences (although numerous other weevils were to be obtained on them at the same time) never seemed to attract specimens of this species.

A specimen from Victoria (Rev. T. Blackburn) differs in having the clothing more uniform in size and each individual scale traceable and larger. The general colour is a rather pale fawn, but with darker patches, the abdomen is sparsely clothed, and the femora are distinctly ringed. It probably represents a distinct species, or at least a very distinct variety, as I cannot find the least variation in the clothing of eighteen specimens of the typical form.

DECILAUS CORYSSOPUS, n. sp

Black, antennæ (club infuscate), and tarsi dull red. Densely clothed with dark, muddy-grey, thickly interspersed with sooty, erect scales; an obscure patch of paler scales on each side of elytra at basal third, and which is sometimes continued on to shoulder. Scales of under surface, both of body and legs, of a rather dark brown.

Punctures of *head* and basal third of rostrum entirely concealed; apical two-thirds of rostrum shining, and with round and moderately coarse punctures, not at all seriate in arrangement. Scape inserted nearer base than apex, the length of two basal joints of funicle; of these the second is slightly longer than the first. *Prothorax* distinctly transverse, sides strongly rounded: with dense, moderately large, round, clearly-cut punctures, which, however, are almost concealed by the clothing. *Elytra* subcordate, widest about middle;

striate-punctate, punctures moderately large, but almost concealed; interstices slightly rough, gently convex, much wider than punctures. *Abdomen* with dense round punctures. Anterior *femora* distinctly, the four posterior rather feebly, dentate. Length, 5; rostrum, $1\frac{1}{2}$; width, $2\frac{1}{2}$; variation in length, $4\frac{1}{2}$-$5\frac{1}{2}$ mm.

Hab.—Tasmania: Hobart (H. H. D. Griffith and A. M. Lea).

The tooth on each of the anterior femora is triangular, compressed, and distinct, although not large; it is, however, of the same character as that of *moluris*.

A specimen (also from Hobart) differs in having the scales of a pale fawn, interspersed with sooty brown, and a few whitish ones; the elytra have sooty suberect scales scattered about, and in places forming feeble spots, but forming a moderately distinct fascia across middle and a distinct spot on third interstice at base; the clothing of the under surface and legs is of a uniform fawn.

Decilaus ovatus, n. sp.

Dark brown, antennæ (club excepted) and claw joints paler. Densely clothed with stout adpressed scales of various shades of grey, and stouter on prothorax (where three or five paler lines are sometimes traceable) than on elytra.

Head with dense concealed punctures. Rostrum rather strongly curved, comparatively (for the genus) thin, sides lightly incurved to middle; basal half with coarse punctures subseriate in arrangement, apical half with moderately large punctures. Scape inserted almost in exact middle of rostrum, the length of three basal joints of funicle; of these the first is slightly longer than the second. *Prothorax* rather strongly transverse; with dense and rather large, round, clearly-cut punctures, which, however, are almost concealed. *Elytra* not twice the length of and outline subcontinuous with that of prothorax; punctate-striate, punctures separated by feeble ridges, and becoming very small posteriorly, but everywhere concealed; interstices convex, punctate, considerably wider than striæ. *Under surface* with dense and large, but almost entirely concealed, punctures. *Femora* slightly but acutely dentate. Length, 5; rostrum, $1\frac{1}{3}$; width, $2\frac{3}{4}$; variation in length, $3\frac{3}{4}$-$5\frac{1}{2}$ mm.

Hab.—Queensland: Cooktown (J. Faust).

The dentition of the femora associates this species with *moluris* and *corysopus*, from both of which it may be readily distinguished by the clothing; in general appearance it approaches *litoralis*. The rostrum is unusually thin for *Decilaus*. In one specimen (probably immature) under examination, the whole of the derm is red, the rostrum and elytral suture being reddish-brown.

Insects Collected in the North-Western Region of South Australia Proper by H. Basedow; with Descriptions of New Species of Mantidæ and Phasmidæ.—No. 2.

By J. G. O. Tepper, F.L.S., F.S.Sc., etc.

[Read October 3, 1905.]

The insects were collected incidentally during the progress of an expedition fitted out to examine the mineralogical, geological, and economic conditions of this hitherto little visited part of the State, and was engaged in that work from March to November, 1903. The Coleoptera were principally identified by the Rev. Thomas Blackburn, and the Lepidoptera by Mr. O. Lower, the author being responsible for the remainder. The collector, not having much time or adequate facilities at disposal, accounts for the comparative meagreness and not quite satisfactory state of the specimens in some cases. The latter, however, were often supplemented by such obtained previously from neighbouring regions. As it is, the collection, as the first made there, is of some importance in respect of geographical distribution, filling up a considerable gap, and has been deposited by the collector in the South Australian Public Museum.

The present list only comprises the Orthoptera, with supplementary descriptions of new species, in addition to previously published ones, and accounts for the greater part of the collection, as shown by the appended synopsis. The rest of the collection embraces the following identified species:—Hymenoptera—*Chrysis*, sp., *Camponotus testaceipes* (Smith), *Iridomyrmex glaber* (Sm.), *Bothroponera piliventris* (Sm.), *Myrmecia sanguinea* (Sauss), *Mutilla rugicollis* (Sauss), *Eumenes bicincta* (Sauss), *Megachyle Blackburni* (Frogg.), *Saropoda bambiformis* (Sm.). Odonata—*Hemianax papuensis* (Burm.), and *Lestes*, sp. The remainder of these contain species not previously represented in the Museum.

General Synopsis.

Coleoptera	57	genera,	87	species,	211	specimens
Lepidoptera ...	31	,,	39	,,	108	,,
Hymenoptera ...	13	,,	20	,,	31	,,
Orthoptera ...	27	,,	37	,,	67	,,
Odonata and Neuroptera	6	,,	6	,,	11	,,
Hemiptera ...	7	,,	15	,,	21	,,
Diptera	2	,,	2	,,	2	,,
	143	,,	206	,,	451	,,

ORTHOPTERA.

Blattariæ.

Epilampra aspera, Tepper.
Epilampra notabilis (Walk.), Tepper.
Periplaneta basedowi, Tepper.
Pseudepilampra punctata, Tepper, Musgrave Ranges.
Oniscosoma castanea, Brunner.

Mantidæ.

Orthodera marginata, Saussure.
Orthodera prasina, Saussure. (Also an egg-case.)
Pseudomantis pulchellus, Tepper.

Fischeria quinquelobata, *spec. nov.*

Male and female. Resembling *Archimantis latistylus*, Brunner, in general aspect. Greyish-brown. Head much compressed. Eyes large, prominent. Antennæ very slender. Tips of mandibles black. Pronotum oval, minutely tuberculate, margins minutely spinulate, spines alternately black and pale. Meso- and metanotum glabrous, unarmed. Forelegs stout, *coxæ with the strong, external ridge provided with four large lobes and one small one, mucronate, and black underneath;* internal ridge minutely serrate. Fore femora with four spines preceding a fifth much longer one externally; internal ridge with numerous sub-equal spines. Middle and hind legs slender, latter long, unarmed. Tegmina much longer and wider than the wings, greyish; veins dark brown; two black, sub-rotundate spots at and before middle respectively; anal area pale. Wings about half the size of the former; all veins and veinlets of the costal area dark brown (similar to tegmina). Cerci broadly oar-shaped, apex subobtuse.

Length of body, 92-107 mm.; width, 5-9 mm.
Length of head, 2-3 mm.; width, 9-10 mm.
Length of pronotum (base), 7-8 mm.; width, 4-5 mm.
Length of mesonotum (max.), 32-37 mm.; width, 4-6 mm.
Length of metanotum, 5-7 mm.; width, 5-7 mm.
Length of abdomen, 45-52 mm.; width, 6-9 mm.
Length of ant. coxæ, 16-20 mm.
Length of ant. femora, 20-25 mm.
Length of ant. tibiæ, 8-10 mm.
Length of ant. tarsi, 10-13 mm.
Length of med. femora, 20-23 mm.
Length of med. tibiæ, 20-24 mm.
Length of med. tarsi, 12-14 mm.

Length of post. femora, 25-32 mm.
Length of post. tibiæ, 32-38 mm.
Length of post. tarsi, 12-14 mm.
Length of cerci, 9-10 mm.
Length of tegmina, 24-34 mm.
Length of wings, 13-20 mm.
Length of antennæ, 16-20 mm.

The male is similar to the female, only smaller. Besides the specimens from the North-West, there are three others in the Museum collection, viz.:—One, since 1887, from Yactoo, Far North (M. Crawford); another from Broken Hill, in 1890 (F. J. Burgess); and a third from Central Australia (R. Helms); and are comprised in the above measurements and description.

PHASMIDÆ.

Lonchodes caurus, *spec. nov.*

Male. Brownish-grey, glabrous, with more or less distinct black, or blackish, median line or markings dorsally from transverse carina at back of head to fifth abdominal segment. Head a little longer than pronotum, tumid behind antennæ, with a raised flat spot in place of the obsolete central ocellus, and two short divergent ridges lateral thereof. Eyes elliptical, small, scarcely prominent. Antennæ grey, triquetrous (terminal portion wanting). Pronotum rotundately arched above, median line slightly, lateral carina more deeply impressed, transverse carina a little anterior to middle, hind margin narrowly black. Mesonotum slightly wider than head, sides parallel throughout, median line raised, dorsum along the middle with numerous blackish, irregularly scattered dots; lateral carina rather broad, extending for three-fourths of length, brown, externally to same a blackish line extending to hind margin, and forming the crest of a low, broad ridge. Metanotum of same width, or only slightly wider, as the preceding, and of similar structure, but darker brown, and the aggregated dots forming a broad dark median stripe. Abdomen with segments, 1 to 3 subequal and of same width as thorax, 4 to 6 somewhat narrower, and much longer, tapering, next three still more slender, short (two subequal, the third scarcely more than half the length of the preceding), last joint with supra-anal lamina very short, latter with closely adpressed edges, forming a ridge, subacute, and longer than preceding segment. Subgenital lamina boat-shaped, last joint finely rugose, apex ovate, whitish. Cerci very short, concealed. Legs comparatively short and weak, unarmed, scabrous, grey.

Length of body, 70 mm.; width do., 1·5-3 mm.
Length of head, 4·5 mm.
Length of pronotum, 3·5 mm.
Length of mesonotum, 17 mm.
Length of metanotum, 11 mm.
Length of abdomen, 35 mm.
Length of ant. femora, 17 mm.
Length of ant. tibiæ, 16 mm.
Length of med. femora, 14 mm.
Length of med. tibiæ, 16 mm.
Length of post. femora, 20 mm.
Length of post. tibiæ, 16 mm.
Length of tarsi, 3·5 mm.

This species appears to approximate in general form to *Lonchodes Confucius*, Westwood, in general form, but differs from it in being much smaller and differently coloured, while also disagreeing in most of the minute characters. The specimen is fairly perfect, excepting the antennæ, of which only some 12 or 13 of the basal joints are preserved.

Cyphocrania cornuta, *spec. nov.*

Female. Body hoary grey to whitish, or brownish, where discoloured. Head with two thick, acuminate, rugose horns, almost vertical, and subparallel, and with several rows of tubercles. Tegmina small, with brown veins and veinlets. Wings perfect, but too small for flight; costal area with base pale, and adjoining a large black spot, remainder with ill-defined pale and dark bars and blotches; membranous portion deep black, with about five narrow, more or less irregular and disrupted transverse pale bars and some small isolated spots near the external margin. Pronotum tuberculate, furrowed, and ridged. Anterior femora stout, acutely triquetrous, the superior ridge with *four subequal, broad, forward-directed serrations*, terminating in acute spinelets. Mesonotum finely tuberculate in front and behind, with some scattered spinelets (two larger than the rest), on the disc. Median femora with eight spinelets along inferior internal ridge, and one near the middle of the external; internal ridge of median tibiæ with three triangular spines, and one on the external near the joint, besides the terminal spurs. Hind femora with larger spines along the central line beneath, five small spines along the inner lower ridge, and four minute ones on the external. Abdomen stout, cylindrical to fifth segment, but gradually contracted beyond. Posterior margin of fourth segment *with four short ridges*, the outer ones convergent, and the margin between them extended into a *foliate quadrilateral appendage* with rugose edges, and double mid-rib, 4 mm. long. Subgenital lamina much exceeding the next two segments in length (24 mm.), apex broad, subemarginate. Cerci very short, scarcely exceeding anal segment. Under side of abdomen with a double row of tubercles to sixth segment, 6 to 8 on each segment.

Length of body, 172 mm.
Length of head, 10 mm.; width, 7 mm.
Length of pronotum, 8 mm.; width, 6·5 mm.
Length of mesonotum, 38 mm.; width, 6·5 mm.
Length of metanotum, 15 mm.; width, 8 mm.
Length of abdomen, 103 mm.; width, 9 mm.
Length of tegmina, 22 mm.; width, 6 mm.
Length of wings, 47 mm.; width, 47 mm.
Length of ant. femora, 34 mm.
Length of ant. tibiæ, 33 mm.
Length of ant. tarsi, 11 mm.
Length of med. femora, 27 mm.
Length of med. tibiæ, 30 mm.
Length of med. tarsi, 8 mm.
Length of post. femora, 46 mm.
Length of post. tibiæ, 42 mm.
Length of post. tarsi, 10 mm.
Length of antennæ, 35 mm.

The described female is the only specimen in the S.A. Museum collection which possesses both the conspicuous cephalic and the dorsal abdominal appendages denoted, nor have I come across figures or descriptions indicating these in the form mentioned—besides other distinctions. There are, however, one or two other Central Australian species represented, which exhibit similar form and wing structure of the females. There is also in the collection a male with prominent cephalic horns, which may belong to the same species as the described female, although the horns differ in form, being very divergent and compressed laterally. There are also several other males with small tubercular spines on the head, but these appear to belong to the hornless females referred to above. The colour pattern of their ample wings is quite different from that of the described form, but the detailed descriptions, etc., have to be postponed for the present.

Acrophylla nubilosa, *spec. nov.*

Male. Pale brown; body very slender. Head glabrous; flat, with indistinct, whitish dots and lines above. Occiput with two median depressions, and curved impressed furrows on each side. Ocelli obsolete. Antennæ densely hirsute. Pronotum much shorter and narrower than the head, with some longitudinal furrows, terminated by a transverse carina near hind margin. Mesonotum cylindrical, gradually tapering to near base of elytra, then rapidly expanding to more than double between median legs, thickly beset with many small interspersed and some large spines. Metanotum stout, glabrous, with three pairs of short, oblique, white streaks underneath. Legs very long and slender, all ridges with small, distant spinelets, except those of the anterior tibiæ and of the tarsi. Tegmina short and narrow, costa and a short, oblique, discal streak whitish, remainder brown. Wings long and rather narrow; costa with some small dark spots from near middle to apex; veins and veinlets from pale to dark brown, some of the former interruptedly black towards margin; veinlets bordered with blackish-brown; outer margin broadly suffused with dull blackish, likewise the costal part of the membranous disc, with irregular blotches, the dark markings separated by translucent areas. Abdomen very slender throughout; sexual organs, including respective joint and lamina, also anal joints, very short and tumid. Cerci broad, ovate, subacute, nearly as long as the preceding three joints together.

Total length of body, exclusive of cerci, 86 mm.
Length of head, 5 mm.; width, 3 mm. (behind eyes).
Length of pronotum, 3 mm.; width, 2·3 mm.
Length of mesonotum, 15 mm.; width, 1·5-4 mm.
Length of metanotum, 13 mm.; width, 4 mm.
Length of abdomen, 50 mm.; width, 1·5-2·5 mm.
Length of ant. pedes, 61 mm.
Length of med. pedes, 44 mm.
Length of post. pedes, 62 mm.
Length of tegmina, 10 mm.; width, 4 mm.
Length of wings, 52 mm.; width, 22 mm.
Length of cerci, 8 mm.

The species is comparable with *Acrophylla tesselata*, G.R.G., from N. Australia (Westwood, Cat. Phasm. B.M., Plate xxxv., fig. 1), but is larger, and differs in the paucity of the spinulation of the legs, colouration of the wings, etc. There are a pair of similar insects in the collection from Central Australia, but appear to differ in proportions.

Acrophylla paula, *spec. nov.*

Male. Brown; in general aspect resembling the preceding, except size and wing form, in which it approximates *A. tesselata*, Westwood. Head flat, occiput, with anterior median depression (obsolete ocellus) much larger and deeper than in preceding, and other markings different. Antennæ long, slender, 16 (?) jointed, minutely hairy. Pronotum with transverse furrow in the middle. Mesonotum and metanotum similar to preceding; also abdomen. Tegmina reddish-brown, costa not whitish, but a whitish, oblique streak indicated; apex rounded. Wings rather short, obtusely rounded; costal area reddish-brown, with indistinct dark markings along the costal margin: membranous area almost colourless; veins alternately pale and dark; veinlets narrowly bordered with blackish, but no other spots or blotches present. Legs long and slender, with minute, distant spinelets along the ridges of femora and tibiæ.

Length of body without cerci, 73 mm.
Length of head, 4 mm.; width, 2·5 mm.
Length of antennæ, 22 mm.
Length of pronotum, 3 mm.; width, 2 mm.
Length of mesonotum, 10 mm.; width, 1·5 mm.
Length of metanotum, 5 mm.; width, 2·3 mm.
Length of abdomen, 51 mm.; width, 1·3 mm.
Length of tegmina, 8 mm.; width, 3 mm.
Length of wing, 38 mm.; width, 16 mm.
Length of cerci, 5 mm.

Although agreeing in size and colour patterns of the wings with Westwood's fig. 1 of Plate xxxv. (Cat. Phasm., B.M.), the specimen differs much in the minuteness and paucity of the spinelets of the femora and tibiæ of the legs, etc. The ocilli appear also to be practically replaced by mere shallow depressions. There are no other specimens in the S.A. Museum collection resembling either of the above. There is in the collection a female from Lake Aroona (N.W. from Port Augusta), and also a nymph of one, which appear to belong to the described male in general aspect, contour, and colour of wings, etc. Both were collected in December, 1900, by Mr. A. Loveday, and are differing in being larger.

Necroscia bella, *spec. nov.*

Male. Greenish to reddish-brown; very slender. Head above rounded, minutely and distantly tuberculate, occiput anteriorly with a deep oval impression, median line indistinct; sides flat. Antennæ not much longer than the anterior femora, finely and densely hairy. Pronotum narrower and much shorter than the head, with a slight longitudinal and a promiscuous transverse carina in the middle. Mesonotum scabrous, nearly twice as long as the two preceding together, and attenuated towards the middle from both ends. Metanotum stout and the widest part of the body. Abdomen slender, gradually attenuated towards and inclusive of seventh joint, remainder moderately tumid. Subgenital lamina half the length of joint, apex emarginate. Cerci short, ovate, hairy; porrected. Legs simple, very slender, moderately long; femora, tibiæ, and first joint of tarsi minutely and very densely spinulate along all three ridges. Tegmina very small, apex rotundately sinuate, elevated knob dark brown, remainder pale brown. Wings narrow, apex almost subacute; veins and veinlets of costal area from brown at the base to greenish along costa, and whitish near margin; of the remainder from bright to faintly rosy; interspaces pale green near costa, remainder very faintly rosy, transparent.

Length of body, 52 mm.; width, from 1-2·3 mm
Length of head, 3·3 mm.
Length of antennæ, 19 mm.
Length of pronotum, 2 mm.
Length of mesonotum, 9 mm.
Length of metanotum, 3·7 mm.
Length of abdomen, 34 mm.
Length of cerci, 3 mm.
Length of tegmina, 2 mm.; width, 1·5 mm.
Length of wing, 28 mm.; width, 12 mm.
Length of ant. femora, 16 mm.
Length of ant. tibiæ, 15 mm.
Length of med. femora, 10 mm.
Length of med. tibiæ, 10 mm.
Length of post. femora, 14 mm.
Length of post. tibiæ, 15 mm.
Length of tarsi, 3-4 mm.

This species appears to be nearest in affinity to *N. annulipes*, Curtis, but is considerably smaller and more slender, the proportions of antennæ and wings, besides less conspicuous characters, appear also to be sufficiently different to entitle it to specific rank. It is the first of the genus which has reached me from any part of the State of South Australia.

Bacillus peristhenellus, *spec. nov.*

Two males. Body pale ochreous to dull blackish-brown, filiform, thorax carinated. Head pale dull ochreous, with two interrupted black vittæ behind the eyes, an ovate, longitudinal impression anteriorly, on either side of which a fine distinct ridge, hind margin crenate. Eyes yellowish-grey. Antennæ as long or longer as anterior femora, first joint long, flat, next two very short and thick, remainder shorter than first, subequal, filiform. Pronotum rough, dull, same colour as head, wider behind, anterior margin subcrenate, forming a distinct ridge, median carina very fine, marginal ridges distinct, intra-marginal carina rather broad. Mesonotum with subparallel sides, raised median and submarginal ridges, dark brown. Metanotum similar, ridges much more distinct, both meso- and metanotum very minutely papillose between the raised lines, and of the same width. Abdomen very slender, apparently flat underneath, brown in the dried specimens, tapering towards apex. Legs triquetrous, with one or two carina on each face, unarmed. Supra-anal lamina very short, triangular. Cerci not exceeding apex.

Length of body, 35 mm.; width, 1-1·3 mm.
Length of head, 1·6 mm.
Length of pronotum, 1·4 mm.
Length of mesonotum, 9·5 mm.
Length of metanotum, 6·5 mm.
Length of abdomen, 16 mm.
Length of ant. femora, 11 mm.
Length of ant. tibiæ, 11 mm.
Length of med. femora, 8 mm.
Length of med. tibiæ, 8 mm.
Length of post. femora, 10 mm.
Length of post. tibiæ, 7·5 mm.

There are two specimens in the collection, one a mature one apparently, the other immature and much smaller. Although much smaller, they appear to be best comparable with *B. Peristhenes*, Westwood, in general type of form, and to this the trivial name given refers. There are also two other immature specimens, too defective for classification.

Additions to the Cambrian Fauna of South Australia.

By R. Etheridge, junr., Hon. Fellow, Curator of the Australian Museum, Sydney.

[Read April 4, 1905.]

Plate XXV.

Our Cambrian Fauna is, comparatively speaking, of so limited a nature at present that additions are always most welcome. Mr. W. Howchin recently forwarded to me a small collection of fossils from a new horizon, discovered by himself. Mr. Howchin describes the deposit as a "shelly band in an oolitic limestone of much inferior thickness to that carrying the great reef of Archæocyathinæ, situated in the Flinders Range, not far from Wirrialpa."

The limestone is, generally speaking, flesh-coloured, and the fossils break out on fracture in fairly good condition. The oolite grains appear under two conditions: either on a fractured surface, as small spherical or oval bodies up to one millimetre in diameter; or, on weathered faces, in natural section, when their structure, under an ordinary pocket lens, is very misleading. In this condition they present the appearance of minute corallites of a fasciculate Rugose coral, with definite septa, and are closely packed on some pieces of limestone, or sparsely distributed on others. On placing a thin slice of this pseudo-coral, prepared for the microscope, under a high-power objective, the supposed corallites at once resolve themselves into oolitic grains of a peculiar structure. These grains are wholly composed of concentric layers, or zones, of carbonate of lime, with or without a central nucleus of clear calcite, accompanied by a radial structure, and it is the latter that simulates the appearance of a septate coral. In fact, these grains when seen in natural or weathered transverse section resemble very minute Archæocyathinæ, especially when the pellicle is thin, or of small diameter, and enclosing a clear nucleus. This radial structure is not uncommon in oolitic grains, but its remarkable resemblance to a minute coral has not before come under my notice. Between crossed Nicols the black cross is clearly seen in places, indicating crystalline and not organic structure. No organic nucleus was observed in any case.

I have succeeded in determining one Trilobite, five Brachiopods, and one Pteropod, but these, with the exception of the Pteropod, bear no specific relation to the more copious fauna, described by the late Professor R. Tate,*

* Tate—Tr.R.S.S.A., 1892, xv., part 2, p. 183.

from Parara and Curramulka, Yorke Peninsula. The chief point of interest lies in the addition of the genus *Obolella* to the fauna.

The following are descriptions of the fossils:—

TRILOBITA.

Genus Olenellus, Hall, 1862.

(Fifteenth Annual Report New York State Cabinet Nat. Hist., 1862, p. 114.)

Olenellus, *sp.*

(Plate xxv., fig. 1.)

Obs.—Two species of this characteristic Cambrian Trilobite are known already from Australian rocks:—*O. Brownii*, mihi,* and *O. Forresti*, mihi,† with a possible third, *O. (?) Pritchardi*, Tate.‡ The present specimen is very imperfect, but sufficient remains to indicate *Olenellus* rather than *Ptychoparia*. It is certainly distinct from Tate's species, and probably also from *O. Brownii*.

The cephalon, less the free cheeks, is semi-circular-saggitate. The glabella oblong, rounded in front, gently convex, slightly arched in the middle line (most so anteriorly), and with parallel lateral margins; the axial grooves are strong and undulated, to correspond with the glabella furrows; the first pair are mere indentations of the axial grooves and hardly perceptible, the three latter are all complete; the frontal lobe is large and subquadrate, the palpebral lobes obpyriform, the eye lobes large, flat, crescentic, and extend as far forwards as the palpebral, beyond the first pair of glabella furrows, and posteriorly to the fourth complete furrow. The free cheeks, neck lobe, and posterior portion of the glabella are not preserved.

There is not sufficient of this cephalon to enable comparisons to be made; suffice it so say that it certainly is not *O. (?) Pritchardi*, Tate, provided the illustration of the latter is correct, and not a mere conventional figure. The form of the palpebral lobes, and complete condition of the glabella furrows, so far as they are preserved, also forbid a reference to *O. Brownii*. It is nearest to *O. Forresti*, mihi, from the Cambrian rocks of Kimberley, North-west Australia, possessing a similarly elongate glabella, yet not so long as in *O. Forresti*, similarly long and curved eye lobes, and similar pyri-

* Etheridge—Contrib. Pal. S.A., No. 9, S.A. Parl. Papers, No. 127, 1897, p. 13, pl. i., fig. 1.

† Foord—Geol. Mag., 1890, vii., p. 99, pl. iv. figs 2, 2a-b.

‡ Tate—Tr.R.S.S.A., 1892, xv., part 2, p. 187, pl. ii., fig. 11

form palpebral lobes, but our specimen is not sufficiently perfect to complete the comparison.

On the same piece of limestone is a small portion of another glabella, and on another hand specimen part of a frontal border of a cephalon. This lends encouragement to the belief that additional, and it is to be hoped more complete, examples will be forthcoming in the near future.

BRACHIOPODA.

Genus Obolella, Billings, 1861.

(Geol. Vermont, 1861, ii., p. 946.)

Obolella wirrialpensis, *sp. nov.*

(Plate xxv., figs. 2 and 3.)

Sp. Char.—Valve (? pedical) ovate to subquadrate, gently convex, rising dorsally into a small umbo; rounded ventrally and without emargination; lateral angles rounded. Internal muscular scars hardly at all curved, diverging from one another, extending far forward, and tapering to a fine point. Surface characters very marked and distinctive, consisting of a series of clean-cut, flat, concentric steps, the "tread" of each step practically at right angles to its "riser"; no concentric or radial striæ of any kind.

Obs.—*Obolella wirrialpensis* may be regarded as the characteristic fossil of the band of limestone lately discovered by Mr. Howchin, and adds another welcome genus to our Cambrian list of fossils. It is a more quadrate form than most of the American *Obolellæ*, with the exception of *O. cingulata*, Billings;* in fact, the outline is more that of *Obolus* than *Obolella*. On the other hand, the internal structure, so far as it is preserved, is that of the latter, and the outline is more that of the British than the American species. It is further remarkable for its size, being equal to the largest of the latter, and far surpassing the former. Three selected specimens measure as follows:—

	Dorsal to ventral.	Transverse.
a.	7 mm.	8 mm.
b.	11 mm.	10 mm.
c.	11 mm.	12 mm.

The step-like nature of the concentric laminæ is very characteristic, and cannot fail to arrest attention, even in fragments.

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* Billings—Pal. Foss. Canada, 1871, i., p. 8, figs. 8-10.

Obolella, *sp.*

(Plate xxv., figs. 4-6.)

Obs.—It is often a difficult task, in dealing with these old organisms, particularly when imperfect, to determine how far difference in outline is to be allowed to have weight in varietal significance. Associated with *Obolella wirrialpensis* are a few examples differing from the latter by their ovate flask-shaped outline, accuminating towards the umbo, and swelling out towards the front; the sculpture appears to be similar to that of *O. wirrialpensis.*

In form this rarer shell is clearly allied to the little *O. gemma*, Billings,* of the North American Middle Cambrian, but is very much larger than the latter.

I anticipate it will ultimately prove to be specifically distinct from *O. wirrialpensis*, but as the amount of material is limited I content myself by suggesting that it be called *O. wirrialpensis*, var. *calceoloides.*

Genus Orthis, Dolman, 1828.

(Kongl. Vet. Acad. Handlingar, 1827 (1828), p. 96.)

Orthis (?) tatei, *sp. nov.*

(Plate xxv., figs. 7 and 8.)

Sp. Char.—Pedicle valve, dorsal margin comparatively straight; ventral and lateral margins rounded, the former non-emarginate; umbo small, depressed; surface in the median line moderately convex, the wings rather flattened; sculpture consisting of numerous, thick, sometimes bifurcating, radating costæ, which die out, or are only faintly perceptible on the wings or towards the lateral margins of the valves, the surface on these portions being also crossed by very fine concentric lines; by the prominence of two or three costæ on each side of the middle, a flattened space, taking the place of a sulcus, is marked off.

Obs.—In the absence of internal features, I am by no means confident in the generic reference of this fossil, but in all probability it is an *Orthis.* The specimens present a very analogous appearance to one of the late Mr. Thomas Davidson's figures of *O. lenticularis*, Wahl.,† from the Dolgelly Group of the Upper Lingula Flags of Wales.

The shell is named in honour of the late Professor R. Tate, who practically laid the foundation for palæontological study in South Australia.

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* Walcott—Bull. U.S. Geol. Survey, No. 30, 1886, p. 116, t. 10, figs. 2 and 2a.

† Davidson—Mon. Brit. Foss. Brach., part vii., No. 3, 1869, pl. xxxiii., figs. 27-28a.

Orthis (*vel* Orthisina), *sp.*

(Plate xxv., fig. 9.)

Obs.—I regard this as distinct from *O. tatei.* The valve is a single specimen, apparently the pedicle, and is sub-quadrilateral, convex, the greatest convexity at about mid-way in the length of the valve, the sinus gradually deepening and widening towards the front, and bounded laterally by ill-defined folds, one on either side, the surface sloping away on either side rapidly to the lateral margins, and at a very much less angle within the sulcus; there are indications of costæ on the divaricating folds and in the sulcus.

The hinge features are hidden in matrix, nor is the umbo distinctly visible; it may, therefore, be either an *Orthis* or an *Orthisina.*

It is quite distinct from either *Orthis (?) peculiaris,* Tate,* or *Orthisina compacta,* Tate,† but in general appearance it resembles *Orthis (?) spiriferoides,* McCoy,‡ a Caradoc-Bala species.

In the Archæocyathinæ white limestone at Wirrialpa.

Orthis (*vel* Orthisina), *sp.*

(Plate xxv. fig. 10.)

Obs.—In the same white marble occurs another Brachiopod, which may belong to either of the above genera, the same disabilities rendering it impossible to arrive at a satisfactory conclusion, as in the preceding instance.

This valve, again a single example, I take to be the brachial. It is rotundato-quadrate, the cardinal margin as long as the width of the valve, the surface convex, except on the dorso-lateral alations, where it appears to be flattened. There is a central, acute, or pinched-up fold, produced forward, and expanding as it advances. There are indications of the existence of strong, distant, sub-radiating costæ.

Whether or no this is the brachial valve of the species represented by the preceding form, it is, at present, impossible to say; the two occur in the same bed, however. There is a strange resemblance in the pinched-up fold to the same portion on the brachial valve of a Caradoc species, *Orthis vespertilio,* Sby.§

In the Archæocyathinæ white limestone at Wirrialpa.

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* Tate—Tr.R.S.S.A., 1892, xv., part 2, p. 185, t. ii., fig. 5.

† Tate—*loc. cit.*, p. 185, t. ii., figs. 6, 6a.

‡ Davidson—Mon. Brit. Sil. Brach., part vii., No. 4, 1871, p. 275, t. xxxvii., fig. 3a.

§ Davidson—Mon. Brit. Sil. Brach., No. 3, t. xxx., figs. 11, 12a.

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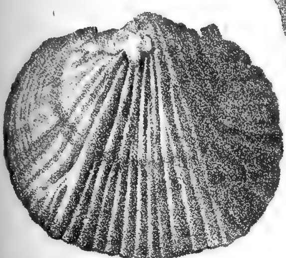

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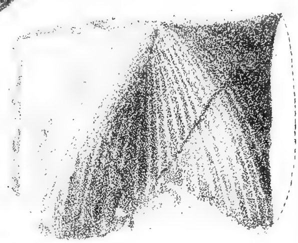

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J. RICHARDSON, DEL ET LITH.. HUSSEY & GILLINGHAM. LITH.

PTEROPODA.

Genus Hyolithes, Eichwald, 1840.

(Sil. Schich. Syst. in Ehstland, 1840, p. 97.)

Hyolithes communis, Billings.

Obs.—This genus is represented by single small tubes up to twenty-five millimetres in length, but without other distinctive characters. I have not seen any trace of an operculum. The facies of the specimens is that of *H. communis*, Billings, already recorded from the Parara limestone at Curramulka by the late Professor R. Tate.

DESCRIPTION OF PLATE XXV.

Olenellus, sp.

Fig. 1.—Incomplete cephalon, showing the glabella, palpebral and eye lobes, etc.— × 2.

Obolella wirrialpensis, *Eth. fil.*

Fig. 2.—External view of a nearly complete pedicle (?) valve — × 3.

Fig. 3.—Imperfect internal cast, exhibiting traces of muscular scars— × 3.

O. wirrialpensis, var. calceoloides, *Eth. fil.*

Fig. 4.—External view of a flask-shaped pedicle (?) valve— × 3.

Fig. 5.—Side view of another specimen— × 3.

Fig. 6.—Umbonal view of the same— × 3.

Orthis (?) tatei, *Eth. fil.*

Fig. 7.—Pedical valve with thick, radiating costæ on the median portion of the valve— × 2.

Fig. 8.—A similar specimen— × 2.

Orthis (*vel* Orthisina), sp.

Fig. 9.—Subquadrilateral pedicle (?) valve, with a moderately deep sinus, bounded by ill-defined folds— × 3.

Orthis (*vel* Orthisina), sp.

Fig. 10.—Rotundo-quadrate brachial (?) valve, with a pinched-up fold— × 3.

Notes on South Australian Decapod Crustacea. Part III.

By W. H. Baker.

[Read October 3, 1905.]

Plates XXXII. to XXXVI.

The following notes deal with some species of *Anomura*. The first three are true hermit crabs of the family *Paguridæ*, which are closely allied to each other, belonging to that division of the family whose chief characteristics are the possession of a pair of modified appendages on the first, and another on the second, abdominal somite in the male, and a pair on the first in the female. The female also is provided with a brood pouch, which arises from the fourth somite on the left side, and covers the unpaired biramous appendages which serve for the attachment of the eggs. These three species are referred to the genus *Paguristes*. Of the four remaining species, three belong to the *Porcellanidæ*. *Petrocheles australiensis*, Miers, is a fine species, showing well the transition to the *Galatheidæ*, and as far as I know has never been figured. Of *Polyonyx transversus*, Haswell, the same may be said; so it is here figured, and the description extended. Lastly, a *Galathea*, belonging to the group which contains *G. australiensis*, Stimpson; *G. aculeata*, Haswell; and *G. magnifica*, Haswell, is described—though provisionally—as *G. setosa*, for the first time.

Family Paguridæ, Dana.

Section I., *Pagurinæ*, Ortmann.

Genus *Paguristes*, Dana.

For latest description of genus see Alcock Cat. Ind. Decap. Crust., part 2, p. 30, 1905.

Paguristes frontalis, M.-Edw. Pl. xxxii., figs. 1-7.

Pagurus frontalis, M.-Edw., An. des Sci. Nat., 2e série, t. vi., p. 283, pl. xiii., fig. 3. Hist. Nat. Crust., t. ii., p. 234.

Paguristes frontalis, Alcock Cat. Ind. Decap. Crust., part 2, p. 155, 1905.

Eupagurus frontalis, Cat. Aust. Crust., Haswell, p. 154.

The carapace anterior to the cervical groove is only slightly convex from side to side, anteriorly depressed, rather oblong viewed from above, the sides behind the curve of anterior angles being nearly straight; its surface is smooth and polished except for some small scattered punctations, but towards the sides it becomes somewhat rough or rugose The triangular rostriform tooth is acute, quickly accuminating to its apex, depressed and projecting between the bases of the scales of the ocular peduncles. The margin of the front is raised, and the antennal projections, which do not reach as far as the rostrum, are each tipped with a small tooth. A depression behind the rostral tooth sends off an oblique branch towards each side marking off the hepatic regions, and also a median longitudinal groove, which, however, is short. In the region of this groove the carapace is slightly rugose transversely. The hepatic regions are prominent and rounded. The antero-lateral portions of the carapace scarcely project forward as far as the tubercles of the first joints of the antennæ; their descending margins carry two or three spinules. The cervical groove is deeply marked, and the carapace behind it is membranaceous, and is marked with some faint, irregular, longitudinal lines: there is a narrow median region expanding anteriorly, and running to a depression behind. The branchial regions are moderately tumid. The carapace is sparingly hairy at the sides.

The narrow tergum of the first abdominal segment is triangular, firm, and bears a few setæ. The remainder of the abdomen is soft, except in some specimens a little leathery underneath; it is glabrous, except the margin of the oviferous sac in the female. The sixth segment is strongly calcified dorsally, and is divided into two main unequal portions by a deep, transverse, irregular furrow, the anterior portion thus divided is irregularly pitted, the posterior has a median, shallow furrow, which broadens out behind.

The ocular peduncles are long, as long as the greatest breadth of the anterior portion of the carapace, moderately robust, not expanding distally, and with a tendency to become slightly unequal in length. The basal scales are rather small, spiniform, close together, and anteriorly depressed. The eyes are rather small.

The basal joint of the antennular peduncle is flattened and hollowed above, its external margin is compressed, and each edge bears distally a minute spine (stylocerite). There is a small distal spine below also. The second and third joints and the thick portion of the upper flagellum are subequal in length; the lower flagellum is about half the length of the upper, and is naked, as is also the short distal portion of the upper flagellum.

The first joint of the antennal peduncle has a prominent tubercle below, which bears the aperture of the green gland. The second joint is produced distally on the outer side, ending in three converging spines, with a group of setæ immediately below, the inner distal angle is less produced, and ends in a downward curved spinule. The upper surface of the joint is hollowed. The third joint is produced below to a strong spine, which projects one-third the length of the fifth joint; the fourth joint is short and bears a small distal spinule above. The fifth joint is cylindrical, slightly curved, and expands slightly towards the distal end, reaching to about half the length of the ocular peduncle. The acicle is short and stout, reaching about as far as the spine on the third joint; it bears, besides the acute apex, two short, strong spines externally, and one near the base above; it also carries several fasciculi of coarse setæ. The flagellum is short, not much more than twice the length of the peduncle, and is non-ciliate.

The mandibles have the edge of the cutting plate entire; a narrow and not deep cleft separates it from the molar process; into this the terminal joint of the palp dips. The molar process is narrow. The palp is three-jointed, the second joint markedly compressed, its plane being transverse to the edge of the cutting plate; the third joint, which is about as long as the two preceding ones together, is compressed and much expanded, its plane being parallel to the same edge.

In the first maxillæ the external branch has the second joint articulated below the apex of the preceding, presenting a bifid arrangement; the distal portion is strongly reflexed. This branch bears a strong setum on the inner side near the base.

In the second maxillæ the third joint is compressed, tapering irregularly, the apex being without setæ.

In the first maxillipeds the third joint is twisted and turned aside so as to be partially hidden behind the exopod. The exopod is flagellate.

The exopods of the two succeeding maxillipeds are very robust, compressed, and flagellate. The third maxillipeds have their coxal joints contiguous, the ischium bears a row of corneous teeth on the inner side, and the merus a few spinules on the same side.

The chelipeds are large and very unequal, the left one is the larger; in it the merus is trigonous, reaching a little beyond the eyes; it bears a few small, low tubercles, which become more numerous and larger towards the distal end; some are minutely punctate at their summits. The upper surface of the carpus is strongly tuberculate, the tubercles becoming almost spiniform on the inner margin. The hand is large and swollen, whitish (in contrast to the rest of the appendages, which are red), and finely granulate, the granules becoming larger towards the inner side. The fingers open transversely, and are excavate, especially the immobile one, the contiguous surfaces having some punctations, from which a few hairs spring. The mobile finger is corneous at the tip. There is a broad, rather obscure, ridge on the outer side of the immobile finger reaching some distance on the hand; at the inner end of this ridge is a small area of well-defined, reddish granules. The hand, including the fingers, is more than twice as long as the carpus. On the outer side the fingers show no hiatus, but a prominence on the immobile one fits into a corresponding slight hollow in the mobile one. The right cheliped has the carpus and hand bearing larger tubercles and granules, and a few fasciculi of hairs on the inner margin.

The second and third pairs of legs are long, almost glabrous and robust, exceeding the chelipeds in length. The third is more robust than the second. In these the meris and propodi are very slightly serrate above and below, the carpi have a distal spine above, and two or three on the outer side, on the distal margin. The dactyli, which are longer than the penultimate joints, are moderately curved and compressed, that of the third pair is more flattened on the outer side, and bears a well-marked, spinulate ridge above; the inner side is rounded and has scattered spinules, the lower margin is acute and serrate, especially towards the end. The spinules usually arise from dark red spots. The dactyli terminate in small black claws.

The fourth pair are much shortened, the joints are setose on their anterior and posterior margins, non-chelate, the propodi becoming narrower distally. The dactyli are short, and bear some stout teeth. The fifth pair are shorter, smaller, and minutely chelate, the pad of scale-like setæ covers the whole breadth of the distal end of the propodus.

The first and second abdominal segments bear sexual appendages in the male, the rami of the first being coalesced to form a semi-cylinder, the inner ramus is provided with a tuft of brown stiff setæ, which originate about the middle of the inner side, and extend beyond its end, intermingling with those of the opposite limb, the outer ramus is thickened, compressed, rounded at the end, which is slightly recurved outwards, bearing a row of minute teeth. The second pair of abdominal appendages are long, slender, and uniramous, and are terminally slightly spatulate and setose. The three succeeding segments are each provided with a weak uniramous appendage on the left side.

The uropods, as usual, are very unequal, the external ramus of the pair of the left side is much larger than the inner, falcate, and expanded with the usual pavement of scale-like setæ.

The telson bears a few setæ in groups, and is divided dorsally into four lobes, with a small lozenge-shaped area in the middle; the two terminal lobes are unequal, with a median cleft between them. The two anterior lobes have each an ear-shaped pit.

The female has a large brood pouch.

This littoral species is one of the largest and commonest hermit crabs of our coast, and varies much in size.

Specimens in the Adelaide Museum.

Length of a medium-sized specimen, 6 cm.

Length of carapace, 26 mm.

Breadth of the anterior portion of the carapace, 10 mm.

Length of large cheliped, 4 cm.

Length of ocular peduncle, 10 mm.

Length of second ambulatory leg, 47 mm.

Paguristes brevirostris, *n. sp.* Pl. xxxiii., figs. 1, 1*a*.

The animal is somewhat hairy, especially on the chelipeds, the hairs there, however, not thick enough to hide the armature.

The anterior portion of the carapace is rather flat above, sparingly pitted, rough or rugose towards the front and sides, with a depression behind the front, marked on each side by a short, slightly oblique ruga, then another small, depressed area lies beween this and the hepatic region. The rostral tooth is very short, obtuse, and scarcely projecting farther than the prominences external to it: these are rounded, and each is tipped with a very small denticle. The hepatic regions are rounded and slightly tuberculate; they are separated from the other regions by a faintly marked, very irregular, longitudinal groove, which joins the cervical groove behind. The frontal margin is thickened. The portion of the carapace behind the cervical groove is thin, and shows some small disconnected areas of calcification. The branchial regions are moderately tumid and sparingly setose; there is a tuft of setæ on each side of the cardiac region.

The ocular peduncles are moderately robust, not as long as the breadth of the anterior portion of the carapace, and somewhat constricted towards the middle. The basal scales are rather small, and bear five or six small red denticles on each. They are well separated from each other.

The antennular peduncles reach nearly to the level of the eyes.

The outer side of the first peduncular joint of the antennæ bears one or two denticles. The second joint is hollowed above, its outer distal angle is produced, bearing four or five spinules, and there are one or two denticles at the inner angle. The acicle is moderately robust, quickly tapering to a terminal spine, with three or four others on its external border, and two on its inner border near the base: it reaches more than half the length of the fifth joint. The third joint is produced below to a prominent spine, and a small spinule terminates the fourth joint above. The fifth joint is short, reaching about two-thirds the length of the ocular peduncle. The flagellum is short, much shorter than the carapace, the internodes of the joints bearing rather long setæ.

The chelipeds are moderately robust, nearly equal. The merus reaches a little beyond the level of the eyes, its lower external border is spinulate, and it is slightly rugose on the external surface; it bears some spinules on the distal margin, and one or two also above a little removed from the distal end. The carpus is short, its anterior surface is covered with white, more or less spiniform tubercles, which become larger on the inner margin. The palm is not much longer than the carpus, and is covered anteriorly with similar spiniform tubercles, which extend on to the fingers; on a side view the joint is strongly wedge-shaped, being swollen proximally and tapering quickly to the end of the immobile finger. The fingers are slightly longer than the palm, transverse, corneous at the tips, and denticulate on their opposable margins, with a small hiatus.

The second and third pairs of legs are nearly equal in length—the carpi and propodi of the more posterior pair being slightly longer—and exceed the chelipeds by about the length of the dactyli. The more anterior pair is more spinulate, spinules being situated on the posterior edges of the meri, and on the anterior edges of the carpi and propodi. The carpi and propodi also show squamose markings, from which hairs arise; these, again, are more evident on the more anterior pair; the dactyli of both pairs are longer than the propodi; they are scarcely compressed, slightly sulcate, and end in dark, corneous claws, and are distally more or less spinulate.

In the male the pairs of appendages to the first and second abdominal segments are well developed, as also are the uniramous appendages on the left side of the third, fourth, and fifth segments; these bear very long setæ.

In the female the brood pouch is a widely open sac, springing from the fourth segment. This covers the biramous unpaired appendages of the second, third, and fourth segments, and carries the ova.

The ultimate segment is four-lobed, with minute teeth and some hairs on the margin of the terminal lobes.

Length of body, 28 mm.

Length of carapace, 11 mm.

Breadth of carapace, anterior portion, 5 mm.
Length of cheliped, 17 mm.
Length of third leg, 19 mm.
Dredged by Dr. Verco, S.A. coast, 20-30 fms.
Types in Adelaide Museum.

Paguristes sulcatus, *n. sp.* Pl. xxxiv., figs. 1, 1*a*.

The animal is very hairy, especially on the chelipeds; the hairs are plumose or pinnate.

The carapace anterior to the cervical groove is medianly smooth, except for a few scattered pits; towards the sides, however, it becomes rough and irregularly furrowed. There is a rather deep depression behind the rostral tooth, and the portion of the carapace immediately behind this dips into it rather abruptly. In this region there are a few slight, irregular furrows, which appear as branching from a median, shallow groove, which extends from the frontal depression for a short distance behind. The lateral portions of the frontal depression are marked on each side by a short, oblique ruga (more pronounced than in the preceding species), and the hepatic regions, which are full and sparingly pitted, are marked off from the rest of the carapace by irregular longitudinal grooves, which join the cervical groove behind. The rostral tooth is triangular, acute, slightly depressed, reaching nearly as far as the ophthalmic scales. The front between the two antennal projections is strongly thickened; these do not project as far as the rostral tooth, and each is tipped with a small denticle.

The abdomen is of the usual soft nature, the dorsal surface of its sixth segment is strongly calcified, and divided by a transverse groove into two unequal parts; the anterior portion is marked with three irregular pits, the posterior by a median sulcus, which is not so deep as the transverse one, and a few small pits.

The ocular peduncles are long and slender, scarcely expanding distally from about the middle; they are a little shorter than the widest part of the carapace anterior to the cervical groove. The ophthalmic scales are small, well separated, and each is tipped with three spinules, one of which is small.

The antennular peduncle reaches nearly as far as the eyes. The upper flagellum slightly exceeds the ultimate peduncular joint in length.

The first joint of the antennal peduncle bears externally two spinules. The upper surface of the second joint is slightly excavated; it is much produced externally, bearing four or five spines, the two apical ones being rather divergent; there is also a prominent spine on the inner angle, with a small spinule just below it. The acicle is robust, regularly tapering to end in two spines, with one just below them on the outer or upper side, and one on the inner side, near the base; the acicle reaches rather more than half the length of the fifth joint. The third joint is produced below to a strong spine, which reaches nearly as far as the fourth joint. The fourth joint has a small spinule above at the distal end. The fifth joint reaches about as far as the middle of the ultimate joint of the antennular peduncle. The flagellum is shorter than the carapace, and hairy.

The chelipeds are equal, and weak. The merus reaches to about the level of the acicle of the antennæ; it bears a few spines on the upper margin, near the distal end, and a few on the other two margins; the external surface is slightly rugose. The anterior surfaces of the carpus and palm are densely hairy—the hairs hiding the spines—flattened and covered with spiniform tubercles, mostly curved forwards, and many with acute, dark tips; these are larger on the inner margins. The palm is shorter than the carpus; it is not swollen behind, as in the preceding species. The fingers are longer than the palm, spinulose, corneous at their tips, and externally marked at their opposable edges with small, rather regular teeth. There is no hiatus.

The second and third pairs of legs are nearly similar, the third pair being slightly longer; they exceed the chelipeds in length by about half the length of the dactyli in the second pair. The meri are slightly rugose externally. The carpi are externally sulcate, as also are the propodi, and with them bear on their anterior margins spines similar to those on the chelipeds, which, however, are smaller and less numerous on the third pair. The propodi also are slightly squamose. The dactyli are about as long as the propodi; they are faintly sulcate and spinulate on their anterior and posterior edges, are slightly curved, and end in dark claws.

The fourth pair is short, non-chelate, the carpus and propodus nearly equal in length, the propodus distally narrowing. The dactylus is short, robust, and spinulate.

The first two pairs of abdominal appendages in the male are well developed; the single pair of the first segment in the female is weak. The other appendages are of the usual character.

The telson is four-lobed, the two anterior lobes larger than the posterior; the posterior lobes are unequal, rounded behind, and spinulate and setose on the margins.

Length of body, 37 mm.
Length of carapace, 16 mm.
Breadth of carapace anterior to the cervical groove, 7 mm.
Length of cheliped, 20 mm.
Length of third leg, 26 mm.
Length of ocular peduncle, 6 mm.
A littoral species. Port Willunga, S.A. coast.
Types in Adelaide Museum.

This species differs from *P. subpilosus*, Henderson, in the following particulars:—The ocular peduncles are longer and slenderer. The ophthalmic scales are smaller and trispinose. The rostral tooth is more acute, and there is a strong depression behind it on the carapace, and a short, median, longitudinal groove. The antennal flagellum is well ciliated. In the chelipeds the hand is not swollen behind. In the second and third pairs of legs the dactyli are not longer than the propodi, and the anterior borders of the last three joints are very spinose. Finally, the telson is quadrilobate.

Family Porcellanidæ.

Genus *Porcellana*, Lamarck.

Porcellana rostrata, *n. sp.* Pl. xxxv., figs. 1, 1*a*, 1*b*.

The carapace is subpentagonal, slightly longer than broad, slightly convex behind the protogastric ridges. The surface is uneven, being marked by numerous minute transverse striæ; some of the striæ are more distinct, bearing groups of soft plumose setæ, especially in the female; two protogastric ridges are particularly thus indicated. The regions are well marked; the cervical groove distinct. The posterolateral regions are rounded and rugose, the rugæ extending around the sides of the carapace to the pterygostomial region, but not uniting dorsally, as a nearly smooth space intervenes. The epibranchial regions are slightly tumid. A narrow, depressed area borders the antero-lateral regions. The front viewed from above shows two prominent lobes, divided by a median sulcation, which extends gradually, becoming shallower backward between the protogastric ridges; from a front view the margins of these lobes show as two arches, the outer limb of each being much shorter than the inner, the two inner limbs uniting to form an almost vertically depressed, acute, median lobe or rostrum; the outer lobes, which form part of the inner margin of the orbits, are also depressed; the edge of the front itself bears a series of small denticles, which extend to the antero-lateral margins. The antero-lateral margin is longer than the postero-lateral; it is cristate, and shows an acute prominence at the external angle of the orbit, a distinct antennal spine, and two others further back; the crest is interrupted by a notch at the anterior end of the cervical groove, and on a slight lobe behind the notch are sometimes found two other small spines. The posterior border is raised and insinuate.

The pleon is smooth, polished, and glabrous, except on the margins.

The *linea anomurica* reaches from beneath the antennal peduncle to the edge of the lateral wall of the carapace, just above the coxa of the third pair of legs, a short, oblique ridge immediately behind the marginal notch before mentioned reaches from the antero-lateral crest across to this suture.

The eyes are small, and scarcely projecting.

The first joint of the antennular peduncle has two oblique ridges, which converge and unite inwardly.

The basal joint of the peduncle of the antenna is somewhat triangular; it forms the external margin of the orbit; its upper portion reaches the margin of the carapace, its lower border bears three or four teeth towards the inner end, the innermost one of which is below the eye, is spiniform, and directed forwards, and is visible from above; the other three teeth are small, and point inward. The third joint is a little longer than the second, expanding towards the distal end, where there is an anterior projection; the fourth joint is small, and also has a slight projection. The flagellum is long.

In the external maxillipeds the ischium is moderately broad, sub-triangular, produced a little, and broadly rounded at the inner distal angle, its outer distal angle having a strong, obtuse tooth, which usually lies in a shallow groove of the exopod. The outer surface is slightly excavate, and the external margin thickened and defined by two ridges. The merus has the inner lobe marked with six or seven denticles. The carpus also has an internal lobe, with a strong tooth below, and a longitudinal lateral ridge, and its upper distal end terminates in an acute tooth. The joints are fringed with the long hairs, as is usual. The exopod is slightly curved, and tapers to an obtuse point. It reaches to more than half the length of the merus; its outer face is slightly excavate.

The chelipeds are usually equal in the female; they are rough, like the carapace. The merus is short, and bears a large anterior lobe, whch is acute, with very small denticles on its edge; there is a small spine on the distal margin underneath. The carpus, which is about as long as the palm, is slightly excavate longitudinally on the inner surface; the upper surface has two longitudinal sulcations, with a prominent ridge between them marked by oblique striæ; the outer margin bears a series of small forward directed teeth; the inner margin is divided into two acute lobes and a distal prominence, the two lobes bear marginal minute denticles; there are also a few spinules near the distal end above; the lower surface is nearly smooth. The palm is much compressed, it widens considerably from the proximal end; there is a broad ridge on the upper surface which extends to the base of the mobile finger; the inner margin is rather acute, with a small tooth near the distal end, besides a terminal one; the outer margin, which is nearly straight for most of its length, bears a series of spinules which extend to the end of the immobile finger; there are also a few spinules along with a dense mass of hair on the upper surface towards the outer margin; the under surface is nearly smooth. The fingers are very much compressed and rather unsymmetrical, meeting their whole length with some obscure longitudinal sulcations; the mobile one has a sharp ridge above, which near its distal end shows some small denticles, its apex is constricted to a hook, its inner surface is excavate. The immobile finger is excavate; its apical tooth is unsymmetrically placed. In the adult male the chelipeds are very unequal, one is often greater developed, the hairs are absent, and the asperities much reduced, the fingers do not meet except at their apices, and there is a tooth on each near the proximal end of their opposable edges. This cheliped takes a strong red colour.

The carapace of the male is much less hairy.

The three pairs of ambulatory legs are stout, rather rough, with groups of soft hairs, the propodi have a series of spines behind, the dactyli are strong, more than half as long as the propodi; they end in one strong claw, at the base of which there is a little tubercle, tipped with a small spine, and inwardly from this there are four spines.

The last pair of legs are very slender and chelate; they reach about half the length of the carapace.

Dredged by Dr. Verco, Investigator Straits, 20-30 fms.
Length of carapace, 6 mm.
Breadth of carapace, 5 mm.
Length of cheliped, female, 10 mm.
Length of cheliped, enlarged, male, 16 mm.
Types in Adelaide Museum.

Sub-genus *Polyonyx*, Stimpson.

Polyonyx transversus, Haswell. Pl. xxxvi., figs. 2, 2*a*.

Porcellana transversa, Haswell, Cat. Aust. Crust, p. 150.

The carapace is nearly smooth, much broader than long, showing from above a transversely ovate shape, very convex in the antero-posterior direction, much less so in the transverse, rather more depressed behind than in front. The regions are faintly defined; the postero-lateral strongly rugose. The protogastric lobes are slightly prominent. The front, when viewed from above, appears slightly arcuate, rather more than one-third the width of the carapace, marked by a distinct ridge or crest, the median lobe of which projects, and there are two lateral lobes very obscure. Slight insinuations mark the orbits above. Viewed from before, the front appears nearly straight, the median portion slightly depressed. The antero-lateral regions are two-lobed, the lobes separated by a wide notch of the cervical groove; they are faintly cristate, and the anterior one is depressed.

The basal antennular joint is ovate and slightly ridged above.

The eyes are small, scarcely projecting beyond the margin of the carapace.

The basal joint of the antenna is large, sub-triangular in shape; its lower margin very arcuate and prominent; a ridge runs nearly parallel to the inner margin, and there is a small tooth projecting inwards at its interior angle beneath the eye; its upper portion reaches the edge of the carapace, and both its inner and outer sides are strongly incurved. The third joint of the peduncle is narrower and longer than the second, the fourth is very short: these three joints are not crested or lobed.

The appendages are more or less iridescent.

The external maxillipeds are smooth. The internal margin of the ischium is almost semi-circular. The merus is subequal in length to the propodus, and there is on the inner side near the proximal end a prominent lobe. The carpus is a little shorter than the propodus: it is sub-triangular in shape from a side view. The joints are fringed with very long hairs. The exopod does not reach to the middle of the merus.

The chelipeds are slightly unequal—in this specimen the right is larger—they are long and well developed, and very hairy. In the right one the merus is short, its upper surface irregularly rugose; there is a small incision on the upper distal end. The carpus is nearly smooth, rounded behind, somewhat spindle-shaped viewed from above, nearly as long as the carapace; the inner and upper margin, which is a thin, very prominent ridge, bordering a deep longitudinal concavity, is entire and convex, and is clothed with very long plumose hairs, which extend to parts of the upper surface: the lower inner margin is scarcely prominent: there is a small incision at the distal end above. The palm is a little shorter than the carpus, it is compressed, rounded on its upper margin, which is marked by a longitudinal line, and bears a few spinules towards the mobile finger. The lower margin is an acute ridge, bearing a row of small teeth, which reach to the end of the immobile finger. The oblique outer surface is covered with a dense mass of plumose or ciliate hairs, which end abruptly at the ridge, the under surface being quite glabrous. The mobile finger bears a longitudinal row of well-developed teeth on the outer side, on a ridge which sharply marks the hairy portion from the glabrous. The fingers are crossed at their apices, and each has an internal large tooth.

The three pairs of ambulatory legs are short, robust, and mostly smooth, very hairy. The propodi have a series of spines behind. The dactyli are short, curved, and end in two claws; behind these there are two or three strong spines. The last pair is very slender and chelate.

The pterygostomial regions are somewhat excavate, and are crossed by a rather sigmoid ridge.

The pleon of the female is very long and partially overlaps the external maxillipeds: it is smooth or slightly punctate. The first joint is narrow at first, but soon becomes as wide as the second, these become successively broader till the fifth inclusive, the sixth is slightly concave at the sides, and bears a pair of well-developed, biramous uropods. The last segment is composed of seven plates, one median and triangular, the others lateral, the most proximal of which is very small compared with the others, the two distal plates form the termination.

Length of carapace, 8 mm.
Width of carapace, 11 mm.
Length of cheliped, 19 mm.
Length of first ambulatory leg, 10 mm.
Dredged by Dr. Verco, 17 fms., off Newland Head, S.A.
One specimen, a female, in Adelaide Museum.

Genus *Petrolisthes*, Stimpson.

Sub-genus *Petrocheles*, Miers.

Petrocheles australiensis, Miers. Pl. xxxvi, figs. 1, 1*a*.

Petrocheles australiensis, Cat. Crust., N.Z., p. 61.
Petrocheles australiensis, Cat. Aust. Crust., p. 174.

The body is nearly flat, covered with scale-like prominences, which are small on the upper surface of the carapace, but larger on the appendages. From the scales arise short, harsh hairs, which, again, are more developed on the limbs.

The carapace is obcordate, slightly convex in the transverse direction, less so in the antero-posterior. The cervical groove is well marked and wide. The protogastric region bears anteriorly just behind the orbits two low spines, followed by some scale-like tubercles, more pronounced than those of the rest of the carapace. Anterior to these spines the front is depressed, triangular, acute at the apex, each side having three strong spines, including the supra-ocular, which is large. The interocular space is more than one-fourth the width of the carapace.

The lateral margins of the carapace are strongly cristate anteriorly, furnished with eignt spines, including the post-ocular: tnese have often a few spinules between them; these spines occupy about three-fifths the length of the lateral border, the postero-lateral remaining portion of which is rounded and marked with some oblique rugæ. The posterior border is strongly insinuate.

The pterygostomial region has a very strong oblique ridge, reaching well behind.

The pleon is broad, the segments marked with transverse, slightly elevated areas, coarsely hairy. The sixth segment is longer than the preceding ones and narrower, the lateral margins being deeply excavated to receive the peduncles of the uropods. The telson is composed of five plates, viz., one large, median, and triangular, two elongate and lateral, and two terminal ovate, with peduncle-like constrictions, and fringed with long, plumose setæ.

The eyes are moderately large, on short peduncles.

The basal joint of the antennule is strongly spined distally, as in *Galathea*.

Three joints of the antennal peduncle are distinct, the first of these is very short, and anteriorly bears a prominence tipped with two or three spines, the second, which is also short, is prominent in front, with one spine and a few spinules, the third, though scarcely shorter, is cylindrical; the flagellum is about as long as the chelipeds.

In the external maxillipeds the ischium is moderately broad, produced at the internal distal angle, and the margin broadly rounded and minutely crenulated, also a little produced at the external distal angle. The merus has the internal lobe only very slightly projecting, above it is a spine, and at the distal end a smaller one. The carpus has two longitudinal ridges on its upper surface, and is a little lobed internally and deeply hollowed below, to receive the process of the following joint. The propodus is much lobed internally, the lobe being hatchet-shaped. The joints bear the usual long, plumose setæ. The exopod is rather slender, reaching about half the length of the merus; it bears a few coarse granules on its outer border.

The chelipeds are long, well developed, very spinose to tuberculate. The merus joint reaches slightly beyond the level of the eyes, and is somewhat compressed, with two small spines on the distal margin above, and with two or three on the inner surface longitudinally placed, with a large spine at the inner distal angle. The carpus is two-thirds the length of the carapace; it is rounded on the outer side with a row of seven or eight moderately-sized spines; the upper surface, which is nearly flat, bears a median row of a similar number of spines. The upper anterior border has six large, forward-directed spines, and besides these the anterior surface, especially towards the distal end, bears some more or less spiniform, scattered tubercles. The lower anterior border is almost entire, except for the ends of scale-like ridges, which are well marked on the under surface. The propodus is much compressed, the upper or inner margin of the palm is a little shorter than the carpus; it is covered by oblique rugæ, which extend for some distance on the under side. The upper or outer surface has a longitudinal granulate to spinulate ridge nearer the inner border than the outer, and between this and the outer margin is a flat area, covered by dense but very short hairs, with some spinules intermingled. The outer margin is slightly raised, granulate to spinulate, and a little sinuate in outline to the end of the immobile finger. The mobile finger is as long as the inner margin of the palm, it bears a row of spines on the inner margin, these project forwards and a little inwards. There is another row of spines on the outer side, near the cutting edge; the immobile finger has a similar row in the corresponding position. The cutting edges of both fingers are furnished with strong teeth, which become smaller and more numerous distally; an hiatus occupies about two-thirds the length of the fingers, and the tip of the mobile finger is long and hooked, and overlaps its fellow, which is almost straight. The under surface of the propodus is covered with scale-like tubercles and is almost glabrous; it has an indistinct, broad, longitudinal ridge, which corresponds in position to the one on the upper surface.

The three pairs of legs which follow are strong, the first reaches a little further than the end of the carpus of the cheliped. They are very setose, and are covered with the scale-like markings. The meri are compressed with a few strong spines on their anterior margins, and one strong spine near the distal end of the posterior border, and another just above it. The propodi, which are scarcely compressed, have three or four small spines behind, especially one at the distal end. The dactyli are short and stout, with one terminal slightly curved claw and four spines inward from this.

The last pair much reduced in size is minutely chelate, and bears terminally many stiff hairs.

Length of carapace in the median line from tip of rostrum to the insinuation of the posterior border, 23 mm.

Breadth, 23 mm.

Length of cheliped, 56 mm.

It is impossible to look at this species without recognising its strong likeness to the family *Galatheidæ*.

Dredged by Dr. Verco, St. Vincent Gulf; also a specimen from Port MacDonnell, collected by Dr. Torr.

Family GALATHEIDÆ.

Genus *Galathea*, Fabricius.

Galathea setosa, *n. sp* Pl. xxxv., figs. 2, 2*a*, 2*b*.

This species is found with *G. australiensis*, Stimpson, and though closely allied to it is, however, I believe, distinct.

The transverse striæ of the carapace, which are much less numerous than in that species, are, especially on the gastric and hepatic regions, broken up into arcuate lobes or squamæ, from which spring very long, coarse, minutely serrate setæ, along with some shorter ones; these extend on to the rostrum, where they arise from small, round tubercles, and are longer than the rostral teeth. The rostral teeth are somewhat ovato-lanceolate in shape, especially the terminal one. The armature of the surface of the carapace is insignificant; there are two very small, obtuse teeth on the gastric region, placed on the most anterior arch, which are wider apart than the two spines of *G. australiensis;* two similar teeth are placed further back and wider apart than these, while there is one on each hepatic region. The first two teeth only are constant. The lateral spines of the carapace are seven, including the post-ocular, which is small.

The three anterior segments of the pleon, except the first, have deep, transverse sulcations, the posterior margins of which, and also faint transverse ridges close to the anterior margins, are fringed with similar forward-directed setæ, as those on the carapace. The fifth segment has a strong transverse ridge about the middle, the hairs of which and also those of its anterior faint ridge are directed backwards.

The eyes are rather large; they have a fringe of strong setæ at their bases.

The spines at the ends of the antennular joints are long, being visible beyond the eyes.

The flagella of the antennæ are longer than the chelipeds and are furnished with setæ at the internodes. (Those of *G. australiensis* are nearly naked.)

The chelipeds, as compared with *G. australiensis*, are shorter and stouter; they are squamose and clothed with long, coarse hairs, the spines also are longer and not so projecting outwards. The fingers are nearly as long as the palm, elongate, and becoming more narrowed or acute at the ends; they are excavate, and have no hiatus in either sex, and are minutely serrate on their outer opposable edges. The immobile finger terminates in two strong, hooked teeth, with one more or less rudimentary on each side. The mobile finger has one hooked tooth, with a rudiment on each side.

The following three pairs of legs are very spiny and very setose. The dactyli are strong, with horny, curved claws and marginal spines.

In both species the telson of the male has on each side above the middle a group of strong, corneous bristles; these on stronger magnification appear to be hollow, and have their tips split, and in spirit specimens have a shiny appearance and golden colour. *G. australiensis* varies in colour, specimens from shallow water are greenish or bluish, those from 20-30 fms. are deep red. The present species has a remarkable colouration. The carapace is white in the middle, and towards each side is a band of colour, in which violet, orange, and brown are seen. The sternal surface is orange. The chelipeds are white, with red spots, the fingers are deep red. The legs are banded with violet, orange, and white. The antennal flagella are red.

Although the differences between these two species are small, they appear constant; a moderate series of specimens having been observed with no sign of intermediacy. In practice they are not difficult to separate.

Through the kindness of the Director of the Australian Museum, I have been able to compare this species with *G. aculeata*, Haswell, and note the following differences:—*G. aculeata* is much less setose and spinose on all parts, its rostrum is nearly smooth, and its terminal spine is much slenderer and lanceolate. The joints of the chelipeds are much less robust, the carpi being longer. The fingers are notably longer than the palm.

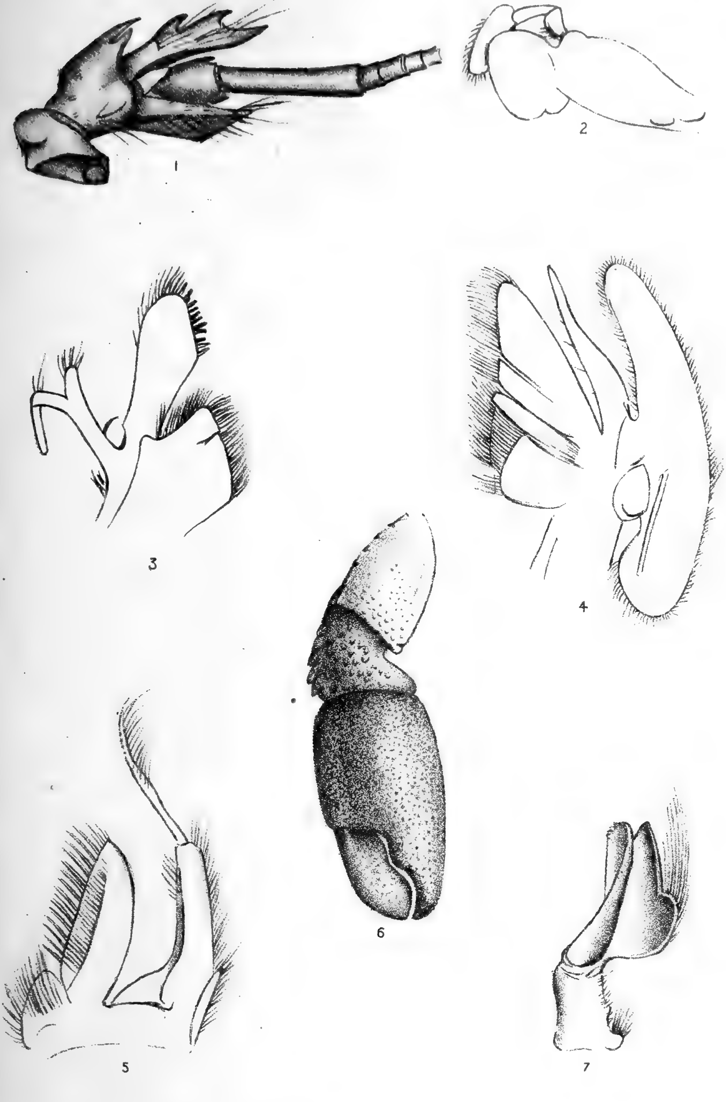
From *G. magnifica*, Haswell, it differs in the coarse and harsh hairs of the carapace. In the striæ of the gastric region being broken up into arcuate lobes. In the setose, rostrum, eye peduncles, and limbs. The colour markings are also different.

Length of carapace, 5 mm.

Length of cheliped, 10 mm.

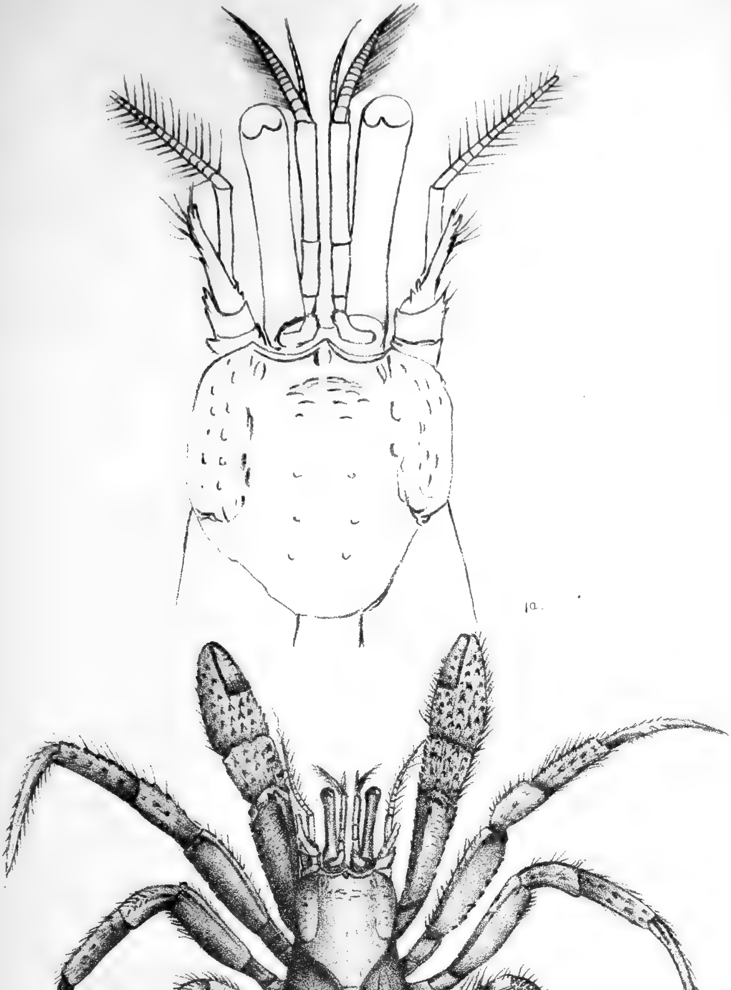
Dredged by Dr. Verco, Investigator Straits, S.A., 20-30 fms.

Types in Adelaide Museum.



W.H.B. DEL. HUSSEY & GILLINGHAM. LITH.

PAGURISTES FRONTALIS.



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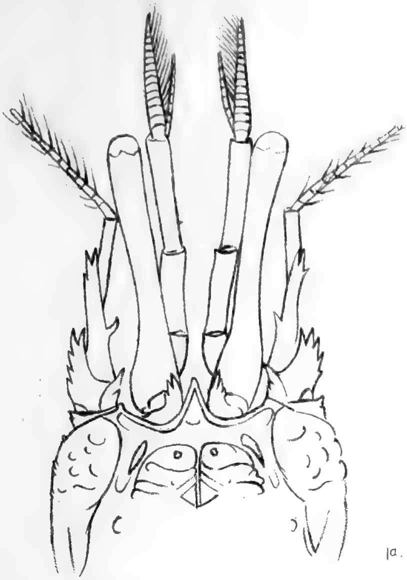
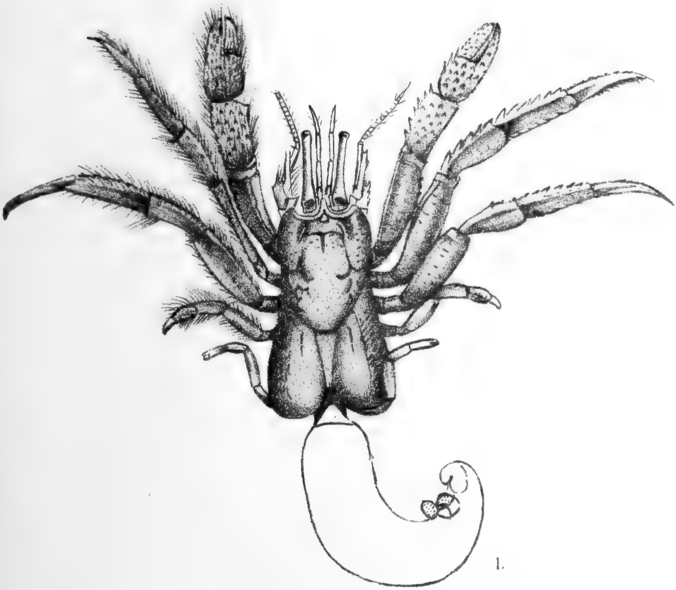
PAGURISTES BREVIROSTRIS.



1a.



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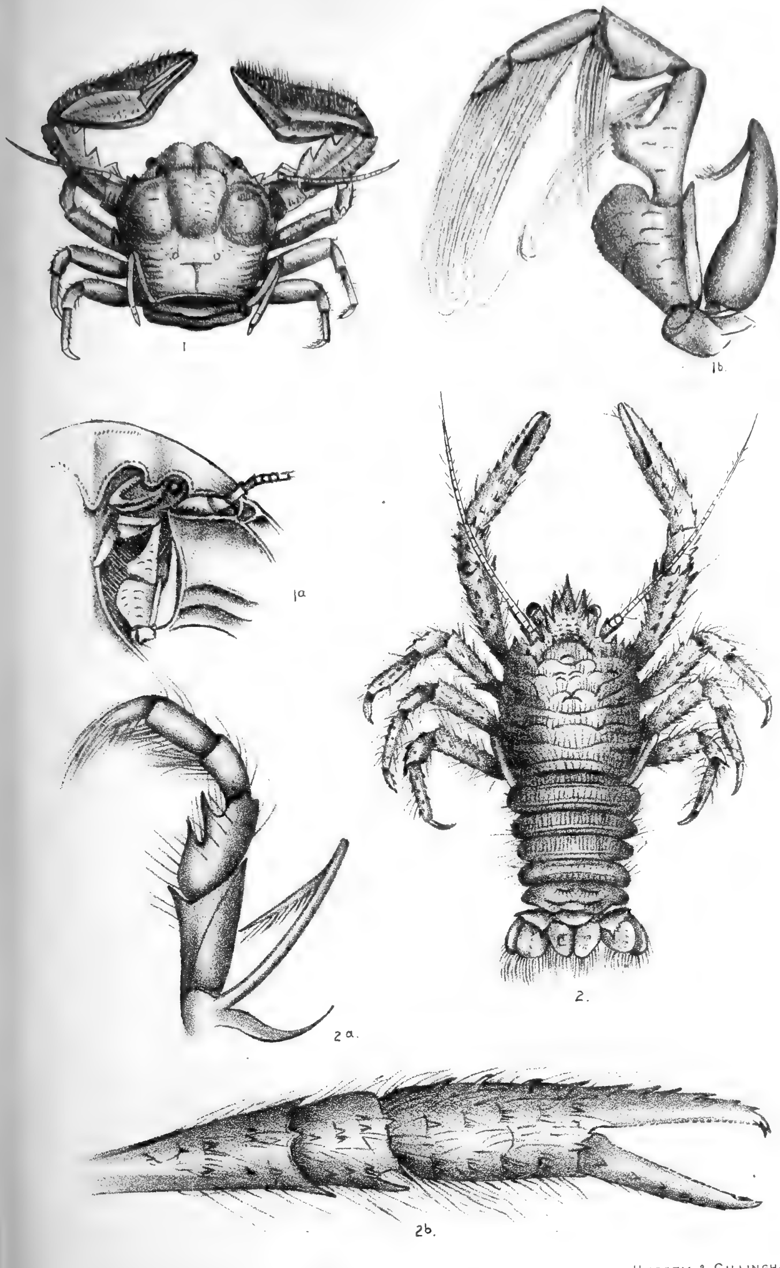
PAGURISTES SULCATUS.



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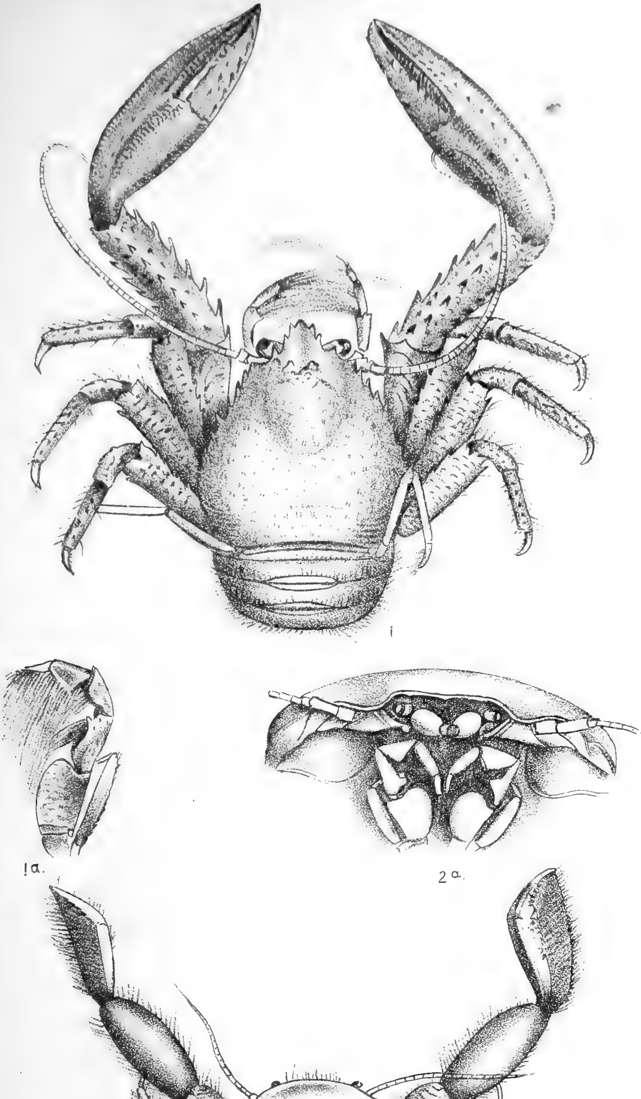
PORCELLANA ROSTRATA. GALATHEA SETOSA.



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PETROCHELES AUSTRALIENSIS. POLYONYX TRANSVERSUS.

DESCRIPTIONS OF PLATES.

Plate XXXII.

Paguristes frontalis, M.-Edw.

Fig. 1. Antennal peduncle, side view, enlarged.
2. Mandible, enlarged.
3. First maxilla, enlarged.
4. Second maxilla, enlarged.
5. First maxilliped, enlarged.
6. Large cheliped, enlarged.
7. Appendage of first abdominal somite of male enlarged.

Plate XXXIII.

Fig. 1. *Paguristes brevirostris* n. sp., enlarged.
1a. ,, ,, anterior regions, enlarged.

Plate XXXIV.

Fig. 1. *Paguristes sulcatus*, n. sp., enlarged.
1a. ,, ,, anterior regions, enlarged.

Plate XXXV.

Fig. 1. *Porcellana rostrata*, n. sp., enlarged.
1a. ,, ,, anterior regions, enlarged.
1b. ,, ,, third maxilliped, enlarged.
2. *Galathea setosa*, n. sp., enlarged.
2a. ,, ,, third maxilliped, enlarged.
2b. ,, ,, cheliped, enlarged.

Plate XXXVI.

Fig. 1. *Petrocheles australiensis*, Miers, enlarged
1a. ,, ,, third maxilliped, enlarged.
2. *Polyonyx transversus*, Haswell, enlarged.
2a. ,, ,, anterior regions, enlarged.

Further Notes on Australian Coleoptera, with Descriptions of New Genera and Species.

By the Rev. T. Blackburn, B.A

[Read October 3, 1905.]

XXXV.

LAMELLICORNES LAPAROSTICTI.

TROGIDES *(continued).*

Liparochrus.

The species of this genus, as distinguished from *Antiochrus*, are of very uniform facies, and much general resemblance, *inter se*, but differing by very satisfactory structural characters. They are easily divided into well-marked groups, distinguished by the number of striæ on the elytra and the external armature of the front tibiæ. The species of only one group—that with numerous, closely placed elytral striæ—are, so far as I know, much subject to variety, and it is just possible that in that group the forms which I regard as varieties of one species may represent a considerable number of very closely allied species. Several species, which I refer to Dr. Sharp's genus *Antiochrus*, have been attributed to *Liparochrus*, and concerning that reference I propose offering some notes below, under the heading "*Antiochrus.*" Sixteen names have been proposed as names for species referred to *Liparochrus*, and one *Liparochrus* has been erroneously named as a member of the genus *Cœlodes*. Of the above-mentioned seventeen names, however, all except (at most) eight, I believe to be synonyms, or not to represent true *Liparochri*, and of the eight one name is of doubtful validity. It will be well to enumerate this synonymy before I pass on to furnish a tabular statement of the distinctive characters of the named *Liparochri* of Australia, and to describe two new species which are before me.

L. crenatulus, Fairm., *pimelioides*, Lansb., and *globuliformis*, Macl., I believe to be synonyms of *multistriatus*, Har., for reasons set forth below, under the name *multistriatus*.

L. (cœlodes) bimaculatus, Macl., is said by Harold to be *L. fossulatus*, Westw. This is probably correct. I have seen the type specimen, and it is certainly a *Liparochrus*. My note, when I examined it, is, "*Liparochrus*, probably (from memory) *fossulatus*, but there is not a specimen of the latter at hand for comparison."

L. raucus, Fairm., is evidently, I think, judged by the description, a synonym of the earlier name, *silphoides*, Har.

L. ciliboides, *Har.*, is described in terms that do not distinguish it from *sculptilis*, Westw., and is probably identical with it.

L. aberrans, Fairm., *oblongus*, Har., and *politulus*, Macl., must be referred to *Antiochrus*.

L. asperulus, Fairm. The author's description of this species does not indicate characters that would enable me to place it in the following tabulation. I conjecture that it has probably tridentate front tibiæ, and if so it certainly must stand among the four species that I have placed last in the tabulation. Fairemaire himself states that it is near one of them (*L. geminatus*, Westw.). The statement that the interstices of its elytra are rugulose seems to distinguish it from all the four species I have referred to above, and its colour being stated as "black" further indicates its distinctness from all of them except *geminatus*. I have not seen any *Liparochrus* which fits Fairemaire's description. Nevertheless, it is to be noted that the differences cited between this species and *geminatus* (in which the elytral interstices of the elytra have a decided tendency towards rugulosity) are so much of degree that there is room for doubt whether the description may not have been founded on a small, strongly sculptured example of the older species, a doubt that could be set at rest only by examination of the type or of specimens agreeing with Fairemaire's description, and emanating from Fairemaire's locality (Peak Downs, Qu.). If its front tibiæ have only two external teeth the word "nitidissimus" in its description distinguishes *L. asperulus* from its congeners of the same group.

TABULATION OF CHARACTERS.

A. Elytra with closely packed, non-geminate striæ ... ... multistriatus, *Har.*
AA. Elytra with widely spaced striæ, which run in pairs.
  B. Front tibiæ bidentate externally.
    C. Elytra opaque, with nitid granules on the interstices ... ... silphoides, *Har.*
    CC. Elytral interstices not bearing nitid granules ... ... sculptilis, *Westw.*
  BB. Front tibiæ tridentate externally.
    C. Elytra blackish, each bearing 2 red spots ... ... quadrimaculatus, *Har.*
    CC. Elytra not bimaculate.
      D. Elytral striæ impressed with comparatively large foveiform punctures ... ... fossulatus, *Westw.*
      DD. Elytral striæ finely (or scarcely) punctulate.
        E. Expanded lateral part of pronotum closely punctulate or strigose.

F. Clypeus not abruptly expanded in front of the eye.	
G. Colour black, or nearly so; elytral interstices somewhat closely punctulate	geminatus, *Westw.*
GG. Colour bright ferruginous; elytral interstices very sparsely punctulate	rufus, *Blackb.*
FF. Clypeus strongly and abruptly expanded in front of eye	dilatatifrons, *Blackb.*
EE. Expanded lateral part of pronotum punctureless, with a few setiferous granules ...	nitidicollis, *Blackb.*

L. multistriatus, Har. I believe this to be an extremely variable species, widely distributed in Northern Australia, and *L. crenatulus*, Fairm., *pimelioides*, Lansb., and perhaps *globuliformis*, Macl., to be synonyms of Harold's name. I have examined a large number of specimens from numerous localities, having the closely striated elytra which distinguish the above-named forms from the other named Australian *Liparochri*, and find among them a wide range of size and many differences in the sculpture of the pronotum, all these differences being observable, *inter se*, among specimens sent in batches from a common locality (*e.g.*, in a batch of specimens from Port Darwin). According to description *crenatulus* differs from *multistriatus* in its pronotum being "sat dense punctatum," while that of *multistriatus* is "in disco parce punctatum." I have both forms, and also many intermediate, and specimens whose pronotum is devoid of puncturation except close to the lateral margin. *L. pimelioides* should be smaller, with the elytra more dilated behind, and having the front angles of the prothorax less acute. A specimen before me presents these characters except the last, but, on the other hand, I have an example with the last-named character very conspicuous, but otherwise agreeing with typical *multistriatus*. *L. globuliformis*, Macl., should be smaller than *multistriatus*, with the pronotum more sparsely punctulate. I have specimens agreeing with the latter character, but have not seen any quite so small as the size Macleay gives (long., $1\frac{3}{4}$ l., my smallest specimen being $2\frac{1}{4}$ l.), and this extremely small size perhaps suggests specific validity. If the characters named as distinguishing the three forms that have been separated from *multistriatus* are to be regarded as valid, several others of the forms before me must be treated as distinct species.

L. dilatatifrons, sp. nov. Nitidus; brunneo-rufus; convexus; latissime ovalis; sat glaber; clypeo antice late leviter emarginato, rugulose subgrosse punctulato, lateribus ante oculos subito sat fortiter dilatatis; prothorace fortiter transverso, antrorsum fortiter angustato, supra in disco sparsim subtilissime (in lateribus fortiter et strigatim) punctulato, lateribus leviter arcuatis, angulis obtusis, basi marginata; scutello sparsim subfortiter punctulato; elytris sat fortiter geminato-striatis striis vix perspicue punctulatis, interstitiis sat latis leviter subconvexis sparsim sat fortiter (nullo modo rugulose) punctulatis; tibiis anticis extus tridentatis. Long., $3\frac{1}{2}$ l.; lat., $2\frac{1}{2}$ l.

Among the nitid *Liparochri* having geminate non-punctulate (or nearly so) elytral striæ, this species stands alone (unless *L. asperulus*, Fairm., agrees with it) in having the part of its clypeus immediately in front of the eyes abruptly and horizontally dilated. This clypeal structure is found in some species of other groups (e.g., *multistriatus*, Har.). Australia. I am not sure of the exact locality, but believe it to be in tropical Queensland.

L. nitidicollis, sp. nov. Nitidus; brunneo-rufus; convexus; latissime ovalis; sat glaber; clypeo antice late vix emarginato, rugulose grossissime strigato, lateribus ante oculos haud dilatatis; prothorace fortiter transverso, antrorsum fortiter angustato, supra in disco subtilissime sparsissime punctulato, in lateribus haud punctulato sed granulis setiferis sparsis instructo, lateribus arcuatis, angulis anticis subacutis posticis rotundatis, basi marginata; elytris subtilius geminato-striatis, striis vix perspicue punctulatis, interstitiis planis lævibus sat latis; tibiis anticis extus tridentatis. Long., 3 l. (vix); lat., $1\frac{4}{5}$ l.

A very distinct species, differing widely from all its congeners in the sculpture of the lateral portions of its pronotum, which are perfectly smooth and very nitid (*i.e.*, devoid of any punctures or strigosity), but bear a few very conspicuous setiferous granules.

N.W. Australia.

Antiochrus.

I have before me about a dozen specimens which I have no doubt are congeneric with *A. brunneus*, Shp. The only difficulty I feel in thus referring them consists in the absence from Dr. Sharp's diagnosis and description of any mention of the peculiar sculpture of the marginal part of the elytra, which is present in all the specimens before me. They, however, present all the characters attributed by Dr. Sharp to *Antiochrus*, and moreover are evidently very close to *Liparo-*

chrus oblongus, Har, with which its author subsequently stated that *A. brunneus*, Shp., is identical. If I am in error in referring these specimens to *Antiochrus* they must be regarded as members of an unnamed genus very near to *Liparochrus*. There can, at any rate, be no objection to placing them provisionally in *Antiochrus*. Dr. Sharp says that the only definite character he can assign to *Antiochrus*, as distinguishing it from *Liparochrus*, consists in the great dilatation and compression of the posterior tibiæ, which is certainly very conspicuous in all the specimens I am discussing; but it is unquestionably the case that the form of the tibiæ is not constant in typical *Liparochri*, some of them (*e.g.*, *L. geminatus*, Har.), having hind tibiæ very much compressed and dilated; in fact, almost as strongly as they well could be. I should, therefore, as far as that particular character is concerned, hesitate to regard it as generally satisfactory if it stood alone. I find, however, that the species I regard as *Antiochri* also differ from *Liparochrus* very considerably in facies, being (as Dr. Sharp remarks of the typical *Antiochrus*, though he does not definitely make it a generic character, probably on account of having seen only one species of the genus), in shape more like *Trox* than *Liparochrus*, *i.e.*, more elongate, narrow, and parallel than *Liparochrus*. When in addition to this marked difference in *facies* I observe that all these *Trox*-shaped allies of *Liparochrus* with exaggeratedly dilated posterior tibiæ have also a peculiar elytral sculpture, of which there is no trace in any described typical *Liparochrus*, I have no hesitation in regarding them as generically distinct from *Liparochrus*. The peculiar sculpture I refer to is the presence (on the surface of the elytra close within the hinder part of the lateral margin, and more or less extended forward, according to the species) of several very fine, parallel raised lines placed close to each other, and parallel with the actual margin. In *Liparochrus* the character of the elytral sculpture is uniform quite up to the margin.

Although it seems desirable to set forth the foregoing notes on a genus of Australian *Trogides*, which appears to me distinct from *Trox* and *Liparochrus*, and which I believe to be identical with *Antiochrus*, I regret to find myself unable to write anything satisfactory about the species. The following species are all, I have little doubt, members of this genus:—*A. brunneus*, Shp., and *Liparochrus oblongus*, Har., *aberrans*, Fairm., and *politulus*, Macl. As stated above, Harold has identified the first two of these names as representing a single species. The only one of them named in my collection is *A. politulus*, Macl., my example of which has been compared with the type. It appears to be distinct from *brunneus* and *oblongus*, *inter alia*, by its head not being granulate. It is also quite distinct from all the other *Antiochri* known to me by the extraordinary thickening of the hinder part of the lateral margin of its elytra. Among the remaining eleven specimens before me there are clearly at least four species, but as I am unable to point out any definite character in them as reliably specific—as one of them is certainly variable in respect of sculpture—and as any one of them might be *A. aberrans*, Fairm., I must leave the determination of the species of this genus for future study and increased material.

LAMELLICORNES PLEUROSTICTI.

The *Trogides*, which end, as far as known Australian species are concerned, with *Antiochrus (vide supra)*, form, in the Lacordairean system of classification, the sixth tribe of the first subfamily, or "legion," *(Lamellicornes laparosticti)* of the family *Lamellicornes*. The seventh tribe of that subfamily, the *Glaphyrides*, has no known representative in Australia. One Australian genus *(Phœnognatha)*, through its alliance with a non-Australian genus *(Aclopus)*, which Erichson referred to the *Glaphyrides*, has been placed by some authors in the same tribe; but Lacordaire (Gen. Col., iii.; p. 160; note 4) has shown that Erichson was wrong in referring *Aclopus* as he did, and that the proper place for it is in the second subfamily of *Lamellicornes*. That this is the case with *Phœnognatha* is obvious to any one who examines a specimen of that genus. These remarks seem desirable because *Phœnognatha* stands in Masters' catalogue as a *Glaphyrid*.

The *Lamellicornes pleurosticti* are distinguished from the first subfamily by the position of their abdominal stigmata, the hinder three of them being placed (not on the connective membrane of the dorsal and ventral surfaces, but) on the ventral surface of its segment, so that the last of them is ordinarily visible when the elytra are closed, as well as when they are set open to expose the abdomen fully.

These two subfamilies (or "legions," as Lacordaire calls them) comprise on the Lacordairean system of classification the whole of the *Lamellicornes*. The second subfamily, with which I hope to deal, in respect of its Australian species, in this and some following memoirs, is divided into four "tribes," each of which is extensively subdivided into groups, subgroups, sub-sub-groups, and so on. The four main groups or "tribes" are the *Melolonthides*, *Rutelides*, *Dynastides*, and *Cetoniides*. The first of these differs from the others in the hinder three of the abdominal stigmata being only slightly distant from the connective membrane, with the consequence that all the six stigmata are almost in a continuous line, while in the others all the hinder three stigmata are considerably removed from the connective membrane, and therefore quite out of line with the anterior three. The following table shows the characters by which these "tribes" are differentiated:—

A. The abdominal stigmata (or "spiracles") placed almost in a continuous line	Melolonthides
AA. The hinder three abdominal stigmata quite out of line with the others.	
B. The claws of the tarsi unequal ...	Rutelides
BB. The claws equal.	
C. The front coxæ transverse, and but little prominent	Dynastides
CC. The front coxæ evidently less transverse and more prominent	Cetoniides

Most of the information contained in the preceding remarks is, of course, familiar to students of the *Lamellicornes*, but before passing on to work in which I hope to diagnose some new genera and describe new species it seems well to furnish such a brief recapitulation as the above contains of preliminary facts, in order to start with a clear understanding of the order and plan I propose to follow.

MELOLONTHIDES.

This first tribe of the second subfamily of *Lamellicornes* is of all the tribes of the family by far the most numerously represented in Australia. Lacordaire divides it into nine subtribes, and another has since been added by Dr. Sharp. Of these ten subtribes only four are incontestably represented in Australia, while to a fifth subtribe *(Macrophyllides)* have been referred two Australian species (both very rare in collections), whose position in that subtribe appears to me open to some doubt. The following table shows the distinctive characters of these five subtribes:—

A. Labrum fixed to the front of the clypeus, and on the same plane with it	Systellopides
AA. Labrum not as in the *Systellopides*.	
B. Front coxæ prominent, and not or but little transverse.	
C. Palpi inserted very little below the plane of the clypeus	Sericides
CC. Palpi inserted considerably below the plane of the clypeus ...	Sericoides
BB. Front coxæ but little prominent, and strongly transverse.	
C. Ventral segments soldered together	Melolonthides (true)
CC. Ventral segments free	Macrophyllides

The above brief recapitulation of facts regarding the tribe *Melolonthides* is (excepting the tabulation) a mere summary of matters that I have already discussed at some length in a former memoir (Tr.R.S.S.A., 1898, p. 18, etc.), to which I would refer the reader. I repeat the outline merely to avoid the need of having another memoir in hand while making use of the present one. Referring to the tabulation (in which I have departed somewhat from the characters relied on by Lacordaire) I may remind those who may use it that in characterising large aggregates of species it is almost invariably impossible to find single sharply defined points of difference (such as are required for a tabular statement) that can be relied upon as strongly developed in every member of the aggregates in question. The truth of this remark is illustrated by the character assigned to the *Systellopides*, inasmuch as there are genera of the *Sericides* in which to a casual glance it certainly seems to be present. I have discussed this point before *(loc. cit.)*, and therefore merely mention it now with the added remarks that, apart from this character, I cannot see how the *Systellopides* are to be distinguished from the *Sericides* as at present constituted, and that I am unable to satisfy myself that the apparent labrum is really that organ in the *Systellopides*, and is not in such *Sericides* as *Phyllotocus*.

SYSTELLOPIDES (First subtribe of Australian *Melolonthides).*

This subtribe consists of eight species, described by Dr. Sharp, to which it seems probable that the two species of the genus *Prochelyna* ought to be added, and I have two new species now to be described. If *Prochelyna* is distinct from all Dr. Sharp's genera, these twelve species must stand divided into eight genera. They are all extremely rare in collections. Dr. Sharp has conjectured that *Metascelis flexilis*, Westw., the *habitat* of which is not known, may be a *Systellopid*, in which case it might probably be Australian. Dr. Sharp's memoir on the subtribe (Ann. Mus. Gen., ix., pp. 311, etc.), supplies an excellent tabular statement of distinctive characters of those species that can be confidently referred to it. I have no information as to the habits of these insects.

Sphyrocallus.

S. bicolor, sp. nov. Rufo-testaceus, clypeo obscuriori, capite postice elytrisque piceis; pronoto, scutello, sternis et femoribus pilis testaceis elongatis dense vestitis; labro lævi; clypeo creberrime sat fortiter punctulato; fronte antice sparsius (postice sparsissime) punctulata; sutura clypeali impressa; prothorace fortiter transverso, antice minus angustato, supra opaco, vix perspicue punctulato (sculptura sub pilos densos abdita), lateribus sat arcuatis, angulis obtusis; elytris subnitidis crebre subtilius minus æqualiter punctulatis, leviter minus æqualiter geminato-striatis; tibiis anticis extus tridentatis. Long., 8 l.; lat., 4 l.

This species certainly ought not to be separated generically from *S. brunneus*, Shp., of which I possess an example agreeing perfectly with Dr. Sharp's description, and taken in N.W. Australia (the original locality). Nevertheless, it differs from *S. brunneus* in respect of a character that Dr. Sharp regards as generic in having its clypeus separated from the frons by an ordinary suture, not a raised line. Also, it departs somewhat in the structure of the labrum, which is intermediate between that of *S. brunneus* and *Chilodiplus* (also in my collection), the front portion of that organ being evidently *thickened* or *tumid*, though the organ is not distinctly bipartite, as in *Chilodiplus*. Apart from these slight structural modifications the present species and *S. brunneus* are extremely close, even specifically, the principal external differences being in the darker head and elytra of the present insect, the shorter joints of its antennal flagellum, the opaque pronotum, the less depth of its elytral striæ, its more nitid and less pilose pygidium, its more densely pilose pronotum, the presence of three external teeth on its front tibiæ (my example of *S. brunneus* has only two, including the apical one), and the greater length of its ventral segments. I have no doubt that my *S. brunneus* and *S. bicolor* are male and female respectively of two allied congeneric species. The joints of the flagellum of the antennæ in *brunneus* are nearly four times as long as the preceding four joints together, in *bicolor* scarcely twice as long. Some of the distinctions between the two that I have mentioned above are probably sexual, but those of the labrum, the opacity of the pronotum, and the striation of the elytra (it is hardly likely that the deeper sculpture would be in the male), together with much colour difference and widely separated locality, point to specific distinctness.

W. Australia; near Eucla.

Enamillus.

The following species must be referred to this genus according to the tabular statement of the characters of the *Systellopid* genera furnished by Dr. Sharp (Ann. Mus. Gen., ix., p. 319), though it is not unlikely that had it been before Dr. Sharp he would have found a new generic name for it. It presents all the characters indicated for *Enamillus* in the tabulation, but differs from those set out in the subsequent detailed diagnosis in respect of the antennæ, the basal joint of the flabellum not enfolding the following joints (although the apical joint enfolds the preceding ones, as in *Enamillus*). It also differs widely as a species from the unique *Enamillus* (*E. striatus*, Shp.), especially in its pronotum not being pilose and its elytra not regularly striate, but it is certainly so close structurally to *Enamillus* that no confusion can result from its being assigned to that genus. Unfortunately, my specimen has lost its legs, though in all other respects it is in excellent condition. The *Systellopides* are so rare in collections that I do not like to omit the opportunity of describing this one, and the species of that subtribe are, so far as known, such isolated forms that it is unlikely any other species exists which would be capable of confusion with the present one for want of a description of the colour, etc., of its legs.

E. sharpi, sp. nov. Testaceus, antennarum flabello, palporum maxillarium articulo apicali, capite postice pronoto medio et elytris rufo-piceis (pedibus exempli typici carentibus); supra sat glaber sed prothorace piloso-fimbriato; subtus sat hirsutus; capite (labro sat lævi excepto) crebre sat rugulose punctulato; pronoto subnitido minus crebre minus fortiter punctulato, fortiter transverso, antice valde angustato, lateribus fortiter rotundatis, angulis anticis sat acutis posticis nullis; scutello transverso sparsim punctulato; elytris inæqualiter sat crebre punctulatis, subopacis nec velutinis, striis subsuturali fortiter duabus (geminatim positis) modice quatuor (geminatim positis) vix et tribus sublateralibus fortiter impressis. Long., 5½ l.; lat., 2½ l.

The elytral striæ are as follows:—A subsutural stria deeply impressed except close to the scutellum; three pairs of striæ (the two of each pair very close to each other) at wide intervals from each other and from the subsutural stria, the first pair obsolete in front, but moderately deep behind, the other two pairs scarcely distinct; three entire, fairly deep striæ close to each other and to the lateral margin. The piceous median portion of the pronotum is narrow in front and much dilated hindward, so as to be of triangular form.

W. Australia.

SERICIDES (Second subtribe of Australian *Melolonthides*).

Regarding this subtribe I have little to add to what I wrote seven years ago in the memoir already referred to, where I discussed at some length the character that Lacordaire relied on as essentially distinguishing the *Sericides* from the *Sericoides*, and, without disputing its validity, proposed a different way of determining its presence or absence, which would involve some variation from Lacordaire's classification of these *Melolonthides*. I still hold the same opinion on the matter that I did then. In the memoir mentioned, however, I omitted to refer to Lacordaire's subdivision (into smaller aggregates of genera) of this and the following subtribe—a reference which seems to be called for by the fact that my proposed different expression of the distinction between the subtribes involves a certain degree of re-arrangement of their "groups" (or sub-sub-tribes). These I ignored, provisionally, and furnished a tabulation of the genera without any intermediate subdivisions. Lacordaire subdivides the *Sericides* into five groups, two of which being non-Australian need not be discussed here; and a third *(Mæchidiides)* has the insertion of its maxillary palpi much below the plane of the clypeus, which I regard as associating them with the *Sericoides* rather than with the other Australian genera that Lacordaire places among the *Sericides*. The *Sericoides* Lacordaire subdivides into six "groups," two of whch are not known to be found in Australia. Of the remaining four groups two *(Pachytrichides* and *Aclopides*—at any rate the Australian member of the latter) have their maxillary palpi inserted close to the under surface of the clypeus (as in *Phyllotocus* etc.), and, therefore, in my judgment, should stand near *Phyllotocus*, etc., rather than among such genera as *Colpochila*, *Heteronyx*, etc. I, therefore, hold that these "groups," assuming that the non-Australian *Aclopid* genus is rightly associated with *Phænognatha)*, should be transferred to the *Sericides*, so that there will be four "groups" of Australian *Sericides* and two of Australian *Sericoides*. And here I may refer to a valuable memoir on *Pachytricha* (Ent. M.M. xi., pp. 2, etc.), in which Dr. Sharp discusses the difficulty of placing that genus in the *Melolonthid* series with all the advantage of his profound learning in anatomy, but does not state his own judgment as to what place it should occupy; although I do not find in his remarks anything inconsistent with the view I have taken of the affinities of the genus. The "groups" of the *Sericides* known as occurring in Australia may, then, in my opinion, be thus stated:—

A. Claws bidentate beneath (size very large) ... ... Pachytrichides
AA. Claws not bidentate beneath (size moderate or small).
B. Mandibles surpassing the clypeus and embracing the labrum ... .. Aclopides
BB. Mandibles normal.
C. Hind coxæ very wide ... ... Phyllotocides
CC. Hind coxæ narrow ... ... Diphucephalides.

PACHYTRICHIDES (First group of *Sericides*).

The genus *Pachytricha*, with its six described species, monopolises this group. The species are all, so far as I have observed, rare in collections, nor have any, I believe, been taken except in W. Australia. They are very fine, large insects, and are very closely allied *inter se*. They have been fully dealt with by Dr. Sharp in the memoir already mentioned, and I have nothing further to say about them.

ACLOPIDES (Second group of *Sericides*).

Represented in Australia, so far as known, by the single species, *Phænognatha erichsoni*, Hope, which is fairly common in collections, but seems to be limited, in respect of *habitat*, to the far north of the continent.

PHYLLOTOCIDES (Third group of *Sericides*).

For the present I must pass this group over with the mere remark that I am not yet prepared to deal with it more fully and confidently than I did in my former memoir (already referred to); for, although I have made some progress with a revision of that memoir, it is probable that I may be able at no distant date to examine certain types, the inspection of which will enable me to write more definitely than I could do at this time.

DIPHUCEPHALIDES (Fourth group of *Sericides*).

This last group of Australian *Sericides* contains two genera, *Diphucephala* and *Epholcis*—the former numerous in known species, and widely distributed, many of its species very abundant. The latter, so far as at present known, almost limited to tropical regions, consisting of not more than five described species, and not very frequent in collections. What I have said above concerning the *Phyllotocides* may be repeated, *mutatis mutandis*, concerning this group, and I, therefore, omit further remark on it for the present.

SERICOIDES (Third subtribe of Australian *Melolonthides*).

Having referred the *Pachytrichides* and *Aclopides* to the subtribe *Sericides*, I leave only two of the groups into which Lacordaire divided the *Sericoides*, as representing that subtribe in Australia, viz., the *Heteronycides* and *Stethaspides*. They are distinguished from each other by Lacordaire as follows:—

A. Species not having a sterna! projection ... Heteronycides
AA. Species furnished with a sternal projection ... ... Stethaspides

The former of these is by far the most abundant in species of all the "groups" of Australian *Melolonthides*. The number of species is so overwhelming that until a much larger proportion has been carefully studied and described it would not be wise to venture an opinion as to whether they should all remain included within the limits of the one "group" or ought to be split up into several "groups," and therefore I do not propose to discuss that point at present. I have already published a revision of the enormous genus *Heteronyx*, and have now before me a great number of additional species, which I hope to deal with at no distant date. I have also furnished a revision of the extensive genus *Colpochila* and of that also have now numerous additional species. Of the more extensive genera of the "group" there still remains *Liparetrus* to be revised by me, of which, in the following pages I attempt a revision, adding some notes preparatory for more detailed work on some other genera closely connected with *Liparetrus*. I may here draw attention to my having furnished (in the previous memoir already referred to) a tabulation of the characters, together with some notes on the same, of the Australian genera known to me that can be referred to the *Sericoides*, though it should be noted that in that memoir I omitted the *Stethaspides* (probably by an oversight), and limited my remarks to the *Heteronycid* portion of the sub-tribe. That, however, is a matter of little importance, as the known species of Australian *Stethaspides* are only two in number, nor is it probable that there are many more to be added in the future; and, moreover, I do not think that they will stand permanently in the *Sericoid* series. The *Stethaspides*, however, do not call for remark here.

Liparetrus.

I have found the study of this very extensive genus one of the most difficult tasks that I have encountered in Australian entomology, not on account of the close alliance of its species (for most of them have exceptionally distinctive structural characters), but on account of the very unsatisfactory nature of the monograph of the genus written by Sir W. Macleay, and published in the Proceedings of the Linnean Society of New South Wales, A.D. 1886, which is rendered practically useless by the fact that no reliance can be placed upon the apportionment of the species between the two principal groups into which it divides the genus founded upon the number of joints in the antennæ. I regret to find that I have to make some corrections in my own work on *Liparetrus*, in describing, many years ago, some species as new which I now find had been previously named by Sir W. Macleay, I not having discovered at that time that Sir W. Macleay's statements of antennal structure were in many instances erroneous, so that I assumed species with eight-jointed antennæ to be distinct from those which Sir William asserted to have nine antennal joints. After many attempts to identify Macleay's species by the study of their author's descriptions I arrived at the conclusion that it was impossible to do so, and that an examination of the types (which are in the Sydney Museums) was essential. Accordingly I have recently visited Sydney for the purpose of making that examination, and am now in a position to deal with the matter authoritatively, and the result of my investigations will be found in the following pages.

The number of names that I can ascertain to have been given to species presumably of *Liparetrus*, is 130, of which 29 may be confidently regarded as synonyms, and 9 are so described that they cannot be identified without the examination of types to which I have no means of access, the number of recognisable species being, therefore, 92. To these I have now to add 20 new species, bringing the total up to 112.

As remarked above, the species of *Liparetrus* are in general distinguished by good structural characters, which on first thoughts would suggest the probability of its being easy to break the genus up into satisfactory subgenera and sections; but a prolonged and careful study has forced me to the conclusion that the structural differences are so curiously intermingled that there is not one of them by means of which anything approaching a natural group can be formed. The most striking of the structural characters that I refer to are—*(a)* nature of sexual differences; *(b)* form of clypeus; *(c)* structure of hind tarsi; *(d)* vestiture of dorsal surface; *(e)* structure of front tibiæ; *(f)* structure of antennæ.

The species, however, which are associated by agreement in any one of these respects differ widely as regards the other respects, and the species which are placed together by reliance upon any of them are not naturally associated, and have their closest allies in other groups. I have, therefore, not thought it well to form any subgenera, but have made the best use I can of the structural characters for grouping, without claiming to have succeeded in accomplishing a breaking up into natural aggregates except in so far as I shall indicate in the course of this paper that one or two of the subordinate aggregates seem to be a natural association of species.

It must be noted here, however, that *Liparetrus*, as treated by Blanchard and Macleay, includes a number of species of a genus separated by Burmeister from *Liparetrus* under the name *Automolus* (which I hope to discuss in a future memoir under the heading of that name), and it is to

Liparetrus, as characterised by Burmeister, that the preceding remarks refer.

The previous authors who attempted more or less grouping of the *Liparetri* known to them were Burmeister, Blanchard, and Macleay. Burmeister characterised his main groups according to the relative length of the joints of the hind tarsi—a system fairly easy to apply, but supremely unnatural in result. Blanchard founded his groups on antennal structure alone, and this system also leads to unnatural grouping, and in some cases requires use of a microscope. Macleay took the antennal structure as the basis of his classification, with the nature of the sexual distinctions, as indicating secondary aggregates—a system which is not only open to the same objection as Blanchard's, but also is vitiated by the existence of many species of which only one sex is known. I am unable, however, to find any method of grouping the *Liparetri* which will avoid relying upon the characters that I have referred to as unsatisfactory. I hope, nevertheless, to combine them in such fashion as will furnish a tabulation by which few species will be difficult of identification, although I can make no claim for my aggregates of being more *natural* groups than those of the authors I have referred to above. I divide the genus into 19 groups, on each of which separately I append some remarks, but it seems more convenient to make the *tabulation* of the species a continuous one than to provide 19 separate tabulations.

In stating the number of the external teeth of the front tibiæ I have included the apical projection of the tibiæ as a tooth. These teeth do not, I find, as a rule, vary sexually in any marked degree, though they certainly appear to vary in size somewhat in individuals of the same sex. In some species (*e.g.*, *discipennis*, Guér.), with bidentate front tibiæ, the upper tooth is very feeble in some specimens as compared with others, and it is usually most feeble in the males; but where it is well defined in the female it is always, as far as my observation goes, not actually *wanting* in the males. The species showing the greatest sexual disparity, known to me, in this. respect is *L. discipennis*. In the closely allied *L. canescens*, Macl., I do not find any sexual difference whatever in the armature of the front tibiæ.

Before I pass to the tabulated statement of the characters of the species, a list of the names that have to be sunk as synonyms, and some brief notes on the species that I have had to omit from the tabulation, seem to be required. I place the names that must be sunk as synonyms in alphabetical order, setting against each the name of which it becomes a synonym. *Basalis*, Macl., and *glaber*, Macl., are *nom præocc.* *Convexus*, Boisd., and *obscurus*, Homb. & Jacq., I have not been able to identify, and merely place them on the authority of other authors. My reasons for the rest of the synonymy will be found detailed in the following pages. It should be noted that *obscurus*, Macl., sinks as a *nom. præocc.*, as well as for the reason noted under the name *picipennis*, Germ. The three *nom. præocc.* are additional to the 29 original names that are synonyms:—

**acutidens*, Macl. = *tridentatus*, Macl.
**Adelaidæ*, Blackb. = *comatus*, Macl.
**agrestis*, Blackb. = *lævis*, Blanch.
**basalis*, Blanch. = *sylvicola*, Burm. (? Fab.).
basalis, Macl. = *albohirtus*, Mast.
**brunneipennis*, Blackb. = *ubiquitosus*, Macl.
convexus, Boisd. = *sylvicola*, Burm (? Fab.).
**flavopilosus*, Macl. = *fulvohirtus*, Macl.
glaber, Macl. = *lævatus*, Macl.
**hirsutus*, Burm. = *marginipennis*, Blanch.
**lanaticollis*, Macl. = *Palmerstoni*, Blackb.
**latiusculus*, Macl. = *sericeus*, Macl.
**Macleayi*, Blackb. = *sylvicola*, Burm. (? Fab.).
**Mastersi*, Macl. = *Germari*, Macl.
**maurus*, Blackb. = *collaris*, Macl.
**montanus*, Macl. = *auscipennis*, Guér.
**nigriceps*, Macl. = *lævis*, Blanch
**nigrohirtus*, Macl. = *marginipennis*, Blanch.
**nitidior*, Macl. = *picipennis*, Germ.
**nitidipennis*, Macl. = *ater*, Macl.
obscurus, Hombr. & Jacq. = *iridipennis*, Germ.
**obscurus*, Macl. = *picipennis*, Germ.
**parvulus*, Macl. = *lævatus*, Macl.
**perplexus*, Blackb. = *criniger*, Macl.
**propinquus*, Macl. = *rubicundus*, Macl.
**pruinosus*, Burm. = *vestitus*, Blanch.
**rugosus*, Macl. = *nigrinus*, Germ.
**salebrosus*, Macl. = *sylvicola*, Burm. (? Fab.).
**senex*, Blackb. = *iridipennis*, Germ.
**simillimus*, Macl. = *abnormalis*, Macl.
**simplex*, Blackb. = *rotundipennis*, Macl.
**spretus*, Blackb. = *asper*, Macl.

The following are the names of the species that I am unable to place in my tabulation. The type specimens of

* This synonymy has not, I believe, been previously notified.

those of them whose names are not Macleay's are in Europe, I presume, if still in existence:—

L. uniformis, Blanch., from Eastern Australia, seems likely to be a member of my twelfth group. The description implies that its elytra are of testaceous colour, without either pilosity or dark markings. If that be so, it is probably a species that I have not seen. Its author supplies no information about the structure of its hind tarsi. Macleay suggests its possible identity with his *luridipennis*, but that is most improbable. The descriptions do not agree, and the localities are very far apart.

L. convexiusculus, Macl. Quite unrecognisable by the description. I could not find the type in either of the Sydney Museums, where it might be expected to be.

L. curtulus, Burm. I suspect this species of being identical with *ferrugineus*, Blanch., although there are discrepancies of colour which render the identity doubtful. The description of colour agrees better with *ubiquitosus*, Macl., but the clypeus of the male does not seem to agree with that of the latter species. It may be distinct from both, in which case I have not seen it.

L. glabratus, Burm. I cannot identify this species. It is probably a member of my fourth group, and seems to be nearest to *incertus*, Blackb., but, *inter alia multa*, differs extremely in colouring. If the type was a specimen from whose propygidium and pygidium the vestiture had been removed by abrasion it might be *L. ovatus*, Macl.

L. glaber, Burm. This species is scarcely described. There being no information given by its author with regard to even such important characters as the structure of the antennæ and the front tibiæ, it is useless to hazard a guess as to its proper place in the genus.

L. Lottini, Dupont. According to Macleay, this species is identical with *L. humilis*, Blanch., in which case it is an *Automolus*. I cannot see, however, that Macleay can have had any solid ground for identifying it with any insect in particular, as the description is quite worthless.

L. nigricollis, Hope. This is a mere name; it is unaccompanied by any information that would associate the species with *Liparetrus;* in fact, the scanty remarks on the elytra seem to be more consistent with a place in some other genus.

L. gagaticeps, Macl. The presumable type is in the Macleay Museum. It appertains to a species that I have not seen elsewhere. Unfortunately, the structure of its antennæ cannot be examined without manipulation that could not be resorted to. Those organs, however, I can say with confidence, have not more than eight joints. If they are eight-jointed, the insect should be placed in my tabulation with *lævatus*, Macl., from which it differs by, *inter alia*, its brightly testaceous prothorax. If the antennæ are seven-jointed the insect should be placed in my tabulation with *opacicollis*, Macl., from which it differs by, *inter alia*, its being less than half the size of that species.

L. striatus, Blanch. Without information as to the structure of the hind tarsi it is impossible to place this species in a tabulation. If the basal joint of those tarsi be shorter than the second joint it might probably be identical with *L. glaber*, Burm., and also with *ovatus*, Macl., in which case it would have priority over those two names. If its hind tarsi be not as suggested above it is a species that I have not seen.

A. Antennæ 9-jointed.
B. Front tibiæ 3-dentate externally.
C. Basal joint of hind tarsi evidently shorter than the 2nd joint.
D. Disc of pronotum bearing erect pilosity.
E. Erect pilosity largely extended on the elytra.
F. Pilosity of pronotum entirely of pale colour.
G. Front margin of clypeus very deeply emarginate (as deeply as in *abnormalis*, Macl.) Kennedyi, *Macl.*
GG. Front margin of clypeus not (or more feebly) emarginate.
H. Basal joint of front tarsi (male) produced at inner apex.
I. Elytra not closely punctulate; geminate striæ well marked ... ... comatus, *Macl.*
II. Elytra closely punctulate; geminate striæ feebly defined ... ... fulvohirtus, *Macl.*
HH. Basal joint of front tarsi (male), not, or scarcely, produced at inner apex.
I. Pygidium black ...
J. Elytra with geminate striæ not, or scarcely, traceable ... xanthotrichus, *Blanch*

JJ. Elytra with geminate striæ well marked ... ... necessarius, *Blackb.*

II. Pygidium red ... rufiventris, *Macl.*

FF. Pilosity of pronotum blackish in middle part.

G. Basal joint of front tarsi (male) keeled on inner edge.

H. Size very large (about 5 l.); geminate striæ of elytra strong ... ... ater, *Macl.*

HH. Size moderate (about 4 l.); geminate striæ of elytra feebler ... phœnicopterus, *Germ.*

GG. Basal joint of front tarsi (male) not keeled, but produced at inner apex.

H. Front of clypeus (male) bisinuately emarginate (as in *xanthotrichus*) ... Mitchelli, *Macl.*

HH. Front of clypeus (male) not bisinuate villosicollis, *Macl.*

EE. Elytra glabrous, or nearly so.

F. Clypeus of male truncate; pilosity of pronotum of pale colour.

G. Clypeus scarcely narrowed forward. Front tarsi of male much thickened ... ... Germari, *Macl.*

GG. Clypeus considerably narrowed forward. Front tarsi of male scarcely thickened ... capillatus, *Macl.*

FF. Clypeus of male rounded in front; pilosity of pronotum blackish ... dispar, *Blackb*

DD. Pronotum glabrous on disc, but frilled with erect hairs all across front.

E. Front margin of clypeus with a median tooth-like obtuse prominence in both sexes ... ... Kreusleræ, *Macl.*

EE. Front margin of clypeus not prominent in the middle.

F. Lateral angles of clypeus acute in the male.

G. All the joints of front tarsi (male) keeled internally ... ... lugens, *Blackb.*

GG. Tarsi of male not keeled internally.

H. Elytra strongly pruinose and iridescent ... angulatus, *Macl.*
HH. Elytra not pruinose nor iridescent ... fimbriatus, *Blackb.*
FF. Lateral angles of clypeus roundly obtuse ... concolor, *Er.*
DDD. Pronotum glabrous on disc, or with only a few hairs on the antero-external parts.
E. Clypeus conspicuously tridentate in front ... ... distans, *Blackb.*
EE. Clypeus not dentate (or scarcely so).
F. Entirely testaceous (including the head) ... aridus, *Blackb.*
FF. Some part (at least the head) dark.
G. Sides (but not middle part) of front margin of pronotum pilose ... picipennis, *Germ.*
GG. Front margin of pronotum glabrous.
H. Propygidium and pygidium clothed with coarse squamiform setæ.
I. Clypeus (at least of male) sharply truncate, with well defined angles ... lividipennis, *Blackb.*
II. Clypeus rounded off at the angles in both sexes.
J. Size fairly large (3 l. or more); tarsi and claws very long .. ovatus, *Macl.*
JJ. Size small (less than $2\frac{1}{2}$ l.); tarsi and claws much shorter.
K. Median line of pronotum well impressed ... rubefactus, *Macl.*
KK. Median line of pronotum not impressed subsquamosus, *Macl.*
HH. Propygidium and pygidium devoid of squamiform setæ ...
I. Propygidium and pygidium almost without sculpture.
J. Prothorax very strongly transverse ... ... rufipennis, *Macl.*
JJ. Prothorax much more feebly transverse ... posticalis, *Blackb.*

II. Propygidium and pygidium with well defined puncturation.
J. Head sparsely punctulate ... juvenis, *Blackb.*
JJ. Head closely punctulate ...
K. Pronotum conspicuously canaliculate (at any rate near base).
L. Size moderate (3 l. or more) ... incertus, *Blackb.*
LL. Size very small (scarcely 2 l). ... insularis, *Blackb.*
KK. Pronotum not canaliculate ... vicarius, *Blackb.*
CC. Basal two joints of hind tarsi equal (or scarcely differing) in length.
D. Disc of pronotum pilose.
E. Basal joint of hind tarsi longer than apical spine of its tibia.
F. The hairs of the upper surface black, or nearly so.
G. Propygidium (at least of female) closely rugulose and subopaque ... vestitus, *Blanch.*
GG. Propygidium (at least of female) with coarse sparse punctures, and somewhat nitid ... nigro-umbratus, *Blackb.*
FF. The hairs of the dorsal surface flaxen ... ... glabripennis, *Macl.*
EE. Basal joint of hind tarsi shorter than apical spine of its tibia ... ...
F. Size large (5 l.): geminate striæ of elytra well defined ... ... erythropterus, *Macl.* [(?*Blanch.*)
FF. Size much smaller (less than 3 l.): geminate striæ of elytra very feeble ... ... amabilis, *Blackb.*
*DD. Disc of pronotum not, or scarcely, pilose; a frill of very conspicuous pilosity all across the front margin.
E. Pronotum sharply and conspicuously punctulate.
F. Size fairly large ($3\frac{3}{4}$-$4\frac{1}{2}$ l.): pilosity of pronotum black ... ... collaris, *Macl.*

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* In *L. puer* there are a few inconspicuous hairs.

FF. Size small (scarcely 3 l.); pilosity of pronotum fulvous ... ... analis, *Blackb.*

EE. Pronotum faintly, or scarcely, punctulate.

F. Size moderate ($3\frac{1}{4}$ l. or more).

G. The submarginal geminate striæ of elytra become much deeper close to apex ... ... consanguineus, *Blackb.*

GG. The submarginal geminate striæ of elytra obsolete towards apex Sedani, *Blackb.*

FF. Size small (less than $2\frac{1}{4}$ l.).

G. Disc of pronotum with a few scattered hairs puer, *Blackb.*

GG. Disc of pronotum glabrous ... ... rotundiformis, *Macl.*

DDD. Pronotum not pilose either on disc or all across front margin.

E. Front of clypeus deeply and angularly emarginate ... abnormalis, *Macl.*

EE. Front of clypeus not, or scarcely, emarginate.

F. Entirely testaceous, except infuscate head ... distinctus, *Blackb.*

FF. Entirely black (unless elytra red).

G. Propygidium and pygidium densely clothed with adpressed squamiform setæ ... ... tristis, *Blanch.*

GG. Propygidium and pygidium normal.

H. Front margin of pronotum entirely glabrous.

I. Clypeus more produced (in male strongly tridentate); lateral fringe of pronotum whitish. ... ... iridipennis, *Germ.*

II. Clypeus less produced (in male feebly tridentate); lateral fringe of pronotum brown

J. Puncturation of propygidium obsolete in front part ... ... gracilipes, *Blackb.*

JJ. Puncturation of propygidium not obsolete in front part ... ... holosericeus, *Macl.*

HH. Front margin of pronotum with a pilose frill widely interrupted in middle — sericeus, *Macl.*

CCC. Basal joint of hind tarsi distinctly longer than 2nd joint.

D. Disc of pronotum pilose (in some species more conspicuously so across base and front margin than elsewhere).

E. Apex (and hind part of sides) of elytra set with short stout bristles ... asper, *Macl.*

EE. Elytra without marginal bristles.

F. Elytra black.

G. Clypeus distinctly tridentate in both sexes — atratus, *Burm.*

GG. Clypeus slightly emarginate, not at all dentate ... ... ebeninus, *Macl.*

FF. Elytra red (blackish, or not, near base).

G. Front of clypeus with 3 sharp recurved teeth ... tridentatus, *Macl.*

GG. Front of clypeus feebly and obtusely tridentate.

H. Elytral puncturation strong (about as in *L. villosicollis*, Macl.) — parvidens, *Macl.*

HH. Elytral puncturation notably finer ... obtusidens, *Macl.*

DD. Pronotum not pilose on disc, but having a fringe of erect hairs all across its front — Rothei, *Blackb.*

DDD. Pronotum not pilose on disc, and not fringed across its front.

E. Front of clypeus having 3 strong sharp recurved teeth — Perkinsi, *Blackb.*

EE. Front of clypeus distinctly tridentate; the teeth feeble, blunt, and not recurved.

F. Pronotum and pygidium dark ... ... bituberculatus, *Macl.*

FF. Pronotum and pygidium testaceous red ... ... melanocephalus, *Blackb.*

EEE. Front of clypeus not at all tridentate.

F. A curved impression on either side, on pronotum behind its middle ... impressicollis, *Macl.*

FF. Pronotum normal.

G. Size moderate ($2\frac{1}{2}$ l.); subopaque; colour subuniform, piceous ... convexior, *Macl.*

GG. Size very small (less than 2 l.); nitid; colour variegated, partly testaceous ... ... læticulus, *Blackb.*

BB. Front tibiæ not tridentate externally.
C. Pronotum pilose, at least with a fringe of hairs across its front margin.
D. Elytra pilose.
E. Elytra very long, quite or almost covering propygidium in both sexes ... ... alienus, *Blackb.*
EE. Elytra normal (or very short).
F. Elytra unicolorous.
G. Front tibiæ very strongly bidentate externally suavis, *Blackb.*
GG. Front tibiæ not, or scarcely, bidentate externally.
H. Elytra bearing very long and very coarse sparse white bristles diversus, *Blackb.*
HH. Elytra clothed with fine soft hairs ... rotundicollis, *Blackb.*
FF. Elytra bicolorous.
G. Front tibiæ not toothed externally above the apical projection.
H. Basal joint of hind tarsi fully half again as long as 2nd joint ventralis, *Blackb.*
HH. Basal joint of hind tarsi notably shorter in proportion to 2nd joint ... ... assimilis, *Macl.*
GG. Front tibiæ distinctly bidentate externally.
H. Basal joint of hind tarsi at least half again as long as 2nd joint ... ...
I. Pilosity of dorsal surface dark .. discipennis, *Guér.*
II. Pilosity of dorsal surface almost white ... ... albohirtus, *Mast.*
HH. Basal joint of hind tarsi very little longer than 2nd joint canescens, *Macl.*
DD. Elytra glabrous, or with only a few hairs close to base.
E. Basal joint of hind tarsi not shorter than 2nd joint.
F. Dorsal surface not uniformly dark.
G. Elytra pilose in front part ... ... gravidus, *Blackb.*
GG. Elytra glabrous.
H. Disc of pronotum clothed with erect hairs.

I. Basal two joints of hind tarsi equal, or subequal, in length.
J. Pilosity of pronotum nearly white ... discoidalis, *Macl.*
JJ. Pilosity of pronotum dark brown or blackish.
K. Front tibiæ conspicuously bidentate externally ... occidentalis, *Macl.*
KK. Front tibiæ with upper tooth all but non-existent ... luridipennis, *Macl.*
II. Basal joint of hind tarsi very much longer than 2nd joint ... ... sericeipennis, *Macl.*
HH. Pronotum glabrous on disc, but with a fringe of long hairs across front ... ... cinctipennis, **Blackb.**
FF. Dorsal surface uniformly dark ... ... nudipennis, *Germ.*
EE. Basal joint of hind tarsi notably shorter than 2nd joint ... ... Palmerstoni, **Blackb.**
CC. Pronotum glabrous, or at most fringed with hairs on lateral parts of front margin.
D. Basal joint of hind tarsi fully as long as joints 2 and 3 together ... ... caviceps, *Blackb.*
DD. Basal joint of hind tarsi much shorter.
E. Clypeus very distinctly tridentate in front ... ... minor, *Blackb.*
EE. Clypeus not tridentate in front.
F. No part of dorsal surface (unless head) black.
G. Basal joint of hind tarsi not longer than 2nd joint.
H. Front tibiæ conspicuously bidentate externally ... ... pallidus, *Macl.*
HH. Front tibiæ with no distinct tooth above the apical projection.
I. Flabellum of antennæ piceous: head confluently transversely rugulose ... ... brevipes, *Blackb.*

II. Antennæ entirely testaceous; head punctulate (not very closely) ... Blanchardi, *Blackb.*
GG. Basal joint of hind tarsi considerably longer than 2nd joint ... modestus, *Blackb.*
FF. Dorsal surface (except elytra) black.
G. Front tibiæ unarmed above the apical projection ... ... Leai, *Blackb.*
GG. Front tibiæ distinctly bidentate ... ... rotundipennis, *Macl.*
AA. Antennæ consisting of 8 joints (only).
B. Front tibiæ tridentate externally.
C. Basal joint of hind tarsi not longer than 2nd joint.
D. Pronotum pilose on disc, or at least all across front margin.
E. Pilosity largely extended to the elytra.
F. Propygidium and pygidium not coarsely vermiculate-rugulose.
G. Elytra sparsely punctulate, red (more or less black-margined).
H. Basal joint of hind tarsi notably shorter than 2nd joint ... marginipennis, *Blanch.*
HH. Basal 2 joints of hind tarsi equal ... pilosus, *Macl.*
GG. Elytra closely punctulate, black (at most reddish near apex).
H. Front angles of male clypeus acute and directed outward ... callosus, *Macl.*
HH. Front angles of male clypeus not acute and not directed forward nigrinus, *Germ.*
FF. Propygidium and pygidium coarsely vermiculate-rugulose ... ... sylvicola, *Burm. (?Fab.)*
EE. Elytra glabrous, or with only a few basal hairs.
F. Sculpture of elytra not transversely rugate.
G. Male clypeus strongly emarginate, with strong, sharp angles; pronotum of female glabrous on disc ... ferrugineus, *Blanch.*
GG. Male clypeus scarcely emarginate, and with feeble angles; pronotum pilose on disc in both sexes.

H. Form broadly ovate; pygidium dark in both sexes ... ... ubiquitosus, *Macl.*

HH. Form much narrower; pygidium (and pronotum) bright red in male ... ... rubicundus, *Macl.*

FF. Elytral sculpture strongly and conspicuously transversely rugate ... rugatus, *Blackb.*

DD. Pronotum glabrous (the lateral margins disregarded).

E. Head, pronotum, and elytra black ... ... erythropygus, *Blanch.*

EE. Pronotum (at least partly) and elytra testaceous.

F. Clypeus subtridentate (distinctly bisinuate) ... badius, *Macl.*

FF. Clypeus not bisinuate.

G. Hind angles of pronotum quite defined.

H. Puncturation of pronotum quite sparse... monticola, *Macl.* (? *Fab.*)

HH. Puncturation of pronotum close ... fallax, *Blackb.*

GG. Hind angles of pronotum rounded off (non-existent) ... ... atriceps, *Macl.*

EEE. Entirely black, except the elytra, which are testaceous (black bordered) ... micans, *Macl.*

CC. Basal joint of hind tarsi much longer than 2nd joint ... criniger, *Macl.*

BB. Front tibiæ with less than 3 external teeth.

C. Front tibiæ conspicuously bidentate externally ... ... lætus, *Blackb.*

CC. Front tibiæ with no distinct tooth above the apical projection ... ... lævatus, *Macl.*

AAA. Antennæ consisting of 7 joints only

B. Pronotum not confluently and asperately punctulate.

C. Pronotum nitid; its longitudinal channel deep and entire.

D. Pronotum sparsely punctulate mysticus, *Blackb.*

DD. Pronotum closely punctulate globulus, *Macl.*

CC. Pronotum not as C.

D. Surface of pronotum entirely clothed with long pilosity ... insolitus, *Blackb.*

DD. Pronotum glabrous, except on sides and across front margin.

E. Surface of propygidium even lævis, *Blanch.*

EE. Surface of propygidium strongly gibbose in middle tuberculatus, *Lea* (?)

DDD. Pronotum entirely glabrous (except lateral fringe) ... opacicollis, *Macl.*

BB. Pronotum confluently and asperately punctulate ... ... squamiger, *Macl.*

FIRST GROUP (A, B, C, D, E, OF TABULATION).

The species under this heading form part of a natural group with which, however, some species with very different antennal structure (AA, B, C, D, E, of tabulation) are so closely allied that they ought to be placed in it to make it complete as a natural group. Sir W. Macleay placed them all together, and attributed similar antennal structure to them all. There are strongly marked sexual characters in the clypeus of all of them, and in the front tarsi of more than half, sexual characters in the antennæ moderately strong, in the abdomen almost none, vestiture of dorsal surface and structure of hind tarsi uniform, or but slightly varying specifically, structure of front tibiæ very uniform. The following are notes on some of the species:—

L. Adelaidæ, Blackb., is *L. comatus*, Macl., although the description of *comatus* is extremely misleading, being founded on a colour var. such as I have not seen, and said to resemble *L. marginipennis*, Blanch., which is a species of the same natural group, but by no means one of the most like it superficially. Macleay had a peculiarly coloured example before him, and gave a by no means felicitous description of it under the name *comatus*.

L. flavopilosus, Macl. This species was described from Gayndah specimens, as also was *fulvohirtus*, Macl. Between the two descriptions I find absolutely not one differential character except that the pilosity of one is called "pale red" and of the other "yellowish." In the Australian Museum I find one specimen (male) of *flavopilosus* and two (female) of *fulvohirtus*, doubtless including the types. They are all from one locality (Gayndah), and do not seem to differ *inter se* except in sex.

L. xanthotrichus, Blanch. Macleay says that the basal two joints of the hind tarsi are equal. The specimens so named in the Sydney Museums—as also in my own collection—have hind tarsi with the basal joint (though longer than is usual in this group) distinctly shorter than the second joint. The author of the name does not mention the hind tarsi.

L. ater, Macl. A male (unique) in the Macleay Museum is evidently the type of this species. Excessively close to *phœnicopterus*, Germ., and attributed to the same region (S. Australia) as that species. It is notably larger than any specimen that I have seen of ordinarily coloured *phœnicopterus*, nor have I seen *phœnicopterus* (of ordinary size) with elytra dark piceous in colour as they are in *ater*. The geminate striæ of the elytra are more strongly marked than in ordinary examples of *phœnicopterus.* *L. ater* may prove to be a good species, but is possibly only an aberrant specimen of *phœnicopterus.*

L. nitidipennis, Macl. A female (unique) in the Macleay Museum is, no doubt, the type of this species. It is in bad condition, and seems to me to be certainly the female of *L. ater*, Macl. It is of the size and colouring of a typical example of *phœnicopterus*, Germ., but differs from the female of that species by the more strongly marked geminate striæ of its elytra, and the more abruptly narrowed front portion of its clypeus. Like *phœnicopterus* and *ater* it is from S. Australia.

L. Mitchelli, Macl. A male (unique) in the Macleay Museum, is, no doubt, the type of this species. I do not find any character to distinguish it from *L. villosicollis*, Macl., except the slight difference (indicated in the preceding tabulation) in the form of its clypeus. This difference, however, remoteness of locality being given due weight, seems to indicate probable specific validity.

SECOND GROUP (A, B, C, D, EE, OF TABULATION).

Differs from the preceding group only by the elytra of its members being glabrous, or with only a few hairs close to the base.

L. Mastersi, Macl. Among the specimens standing under this name and *L. Germari*, in the two Sydney museums, it is impossible to identify the actual types. The distinctions indicated in Macleay's note on *Mastersi* (it can hardly be called a description) are too slight to be seriously regarded. In *Germari* the male clypeus is said to be nearly quite truncate, the angles not very acute; in *Mastersi*, "slightly emarginate in front, and acutely angled." In *Germari* the median line of the pronotum is said to be "quite traceable," and in *Mastersi* not traceable. Slight differences in puncturation and vestiture are mentioned. Differences in the inner apical spur of the front tibiæ and the degree of dilatation of the male front tarsi are also mentioned. The last-mentioned character, if it were strongly marked and constant, would, no doubt, be of importance; but, after careful study of the specimens pinned into the two labels ("*Germari*" and "*Mastersi*"), in the Macleay Museum—among which presumably are the types—I have failed in finding two specimens that present this difference *inter se*, or even that differ *inter se*, as *Germari* and *Mastersi* should do in respect of the other slight characters. I must, therefore, regard them as but one species, and as "*Germari*" stands before "*Mastersi*" in Macleay's Monograph, and is described (while *Mastersi* is not), the species must bear the name "*Germari*."

L. capillatus, Macl. Here, again, the identification of the type is mere guesswork. It is supposed to be in the Macleay Museum, where I find two specimens (male and female), pinned into a label bearing the name *capillatus*. The female is in very bad condition, and does not seem to be specifically identical with the male, having strongly pilose elytra, while the elytra of the male are glabrous. The specimens named *capillatus* in the Australian Museum are identical (so far as can be judged in dealing with bad specimens) with the female in the Macleay Museum. As it was a male that Macleay described, I take it that the male in the Macleay Museum is probably the real type, and I have accordingly treated it as such. It is much like *Germari*, Macl., but is very much smaller, with different male characters (*i.e.*, clypeus much narrowed from base to apex, and front tarsi only very slightly thickened). Macleay's description of *capillatus* is not definite enough to assist identification of type. It may be added that a male standing in the Australian Museum as *capillatus* differs from the male in the Macleay Museum by its elytra being pilose and with a dark basal border, and by its front tarsi being strongly thickened.

L. dispar, Blackb. I place this species in the second group only with hesitation, since the basal joint of its hind tarsi is not much shorter than the second joint, and consequently it is somewhat intermediate between this group and the fifth, from the species of which it differs in the following respects, *inter alia*:—From *vestitus*, *nigro-umbratus*, and *glabripennis*, by the basal joint of its hind tarsi, notably shorter absolutely (as well as in proportion to the second joint), from *amabilis* by much larger size and quite different colouring; and from *erythropterus* by its pronotum considerably more closely punctulate, and its elytra widely dark at the base.

THIRD GROUP (A, B, C, DD, OF TABULATION).

The front of the pronotum entirely bordered with a frill of erect hairs renders this group easily recognisable among the *Liparetri* which have three somewhat equally spaced external teeth on their front tibiæ, nine-jointed antennæ, and the basal joint of their hind tarsi decidedly shorter than the second joint. The last-named three characters are all well defined in all of them, except that in *L. lugens* the difference in the length of the joints of the hind tarsi is somewhat feeble. If that species were regarded as having those joints subequal it would be brought into the sixth group, from all the species of which (not greatly differing in size) it differs by its being devoid of iridescence, and having its pronotum subopaque and closely rugulose.

L. Kreuslerœ, Macl. The pronotum of this species is stated by its author to be "free from hair except on the lateral margins." That, however, is a mistake. There are specimens in the Macleay Museum (bearing the name), no doubt including the type, and agreeing with the description in all other respects, but having the apical margin (as well as the lateral margins) of the pronotum pilose. I have, therefore, no hesitation in correcting Sir W. Macleay's description in that respect.

L. angulatus, Macl. Two specimens (male and female) are pinned into the label bearing this name in the Macleay Museum, and are doubtless the types. The species is one I have not seen elsewhere. It is near my *L. fimbriatus*, but differs from it *inter alia* by its strongly pruinose and iridescent elytra.

FOURTH GROUP (A, B, C, DDD, OF TABULATION).

This group is a somewhat heterogeneous assemblage of species, among which there is considerable variety of facies, etc. The characters that I have indicated as common to the group are well marked in all its species, with the exception that a few of them (notably the female of *L. aridus*, Blackb.), are somewhat intermediate between the fourth and seventh groups, owing to the basal joint of the hind tarsi being only a little shorter than the second joint. The use of this character in the hind tarsi is too valuable in dealing with a long series of species to be discarded on account of these doubtful cases, but it seems necessary to furnish a note on each of the latter showing how the species differs (disregarding the hind tarsi) from its allies in the seventh group.

L. aridus, Blackb. The entirely testaceous colour of this species prevents its confusion with any member of the seventh group except *distinctus*, Blackb. The basal joint of the hind tarsi in the latter is quite fully as long as the second joint, the general build is much more robust than in *aridus*, the prothorax much more narrowed in front and much less finely punctulate on its upper surface, its colour a much less pallid testaceous, etc.; also it has remarkable sexual characters on the abdomen which are wanting in *aridus*.

L. picipennis, Germ., can scarcely be confused with the seventh group, as the basal joint of its hinder tarsi is quite distinctly (though not very much) shorter than the second joint. It presents the unusual character of a row of erect hairs widely interrupted in the middle on the front margin of its pronotum. The presumable types of *L. nitidior*, Macl., and *L. obscurus*, Macl., are mere colour vars. of *picipennis*.

L. rubefactus, Macl., is in no danger of confusion with the seventh group, but it is desirable to note that its colour is extremely inconstant, the elytra propygidium and pygidium varying from a rusty testaceous, or a distinctly red, colour to black. The darker specimens are for the most part males.

L. subsquamosus, Macl. A single specimen—no doubt the type—is pinned into the label bearing this name in the Macleay Museum. It is extremely close to *L. rubefactus*, Macl., especially the dark examples of that species; but the difference in the sculpture of the pronotum, in combination with great distance of *habitat*, justify the retention (at any rate, provisionally) of a separate name for this insect. It is difficult to understand why Macleay placed *rubefactus* and *subsquamosus* in different sections of *Liparetrus*, as having the "upper surface entirely glabrous" in the case of the former, and the "body squamose" in the case of the latter. The (presumable) types of the two do not differ at all in that respect from each other.

L. rufipennis, Macl. The presumable type of this insect (in the Macleay Museum) is devoid of distinct puncturation on the propygidium and pygidium—a very unusual character in *Liparetrus*. Macleay does not mention it, unless the phrase "pygidium glabrous" is intended to refer to it.

L. ovatus, Macl. I have examined the presumable type of this species in the Macleay Museum. There are specimens in the collection of Mr. H. J. Carter with their elytra black, which I cannot distinguish otherwise from the type. They are from W. Australia (the original locality).

L. posticalis, Blackb. This species is certainly rather close to that discussed above as *L. rufipennis*, Macl., but I believe it to be distinct, although the examination of more specimens from the same locality (Port Darwin) would be desirable to settle the point finally. It is of very evidently narrower and more elongate build than any of the numerous specimens that I have seen of its ally, the prothorax especially being longer in proportion to the width. There are also differences in the puncturation of the head, the punctures of the clypeus being more coarse and sparse and those of the frons distinctly asperate, which they are not in the Queensland insect, and the tarsi are manifestly less robust than in either sex of that species. I believe the type to be a female.

L. juvenis, Blackb. In my description of this species I called the basal joint of the hind tarsi "*vix breviorem*," as compared with the second joint. It is, however, sufficiently shorter to place the species in my fourth group rather than the seventh. Apart from that character, its uniform pale colour (except on the head and sterna) distinguishes it readily from all the species placed in the seventh group.

FIFTH GROUP (A, B, CC, D, OF TABULATION).

This group differs from the second by the much greater length of the basal joint of the hind tarsi in comparison with the second joint. The following are notes on some of its species: —

L. pruinosus, Burm. Macleay did not know this species. I have found in Mr. Griffith's collection two examples (from Tasmania, the original locality), which agree very well with Burmeister's description. There appears, on first thoughts, to be a serious discrepancy from Burmeister's description, which attributes to *pruinosus* hind tarsi having the basal joint longer than the second joint, whereas I have placed the insect in a group having those joints equal, or almost equal. The fact is, Burmeister did not separately describe the hind tarsi of each species, but made his primary division of the genus into species having *(a)* the basal; or *(b)* the second joint longer than the other, and recognised no intermediate group, and by placing *pruinosus* in *(a)* he indicates the basal joint as the longer. If the basal joint of the species before me be examined (with care that the whole length of the joint be in sight) it is seen to be slightly longer than the second joint, so that in Burmeister's arrangement it would properly stand in *(a)*, but the difference is so slight between the length of the joints that they must certainly be called sub-equal. In the Macleay Museum there is no *Liparetrus* ticketed "*pruinosus*," but two examples (from Tasmania), of the insect referred to above are ticketed "*vestitus*, Blanch." I have no doubt of their being correctly named, and of *vestitus* and *pruinosus* being synonyms. In his monograph Macleay places *vestitus* in his section with the "body squamose," but the specimens in the Macleay Museum (presumably those Macleay described) present no such character, nor does Blanchard attribute squamosity to *vestitus*. Blanchard's figure in the "Voyage au Pôle Sud," is evidently the figure of this insect, and the *habitat* is given as "Tasmania," although in Blanchard's "Cat. Coll. Ent." it is "Nouv. Holl." There are in my collection examples of a *Liparetrus* from New South Wales that I cannot distinguish from the Tasmanian examples of *vestitus* except by their colouring, which is very variable. Unfortunately, all the Tasmanian specimens that I have seen are females, so I cannot be sure of their identity with those from New South Wales. In some females of the latter the dark marginal colouring is absent from the elytra, while the single male in my possession has elytra almost entirely piceous, with only a small area of reddish tone on the disc. The front tarsi of this male are very much longer (but scarcely thicker) than those of the female.

L. nigro-umbratus, Blackb. In my description of this species (Tr.R.S.S.A., 1887, p. 22) I mentioned the size of the upper external tooth of the front tibiæ as probably a sexual character. I am now, however, of opinion that that is not so, that in the case (at any rate of most) of the species of *Liparetrus*, differences in the robustness of the teeth on the front tibiæ are not sexual, and that I do not know the male of *L. nigro-umbratus*.

SIXTH GROUP (A, B, C, DD, EE, OF TABULATION).

The relation of this group to the third is similar to that of the fifth to the second.

L. collaris, Macl. My *L. maurus* is identical with this insect. When I described it (P.L.S.N.S.W., 1892, p. 99) I stated my reasons for considering it distinct from *collaris* (which I knew only by Macleay's description). I have now examined the presumable type (in the Macleay Museum) and find that the two are specifically identical. The structure of the hind tarsi being disregarded, *L. collaris* is distinct from all those resembling it in colour, of the third group (which has similar vestiture), by the form of its male clypeus—notably emarginate in front, and not having the front angles acute.

SEVENTH GROUP (A, B, CC, DDD, OF TABULATION).

The following are notes on species that belong (at least probably) to this group, which has characters similar to those of the fourth group, except in respect of the hind tarsi.

L. iridipennis, Germ. There is no greater difficulty in studying *Liparetrus* than the identification of this species (described A.D. 1848) without examination of the type, which, if still in existence, is, no doubt, in one of the European collections. As far as Germar's description is concerned it applies very accurately to *L. senex*, Blackb.—a common South Australian species, of which I have seen examples from, among other places, the original locality of *iridipennis*. Unfortunately, there is a very important omission in Germar's description, for it contains no reference to the structure of the hind tarsi. Burmeister redescribed *iridipennis*, and placed it in his group of *Liparetri* having the basal joint of the hind tarsi longer than the second joint. For the reason noted above (under *L. pruinosus*, Burm.), this does not seem to me absolutely incompatible with the identification of his *iridipennis* with *senex*, although in *senex* the basal two joints are all but equal—in the male the basal joint, in the female the second, being just barely shorter than the other (Germar and Burmeister both describe the female only). But, unfortunately for that identification Burmeister adds a note that Germar gives the wrong size for his insect, and that it is (not $3\frac{1}{2}$ l., but) $2\frac{1}{2}$ l. long. The smallest specimen that I have seen of *L. senex* is $3\frac{1}{2}$ l. The question, therefore, arises as to the grounds on which Burmeister made this assertion (giving the same size for *iridipennis* that he assigned to *discipennis*, Guér., a very much smaller insect than *senex)*. Without definitely asserting it, he certainly seems to imply that he had seen Germar's type. Nevertheless, I am of opinion that his *iridipennis* is identical with my *senex*, and that, if his measurement is correct, it was founded on an exceptionally dwarfed example. Burmeister's accuracy in respect of this species is certainly discounted by his having represented Blanchard's *sylvicola* as a synonym of *iridipennis*, which is far from a correct statement, Blanchard having merely placed in his descriptive catalogue *sylvicola*, Fab. (without a description, but with the mention of Tasmania as the locality of the specimens before him), and appended some synonymy, at the end of which he places "*iridescens*, Germ." (doubtless a misprint). I feel extremely confident that the Tasmanian specimens which Blanchard catalogued as *sylvicola* were not *iridipennis*. *Sylvicola* is a common species in Tasmania, and I have much negative evidence (from my own collecting, etc.), that *iridipennis* is not found on that island. It seems practically certain that Blanchard's reference to *iridipennis* expresses no more than that author's conjecture that *iridipennis* is identical with *sylvicola*, which is certainly not the case, though that is not to the point here. Macleay's treatment of *iridipennis* is most unsatisfactory. In the Macleay Museum two specimens are pinned into the label "*iridipennis*," one of which is my *senex*, the other my *caviceps* (the former with the front tibiæ tridentate and the basal two joints of the hind tarsi subequal, the latter with the front tibiæ bidentate and the basal joint of the hind tarsi very much longer than the second). Macleay's description of *iridipennis*—which has always been a puzzle to me, appearing to describe a South Australian *Liparetrus* very different from any that I have seen—is evidently a jumble of these two specimens, founded on the front tibiæ of my *senex* and the hind tarsi of my *caviceps*. I may add that my treatment of *senex* as a species distinct from *iridipennis* was founded on its wide divergence from Macleay's redescription, and that author's assurance that specimens of it which I submitted to him were certainly not *iridipennis*. The real identity of *iridipennis* cannot be settled finally without examination of Germar's type: owing to the deficiency of Germar's description, and Burmeister's statement that Germar's measurement is seriously incorrect, it is possible that *iridipennis* is my *gracilipes*, or my *caviceps*, or the species that I regard as *nigrinus*, Germ.: but as my *senex* agrees best on the whole with Germar's description, and is certainly the most plentiful in the locality where Germar's types were collected, the evidence is certainly in favour of my *senex* being the true *iridipennis*. At any rate, it is now clear that Macleay's redescription of *iridipennis* depicts a species that does not exist.

L. gracilipes, Blackb. This species is abundantly distinct from *senex*, Blackb, but it is, as stated above, not certain that it may not be the true *iridipennis*, Germ. Burmeister's *iridipennis* is, I think, certainly not *gracilipes*, as the basal joint of the hind tarsi of the latter is in both sexes a trifle shorter than the second joint. Compared with *iridipennis*, Germ. (*senex*, Blackb.), this species is very similarly coloured, except that the hairs fringing the pronotum laterally are much darker ("dark brown," however, would characterise them better than "black," the word I used in the original description), and the iridescence of the surface is less pronounced; the tarsi are less robust in both sexes; the clypeus is notably less produced in both sexes and less evidently tridentate (male) or sinuate (female), although there is some variability in this respect, some females of both having the clypeus not very far from evenly truncate; the propygidium is very differently sculptured, having the hind part in both sexes more strongly punctulate and impressed with two more or less distinct longitudinal foveæ (these, in some examples, arched so as to meet at both ends and form a ring), between which the surface is more or less gibbous, and the front part abruptly devoid of punctures and highly nitid [in *iridipennis* (*senex*, mihi) the propygidium is in front opaque, with fine, very close punctuation, which becomes continuously stronger and less close hindward, and its surface is even]. In the male of *gracilipes* the middle part of the basal two ventral segments is occupied by a very dense tuft of erect, soft, whitish hairs, which is wanting in its ally.

L. simillimus, Macl. In the Macleay Museum two specimens (one of them presumably the type) are pinned into the label bearing this name. Unfortunately, their sex cannot be confidently determined, as they have both lost their front tarsi, but, judging by the form of the abdomen, I take them to be males, and I think they are males of *abnormalis*, Macl., of which the other specimens that I have seen (including the presumable type in the Macleay Museum) are females.

L. latiusculus, Macl. The presumable type of this species (female) is in the Australian Museum. I can find no non-sexual difference whatever between it and the presumable type (male) of *L. sericeus*, Macl., also in the Australian Museum. It appears to me doubtful whether the specimen pinned into the label "*latiusculus*," is really in its proper place, as Macleay's measurements of that insect indicate a considerably smaller species, but as *latiusculus* is practically undescribed (being merely briefly comparea with *picipennis*, Germ.), it is incapable of identification unless the specimen in the Australian Museum be accepted as the type.

L. holosericeus, Macl. The presumable type of this species is in the Macleay Museum. It is closely allied to *L. iridipennis*, Germ. (*senex*, Blackb.), and *gracilipes*, Blackb., but, *inter alia*, differs from both of them by its clypeus without any tendency to sinuation.

EIGHTH GROUP (A, B, CCC, D, OF TABULATION).

The following notes are on species belonging to this group, which differs from the first and fifth groups by the structure of its hind tarsi, but agrees with them in other characters, *i.e.*, vestiture, etc.

L. asper, Macl. The presumable type of this species is in the Macleay Museum, and the same species also is ticketed "*sylvicola*" in the same Museum. If the specimen pinned into the label "*asper*" is really the type, it is incorrectly described in Macleay's monograph, where the vestiture of the pronotum is stated to be "a frill of long, erect, black hairs on the base, apex, and sides." Owing to that statement I assumed that the species was not *asper*, and described it (P.L.S., N.S.W., 1891, p. 482), as *spretus*. It is very possible that the presumable type is not the real one, but nevertheless, as it now stands in the place of the type, it seems better to admit its claim, and regard *spretus* as a synonym, than to adhere to the description and regard *asper* as a species known only by a brief description, and very likely non-existent. For reasons stated under the name *sylvicola*, Fab., I am quite confident that Macleay was mistaken in ticketing *asper* (*spretus*, mihi.), as *sylvicola*.

L. atratus, Burm. In his monograph Macleay expresses doubt as to his identification of this species, and merely quotes Burmeister's description. I have specimens from Tasmania (the original locality), which agree perfectly with Burmeister's description, and are certainly this insect. In both the Sydney Museums *iridipennis*, Germ. (*senex*, Blackb.) stands as *atratus* (the same species also standing, along with *caviceps*, Blackb.), under its right name). I do not find the true *atratus* in the Macleay Museum, but in the Australian Museum an example of it (and also two of *concolor*, Er.), is labelled "*sylvicola*," which latter name (as noted above) is applied in the Macleay Museum to *asper*, Macl. Apparently it was the specimen of *atratus* labelled "*sylvicola*," which Macleay described in his monograph as *sylvicola*.

L. tridentatus, Macl. The presumable type of this species, and also that of *L. acutidens*, Macl., are in the Australian Museum. I can find no difference whatever between them. After his description of *L. acutidens*, Macleay says that it differs from *L. tridentatus*, "as the description will show, very widely." Placing the two descriptions side by side, however, I have failed to find even *one* definite difference between the two, the nearest approach to it being that the elytra of *tridentatus* are called "subsericeous red," and of *acutidens* "iridescent yellow." I do not find any conspicuous difference, even in respect of colour, between the presumable types.

L. parvidens, Macl. The presumable type of this species is in the Australian Museum. It somewhat closely resembles *obtusidens*, Macl., but is probably a valid species, as its elytral puncturation is very notably coarser than in that species, and its *habitat* (Cleveland Bay) is very far distant from that of *obtusidens*.

NINTH GROUP (A, B, CCC, DD, OF TABULATION).

This group differs from the eighth by the absence of pilosity on the disc of its pronotum, and from the tenth by the presence of a fringe of erect hairs all across the front of that segment. I know only one species (*L. Rothei*, Blackb.) which can be referred to it.

TENTH GROUP (A, B, CCC, DDD, OF TABULATION).

The following are notes on species appertaining to this group, which resembles the preceding two groups except in respect of vestiture of pronotum.

L. bituberculatus, Macl. The female is usually much darker in colour than the male.

L. convexior, Macl. Two specimens (one of them, presumably, the type) are pinned into the label bearing thi name in the Macleay Museum. I have not seen the species elsewhere.

ELEVENTH GROUP (A, BB, C, D, OF TABULATION).

This group differs from all the preceding by the front tibiæ of its species not tridentate externally. The following are notes on species belonging to it.

L. assimilis, Macl. The presumable type is in the Macleay Museum. I think it a male. Its apical ventral segment does not differ materially from that of male *discipennis*, Guér.

L. discipennis, Guér. Specimens from almost all parts of southern Australia and from Tasmania stand in collections under this name. Macleay gives New South Wales and South Australia as its *habitat*. Whether the specimens from Tasmania and South Australia are specifically identical with those from Sydney I feel rather doubtful. It is too variable a species in colouring for great importance to be attached to such distinctions as greater or less width of dark margins of elytra in local races; but the opportunities I have had of examining sexual characters point to difference in the ventral characters of the male in at any rate Tasmanian examples. Unfortunately, there is only a single male among those I have from Tasmania, and I do not think it safe to found a new species on the decided (though not very great) difference between the sculpture of its apical ventral segment and the corresponding segment in the few male Sydney specimens before me. The study of a longer series might not improbably establish specific difference as constant. The species that Germar describes as *discipennis* seems, from the colour of its vestiture, to be that which Macleay named *canescens*.

L. montanus, Macl. I have examined the presumable type of this species, unique in the Australian Museum, and can find no difference whatever between it and *L. discipennis*, Guér. It seems to be a male; at any rate, its apical ventral segment is quite like that of male *discipennis*.

L. canescens, Macl. I have examined the presumable type in the Macleay Museum. It is a common South Australian insect, and very distinct from *discipennis*, Guér. Besides other differences the apical ventral segment of its male is nitid and almost punctureless, with a strong, obtuse carina placed transversely across its middle, the corresponding segment in male *discipennis*, from Sydney, having an even surface, on which there is fine puncturation, mixed with some coarse piliferous granules.

L. albohirtus, Macl. Two specimens are pinned into the label bearing this name in the Macleay Museum. One of them is obviously some very different insect—the other presumably the type. Macleay says that the front tibiæ are "scarcely bidentate," the upper tooth being "nearly obsolete." I find, however, that although the upper tooth is small (as in *discipennis*, Guér., and *canescens*, Macl.), it is perfectly well defined in the type.

TWELFTH GROUP (A, BB, C, DD, OF TABULATION).

Resembles the preceding group in respect of most of its characters, but has elytra glabrous, or with only a little pilosity near base. The following notes relate to members of this group.

L. discoidalis, Macl. This and the next two species are very distinct, *inter se*, but with few distinctive characters that lend themselves readily to tabulation. *Discoidalis* is represented in the Macleay Museum by two specimens (one of them presumably the type). Their elytra are remarkably coloured, there being only a very narrow black border, except at the apex, which is very widely of a deep black colour, so that to a casual glance they seem to have bright red elytra with a wide, apical black fascia. In one specimen the pronotum is partially red. The front tibiæ are distinctly bidentate externally.

L. occidentalis, Macl. Two specimens are pinned into the label bearing this name in the Macleay Museum. There is, however, a difficulty in accepting either of them as the true type, for Macleay says that the hind tarsi were wanting in the specimen described, which is not the case with either of those in the Museum. Nevertheless, as they are distinct from any other species that I can find to have been described, and agree with the brief description, they may fairly be regarded as correctly named. They resemble *discipennis*, Guér., in colouration, but differ from it widely by, *inter alia*, glabrous elytra and basal two joints of hind tarsi subequal. It is near *discoidalis*, Macl., undoubtedly, but with very much darker vestiture, and moreover the colouring of the elytra in the two examples of *discoidalis* is so conspicuous and unusual that there can be little doubt of its being a specific character. I think one of the specimens of this insect (as also of *discoidalis*) is a male. The apical ventral segment in both is not much different from that of male *discipennis*.

L. luridipennis. A specimen bears this name in the Australian Museum, and agrees well with the description except in the pilosity of the pronotum being somewhat darker than "fulvo-villose" would lead one to expect. Its facies is very different from that of the preceding two species, the size being notably larger and the form more robust. The head is more massive, with the clypeus wide and subsemicircular (not unlike that of *rufipennis*, Macl.)—not at all of the *discipennis* type.

L. lanaticollis, Macl. The presumable type of this species is in the Macleay Museum. It is identical with my *L. Palmerstoni*. Both names were proposed in P.L.S., N.S.W., 1888. Macleay's name is a month later than mine.

THIRTEENTH GROUP (A, BB, CC, OF TABULATION).

Distinguished from the preceding group by the absence, or nearly so, of vestiture on the pronotum. The species are all fairly recognisable, and only one remark seems called for here, viz.:

L. simplex, Blackb. This name must become a synonym of *rotundipennis*, Macl. When I described the species I drew attention to its being near Macleay's insect, but I judged from the description of the latter that it was distinct, principally from the absence of two minute tubercles on the head, which Macleay mentions, and from the elytral puncturation being by no means "faint." Comparison with the presumable type in the Macleay Museum has, however, satisfied me that the two are identical, the tubercles on the head being either sexual or accidental, and the elytral puncturation being not quite correctly described by Macleay. Macleay's measurement, moreover, is incorrect, the length being 2½-3 l.

FOURTEENTH GROUP (AA, B, C, D, E, OF TABULATION).

Macleay places all the species of this group among *Liparetri* having nine-jointed antennæ. As a fact, they are so closely allied to the species of the first group that, so far as I have observed, the antennal structure alone distinguishes the one aggregate from the other. It seems clear that Macleay must have examined the antennæ of a few species that fall into my first group, and then assumed a similar structure in the rest of the species that, the antennæ being disregarded, would be properly associated with them. Even on that supposition, however, it is difficult to understand the positive assurance he manifests on the subject, for of *hirsutus*, Burm., he says that the description seems to refer it to the aggregate containing *phœnicopterus*, Germ., but attributes only eight joints to its antennæ, which, he adds, "seems impossible." The following are notes on the species of this group and on their synonomy:—

L. marginipennis, Blanch. There seems to me to be no doubt that Blanchard was mistaken in placing this species among those with nine-jointed antennæ. Blanchard's description (which is a fairly detailed one), and his remark on the close resemblance of *marginipennis* to his *xanthotrichus* seem to forbid any doubt that he had before him a well-known species, which is common in New South Wales, and stands in Australian collections generally under the name *marginipennis;* but there are certainly only eight joints in its antennæ. Probably Blanchard counted the joints in the antennæ of *xanthotrichus*, and assumed that a species so closely resembling it as *marginipennis* does would have similar antennæ. This species stands in the Macleay Museum as *marginipennis*, Blanch. The presumable type of *L. nigrohirtus*, Macl., in the Macleay Museum, is also *marginipennis*.

L. hirsutus, Burm. It seems clear that this species is identical with *marginipennis*, Blanch. The descriptions present no definite difference except in Burmeister stating the number of joints in the antennæ as "only eight," which, as remarked above, is correct. Burmeister's omission to identify *marginipennis* may be accounted for by his remark that he is unable to bring Blanchard's *Liparetri* into his work because their author has not described their tarsi.

L. pilosus, Macl. I have examined the presumable type in the Australian Museum. Its antennæ consist of eight joints only. It is extremely close to *L. marginipennis*, Blanch., but differs by the basal two joints of its hind tarsi being almost equal, *inter se*.

L. callosus, Macl. I have examined the presumable type in the Australian Museum, the colouring of which is very unusual in the genus. Its antennæ have only eight joints. The species seems to be variable in respect of colouring, as other specimens before me (otherwise identical) are without the red mark on the elytra.

L. (Melolontha) sylvicola, Fab. This species is one of the difficult *Liparetri* for identification. Its first assignment to *Liparetrus* seems to be in Blanchard's catalogue, where, however, it is not redescribed. Burmeister redescribed it, and I think his identification must be accepted as reliable, inasmuch as he expressly stated that he had examined the Fabrician types of *Melolonthides* in London, among which that of *sylvicola* was, no doubt, included. Then Macleay followed with a redescription, which, however, is evidently founded upon *L. atratus*, Burm. In the Australian Museum two specimens of *L. concolor*, Er., and one of *L. atratus*, Burm., are pinned into the label "*sylvicola*, Fab.," and in the Macleay Museum, *L. asper*, Macl., stands under that name as well as under the name *asper*. In his monograph, Macleay described Burmeister's *sylvicola* (incorrectly in respect of the antennæ, by placing it among the species having nine-jointed antennæ), under the name *salebrosus*, and without citing any reason for rejecting Burmeister's name. The complications, however, do not stop here, unfortunately; for *sylvicola* is an insect the sexes of which are so different that they have been treated as distinct species. *Sylvicola*, Burm., is the female, and the male was described by Blanchard as *basalis*. Here, again, Macleay has confused matters by describing a totally different species as *basalis*, Blanch. I myself in my earliest memoir on *Liparetrus* neglected to verify this determination of Macleay, and, assuming that *basalis*, Blanch., was rightly identified by Macleay, redescribed the true *basalis* as *Macleayi*.

The synonymy which I believe to be correct, then, stands thus: —

L. sylvicola, Fab., Burm. (*nec.*, Macl), fem.
salebrosus, Macl., fem.
basalis, Blanch. (*nec.*, Macl.), mas.
Macleayi, Blackb., mas.

I do not think that any one comparing Macleay's description of *salebrosus* with Burmeister's of *sylvicola* can doubt that they refer to the same insect, which is a remarkably isolated species, and very common in southern Australia. As to Macleay's "*basalis*, Blanch," it is an *Automolus*, and is found in Victoria and Tasmania. Unfortunately, Blanchard's description of *basalis* is an exceptionally meagre one, and it was perhaps not unnatural that Macleay should have referred it to the insect he did if he had not the genuine *basalis* before him. In fact, it is chiefly a matter of colourng and sculpture (although the two insects differ very widely in respect of important characters that Blanchard does not refer to). Both occur in Tasmania commonly. Blanchard says of *basalis*, "elytris fusco-rubris, basi late nigris," which exactly fits the male of *sylvicola*, Burm. Macleay says of the species that he regards as *basalis*, "elytra brownish-red, the base blackish," which aptly describes his *basalis*, but not the male of *sylvicola*, the former having a mere blackish infuscation across the base of the elytra, the other a wide basal fascia, well defined, and of deep black colour. As to sculpture, Blanchard says of basalis, "prothorace scabroso x x elytris punctato-scabrosis x x pygidio scabroso," which very correctly indicates the vermiculate-rugulose sculpture of *sylvicola* (as characterised by Burmeister, who calls it "rugoso-varioloso"), and of *salebrosus*, Macl., which its author describes as "coarsely variolose-punctate." No other *Liparetrus* known to me in nature or description has any such sculpture. *L. basalis*, Macl. (*nec.*, Blanch.), is quite differently sculptured. Macleay calls it "rugosely punctate," a term which he applies (correctly enough) to the sculpture of numerous other *Liparetri*, corresponding to the "rugoso-punctatus" which Blanchard applies to the sculpture of various *Liparetri*.

As to the identity of *L. sylvicola* (Fab.), Burm., and *basalis*, Blanch. (*Macleayi*, Blackb.), as sexes of one species, I can state that I have taken them paired in Tasmania subsequently to my describing *Macleayi*.

It is, perhaps, best to add that nothing short of Burmeister's strong implication that his description of *sylvicola* is founded on an examination of the specimen that stands as the type would justify the acceptance of his identification as correct, inasmuch as Fabricius's description says, "capite et thorace glabris." If Burmeister's *sylvicola* were regarded as distinct from that of Fabricius, the name of Burmeister's species would have to be changed to *basalis*, Blanch.

L. nigrinus, Germ. The species that stands under this name in the Macleay Museum, and that Macleay describes under this name, is a common South Australian insect, and it does not agree, in an important character, with Germar's description, inasmuch as its front tibiæ are tridentate externally, whereas Germar says, "tibiis bidentatis." I believe, however, that in Germar's description "bidentatis" must be a misprint, as in other respects that description satisfactorily enumerates the characters of the species in question. Moreover, I have not seen in any collection any species with bidentate front tibiæ that could possibly be *nigrinus*, and it is hardly likely that a collection with so many South Australian *Liparetri* as were in that which Germar described would not contain this common one. Germar does not mention the structure of the antennæ, which are eight-jointed, although Macleay's description particularly emphasises them as nine-jointed. The species in the Macleay Museum undoubtedly, however, has antennæ very easily seen to have only eight joints. Burmeister, I think, applied the name *nigrinus* to the same species, although there are difficulties in the way of that opinion. He gives the size as $2\frac{3}{4}$-3 l. (Germar says "$3\frac{1}{4}$ l.," Macleay $3\frac{1}{2}$ l., the smallest specimen I have measured is, long. 4 l.), and says that the clypeus of the male is "obtuse tridentato." Macleay asserts that this (and Burmeister's assertion that the antennæ are eight-jointed) cannot be consistent with Burmeister's *nigrinus* being identical with his (Macleay's). In respect of the antennæ, it was Macleay's mistake, not Burmeister's, as already noted; in respect of the clypeus (the only remaining difficulty), there unquestionably is a slight tendency to bisinuation (scarcely sufficient to deserve mention, I admit, but to which Burmeister, no doubt, referred), in the front margin of the clypeus of the male of this species; indeed, I have a specimen in my own collection in which it is quite distinct, and it is just barely traceable in the specimens that are named *nigrinus* in the Macleay Museum. My conclusion, therefore, is that *nigrinus*, Germ., was correctly identified by both Burmeister and Macleay, the only doubt being connected with what neither of them mentions as a difficulty, viz., Germar's having called the front tibiæ bidentate. It should just be added that this difficulty cannot be got rid of by the supposition that Burmeister may not have counted the apical projection of the tibiæ as an external tooth, for in the case of other species he always does so count the apical projection.

L. rugosus, Macl. The presumable type of this species is in the Macleay Museum, pinned into the label "*rugosus*, S. Australia." It is a female of the species mentioned above as labelled in the same collection, "*nigrinus*, Germ." If it should prove eventually that there is another species (not known to me) which is the true *nigrinus*, the species I believe to be *nigrinus* would, of course, have to bear the name *rugosus*.

FIFTEENTH GROUP (AA, B, C, D, EE, OF TABULATION).

Although this group is distinguished from the preceding one by an apparently slight character (the elytra glabrous or nearly so), its species differ very much in facies from all of the fourteenth group, except *sylvicola*, Burm. (Fab. ?), to which latter they bear more resemblance of a general kind.

L. ferrugineus, Blanch. This is one of the most abundant and widely distributed *Liparetri*. It is remarkable for the pronotum of its male being entirely pilose, while that of the female has only an apical (and, of course, a lateral) fringe of hairs. Blanchard described a female; Macleay's redescription is a mixture of the two sexes. Both authors overlooked the fringe of hairs on the front of the clypeus in the female. I have examined the specimens in the Macleay Museum on which Macleay's redescription was doubtless founded.

L. ubiquitosus, Macl. It is strange that this common New South Wales *Liparetrus* should have remained undescribed until Macleay published his monograph. Nevertheless, it certainly seems to have been unknown to the earlier authors. Macleay is in error in attributing nine-jointed antennæ to it. It is rather near to *ferrugineus*, Blanch., but easily distinguished by the very different sculpture of the clypeus in the male, the much more pilose pronotum of the female, the different colouring, etc. I have examined the presumable type in the Macleay Museum.

L. brunneipennis, Blackb. This name is a synonym of *ubiquitosus*, Macl. At the time when I described the insect I accepted Macleay's statement that his species has nine-jointed antennæ.

L. rubicundus, Macl. Two (presumably including the type) are pinned into the label "*rubicundus*" in the Macleay Museum. Their antennæ have only eight joints, though Macleay calls them nine-jointed.

L. propinquus, Macl. Two specimens (including the presumable type) are pinned into the label "*propinquus*" in the Macleay Museum. They have eight-jointed antennæ. This insect is, I have no doubt, the female of *rubicundus*, Macl.

SIXTEENTH GROUP (AA, B, C, DD, OF TABULATION).

This group includes the species having eight-jointed antennæ, front tibiæ tridentate externally, and pronotum without vestiture (unless along the lateral margins). The following notes are on species appertaining to it:—

L. fallax, Blackb. This species is well distinguished from *atriceps*, Macl., by the hind angles of its prothorax being distinctly defined. It also differs in colouring, its pronotum being uniformly testaceous brown, while that of *atriceps* presents the unusual character of being bicolorous (its front part black). Its pronotum, moreover, is notably less convex longitudinally, that of *atriceps* being exceptionally declivous immediately in front of the base. Also, the general dorsal sculpture of *fallax* is considerably finer and feebler than of *atriceps*. The sexual characters in both species seem to be slight, consisting in little more than an increased robustness of the front tarsi in the male.

L. badius, Macl., is referred by its author to a section of *Liparetrus*, to which he attributes nine-jointed antennæ; the antennæ nevertheless have only eight joints. I have examined the presumable type in the Macleay Museum. The clypeus of that specimen is distinctly bisinuate (or obsoletely tridentate) on its front margin, although that character is not mentioned in the description. I have examples before me of a *Liparetrus* from Beverley, W.A., which I hesitate to regard as specifically distinct from *badius;* nevertheless the front margin of its clypeus is more decidedly tridentate, its colour notably paler testaceous, and the puncturation of its elytra certainly finer and less close than in *badius*.

L. monticola, Macl. (? Fab.). In the Macleay Museum two very much broken specimens are pinned into the label bearing, "*monticola*, Fab." They are examples of two distinct species, one that which elsewhere in the same museum is labelled, "*atriceps*, Macl.," the other superficially resembling it, but different, *inter alia*, by the finer and sparser puncturation, and the well-defined hind angles of its pronotum. The latter is probably that on which Macleay's description is founded, as that description calls the pronotum "thinly punctate." I can give no opinion as to Macleay's reason for the identification with *monticola*—which seems to me doubtful in the extreme; but, as I am quite unable to identify *monticola* myself, I see no objection to allowing this species to stand as "*monticola*, Macl. (? Fab.)" provisionally.

L. atriceps, Macl. This is the species that I had formerly supposed to be *monticola*, Macl. (and have probably so named, for correspondents), on account of its having antennæ with only eight joints, whereas Macleay places *atriceps* in his section of the genus with nine-jointed antennæ. The presumable type is in the Macleay Museum bearing a label, "*atriceps*, Macl." I have mentioned others of its characters (above), under *L. fallax*, Blackb.

L. micans, Macl. Placed by Macleay in his monograph among the species with nine-jointed antennæ. I examined the presumable type, unique in the Macleay Museum, and made the following note on it:—"New to me. Antennæ eight-jointed. Near *fallax*, mihi, from which it differs, *inter alia*, by its quite different colouring, *i.e.*, dorsal and under surface entirely black except disc of elytra."

SEVENTEENTH GROUP (AA, B, CC, OF TABULATION).

This group contains only one known species—*L. criniger*, Macl.—easily recognised by its presenting the following characters in combination:—Antennæ eight-jointed, front tibiæ with three external teeth, basal joint of hind tarsi notably longer than second joint.

L. perplexus, Blackb. This name is a synonym of *L. criniger*, Macl., to which its author incorrectly attributes nine-jointed antennæ; and, owing to that error, I failed to discover the identity of the two until I recently found out that Macleay's characters are not reliable. I have examined the presumable type, in the Macleay Museum.

EIGHTEENTH GROUP (AA, BB, OF TABULATION).

A small aggregate of species presenting the unusual combination of eight-jointed antennæ, with front tibiæ having less than three external teeth.

L. lævatus, Macl. Originally described by its author as *glaber (nom. præocc.)*, and placed in Macleay's monograph among the species with nine-jointed antennæ. I have examined the presumable type, in the Australian Museum, and find that its antennæ have only eight joints.

L. parvulus, Macl. I have examined the presumable type, in the Australian Museum, and find (as Macleay says) that the difference is only in colour, which is, no doubt, either varietal or sexual. I unfortunately omitted to investigate the sex of the types. Both are from Gayndah.

NINETEENTH GROUP (AAA, OF TABULATION).

Easily distinguishable from all the other groups by the antennæ of its species having only seven joints.

L. lævis, Blanch. I have before me specimens from the Swan River (Blanchard's locality) of a species so satisfactorily agreeing with Blanchard's description of this species in every respect, except the number of joints in its antennæ, that I cannot escape the conclusion that that author was mistaken in regard to its antennæ, probably neglecting to examine the antennæ on account of the general resemblance of the insect to other *Liparetri*, which have nine-jointed antennæ. The same species stands in the Australian Museum as *L. lævis*, Blanch.

L. agrestis, Blackb. I regret to find that when I described this species I counted the joints in its antennæ incorrectly, and stated them as eight in number. There was no excuse for doing so (as the joints are evidently only seven). No *Liparetrus* had been previously described as having seven-jointed antennæ, although several species, really having such antennæ, had been described erroneously. I remember thinking that only seven joints was an impossible number, and persuading myself that I discerned a very minute additional joint. In a memoir which I published in the following year attention was first drawn to the existence of *Liparetri* having antennæ of only seven joints. Blanchard having attributed nine-jointed antennæ to his *L. lævis*, I did not take that species into account when I described *agrestis*, but I am now of opinion that the two names represent only one species.

L. nigriceps, Macl. I think there is little doubt of this being the female of *L. lævis*, Blanch. Macleay attributed nine-jointed antennæ to it. I have examined the presumable type, in the Australian Museum, and find it to be—though in very bad condition—certainly conspecific with specimens in my own collection, whch I have long regarded as *nigriceps*, Macl., and as the female of *lævis*, Blanch.

L. globulus, Macl. The presumable type is in the Macleay Museum, and I have examined it there.

L. tuberculatus, Lea. This species is practically undescribed, the structure of the antennæ not being referred to except as involved in a reference to Macleay's grouping of the genus, in which (as mentioned above) the antennal structure is about as often wrong as right. There is no reference at all to the structure of the hind tarsi. As, however, there happens to be one marked character of the insect mentioned in the description, I have selected a *Liparetrus* presenting that character (which, however, is probably sexual), to be called "*tuberculatus*, Lea (?)," and have indicated its characters by its place in the foregoing tabulation.

L. opacicollis, Macl. The presumable type in the Macleay Museum has antennæ of only seven joints. It is near

L. lævis. Disregarding the difference in the vestiture of the pronotum, it is, *inter alia*, a considerably larger insect.

L. squamiger, Macl. I have examined the presumable type, which is in the Macleay Museum.

L. necessarius, sp. nov. Ovatus; minus nitidus; totus cinereo-pilosus, elytrorum pilis nigricantibus exceptis; niger, antennis (clava excepta) palpis et elytris (his ad basin anguste plus minusve nigricantibus) rufis, pedibus plus minusve piceis vel rufescentibus; antennis 9-articulatis; clypeo nitido fortiter minus crebre punctulato; fronte crebre nec subtiliter rugulosa; prothorace fortiter transverso, antice sat fortiter angustato, supra canaliculato, fere ut frons sed paullo minus crebre punctulato, lateribus sat arcuatis; elytris perspicue geminato-striatis, interspatiis sat fortiter vix crebre punctulatis; propygidio sparsius, pygidio magis crebre, rugulosis; tibiis anticis extus tridentatis (dentibus intervallis subæqualibus divisis); tarsorum posticorum articulo basali quam 2[us] sat breviori.

Maris clypeo antice sat profunde emarginato (fere ut *L. villosicollis*, Macl.), angulis sat acutis nec vel vix extrorsum directis; tarsis anticis sat incrassatis.

Feminæ clypeo truncato vix emarginato, angulis sat rotundatis. Long., 3-4 l.; lat., $1\frac{3}{5}$-$2\frac{1}{5}$ l.

The characters indicated in the tabulation satisfactorily distinguish this species from its allies; it is well, however, to remark that it is apparently identical with all the specimens pinned into the label "*capillatus*, Macl.," in the Sydney Museums (so far as the bad condition of those specimens will allow comparison) except the one male in the Macleay Museum, which is the presumable type, and which agrees well with Macleay's description. From that male it differs considerably in vestiture, and also in the form of the clypeus, which, in the present species, is strongly emarginate, and notably less narrowed forward. It should be added that the emargination of the clypeus, though quite strong, is very different from the profound excision of the clypeus of *L. Kennedyi*, Macl. The notably darker colour of the pilosity of the elytra in comparison with that of the pronotum is an unusual character.

Western Australia (Perth, Mr. Lea).

L. distans, sp. nov. Ovalis; sat nitidus; supra sat glaber (lateribus piloso-fimbriatis); subtus cinereo-pilosus; ferrugineus, antennis pallidioribus (his 9-articulatis); clypeo leviter sat grosse subsquamoso-punctulato, antice 3-vel 4-dentato; fronte sat æquali, subtiliter creberrime punctulata; prothorace valde transverso, supra vix manifeste canaliculato antice sat angustato, minus crebre minus subtiliter punctulato, lateribus leviter arcuatis; elytris sat fortiter geminato-striatis, interstitiis subfortiter minus crebre punctulatis; propygidio pygidioque coriaceis, illo vix perspicue punctulato, hoc puncturis sparsis sat magnis minus fortiter impresso et apicem versus pilis nonnullis vestito; tibiis anticis extus 3-dentatis (dentibus intervallis subæqualibus divisis); tarsorum posticorum articulo basali quam 2^{us} perspicue (nec valde) breviori.

Maris abdomine toto longitudinaliter sulcato.

Fem. latet. Long., 5-5$\frac{1}{2}$ l.; lat., 2$\frac{1}{2}$-2$\frac{4}{5}$ l.

One of the largest species in the genus, and with no near ally among the previously described *Liparetri*. I have three specimens before me (two of them belonging to Mr. Griffith), which appear to be of one sex, and the peculiar concavity running down the whole length of the ventral segments is certainly indicative of their being males. In one example the median projection of the clypeus is bifid, making the front of the clypeus 4-dentate.

N.W. Australia.

L. lividipennis, sp. nov. Ovatus; sat nitidus; supra sat glaber (fronte pilis erectis vestita, lateribus piloso-fimbriatis, propygidio pygidioque setis crassis brevibus subsquamiformibus vestitis); subtus cinereo-pilosus; niger, elytris lividis margine obscuro anguste cinctis; antennis 9-articulatis; clypeo antice truncato (angulis subrectis), grosse squamoso-punctulato; fronte sat æquali, crebre subtiliter punctulata; prothorace fortiter transverso, vix perspicue canaliculato, supra ut frons punctulato, antice sat angustato, lateribus leviter arcuatis, pilis lateralibus albidis; elytris vix fortiter geminato-striatis, interspatiis sat fortiter minus crebre punctulatis; propygidio crebre subtiliter, pygidio minus crebre minus subtiliter, punctulatis; tibiis anticis extus leviter 3-dentatis (dentibus intervallis subæqualibus divisis, dente summo subobsoleto); tarsorum posticorum articulo basali quam 2^{us} multo breviori.

Maris quam feminæ antennarum flabello longiori, tarsis anticis robustioribus. Long., 3-3$\frac{1}{2}$ l.; lat., 2-2$\frac{1}{5}$ l.

The uppermost tooth of the front tibiæ is very feeble, and seems to indicate this as a transition form leading on to the *Liparetri* having less than three external teeth. I have two specimens before me, which I believe to be male and female, as the antennal flabellum is distinctly longer and the front tarsi more robust in one than in the other. There is no marked difference between them in respect of the clypeus.

South Australia.

L. incertus, sp. nov. Ovatus; sat nitidus; nonnihil iridescens; supra sat glaber (lateribus piloso-fimbriatis, propygidio pygidioque setis brevibus albidis adpressis vestitis), subtus cinereo pilosus; niger, nonnullorum exemplorum elytris plus minusve piceis vel rufis, antennis (clava excepta), palpisque rufis, pedibus plus minusve rufescentibus; antennis 9-articulatis; clypeo modice reflexo, nitido, sat grosse leviter squamoso-punctulato; fronte antice impressa, crebre punctulata; prothorace fortiter transverso, supra fortius sat crebre punctulato, sat late leviter (basin versus sat fortiter) canaliculato, antice fortiter angustato, lateribus arcuatis (ante basin sat fortiter rotundato-dilatatis); elytris sat elongatis, sat fortiter geminato-striatis, interspatiis sat fortiter sat crebre punctulatis; propygidio subtilius, pygidio magis fortiter, punctulatis, ambobus plus minusve perspicue carinatis; tibiis anticis extus tridentatis (dentibus intervallis subæqualibus divisis); tarsorum posticorum articulo basali quam 2[us] sat (nec valde) breviori.

Maris quam feminæ antennarum flabello sat longiori, tarsis anticis multo robustioribus, clypeo antice magis truncato et obsoletissime tridentato. Long., $3\frac{1}{2}$-$3\frac{4}{5}$ l.; lat., 2-$2\frac{1}{5}$ l.

This species bears much resemblance to *L. picipennis*, Germ., from which, however, it may be at once separated by, *inter alia*, the absence of any erect hairs on the front margin of the pronotum, and the evident (though slight) tendency to tridentation of the front margin of the clypeus in the male. It seems to be a fairly common species in Victoria and New South Wales (southern parts), so that it is difficult to believe Sir W. Macleay had not seen it, but I conjecture that he had not noticed its distinctions from *picipennis*. The colour of the elytra is very variable, but whatever the colour a slight iridescence seems to be constant.

Victoria and New South Wales.

L vicarius, Blackb. Ovatus; minus nitidus; niger, antennis palpis pedibus elytris (et non-nullorum exemplorum abdomine prothoraceque) rufescentibus; supra glaber; subtus pilosus; antennis 9-articulatis; clypeo minus crebre punctulato, antice late rotundato (vix subtruncato); fronte crebre punctulata; prothorace fortiter transverso, antice sat fortiter angustato, supra minus crebre subtilius punctulato, haud canaliculato, lateribus sat arcuatis: elytris geminato-striatis, inter-spatiis subfortiter sat crebre punctulatis; propygidio pygidioque crebre sat fortiter punctulatis: tarsorum posticorum articulo basali quam 2^us sat breviori; tibiis anticis extus tridentatis (dentibus intervallis subæqualibus divisis). Long., 3-3½ l.; lat., 1⅘-2 l.

I think, from slight differences in the form of the abdomen, that I have both sexes of this species before me, but I do not find any sexual characters in the clypeus or tarsi. This insect is near *incertus*, Blackb, from which it differs, *inter alia*, by the considerably less coarse puncturation of its elytra, its non-canaliculate pronotum, and its front tarsi much shorter than those of either sex of *incertus*.

North Queensland.

L. amabilis, sp. nov. Ovatus; parum nitidus; capite prothorace sternisque nigris, elytris abdomine propygidio pygidioque læte rufis, antennis palpis pedibusque ferrugineis vel picescentibus; antennis 9-articulatis, stipite brevissimo; clypeo squamoso-punctulato, antice late subtruncato, cum fronte et pronoto (hoc basin versus glabro) pilis erectis obscure brunneis (certo adspectu nigricantibus) vestito; fronte sat æquali, cum prothorace crebre subrugulose punctulata; hoc fortiter transverso, vix perspicue canaliculato, antice fortiter angustato, lateribus postice ampliato-rotundatis antice sinuatis; elytris minus fortiter geminato-striatis, interspatiis leviter minus subtiliter punctulatis, glabris; propygidio pygidioque pilis brevibus erectis albidis vestitis, hoc grosse (illo sat fortiter) minus crebre punctulatis; corpore subtus albido-piloso; tibiis anticis extus tridentatis (dentibus intervallis subæqualibus divisis); tarsorum posticorum articulis basalibus 2 inter se sat æqualibus. Long., 2⅘ l.; lat., 1⅗ l.

A very distinct species by the structural characters indicated in the tabulation; also by its colouring, which is a uniform bright red, except the black of the head, prothorax, and sterna. It is one of the prettiest of the *Liparetri*. I think the unique type to be a female.

New South Wales (Mulwala); sent by Mr. Sloane.

***L.** analis*, Blackb.? (Mas.). Ovatus; sat nitidus; niger elytris tarsisque obscure rufis, antennis (clava picea excepta) palpisque testaceis, pedibus plus minusve picescentibus; supra glaber (pronoto antice et ad latera pilis fulvis elongatis fimbriato excepto); subtus pilosus; antennis 9-articulatis, stipite perbrevi: clypeo antice leviter emarginato sat fortiter reflexo; fronte crebre subtilius rugatim punctulata, antice impressa, postice longitudinaliter nonnihil subcarinata; prothorace valde transverso, supra sparsius sat fortiter punctulato, subiridescenti, leviter canaliculato, antice sat angustato, lateribus sat arcuatis; elytris minus perspicue geminato-striatis, interspatiis fortiter sat crebre punctulatis; propygidio subtiliter minus crebre (prope apicem magis fortiter) punctulato, longitudinaliter subcarinato; pygidio fortiter sat crebre punctulato, antice longitudinaliter fortiter carinato; tibiis anticis extus tridentatis (dentibus intervallis subæqualibus divisis); tarsorum posticorum articulo basali quam 2[us] parum breviori. Long., 3 l.; lat., $1\frac{3}{5}$ l.

I have abstained from giving a separate name to this insect, because, in view of the great sexual differences of some *Liparetri*, and of the fact that the unique example described above is a male, while the unique type of *analis* is a female, I see nothing conclusive against their specific identity. The two specimens differ greatly in colouring, and the pygidium of *analis* is non-carinate. The hind tarsi of *analis* (type) have only the basal joint, but it is quite like the basal joint of the hind tarsi of the specimen described above. If further investigation should prove that the male described above is distinct from *analis*, it will be time then to give it a separate name. The *habitat* of the type of *analis* is uncertain. The fact that the basal joint of the hind tarsi is a trifle shorter than the second joint renders it desirable to compare it with the species of the third group, from all of which its nitid pronotum bearing strong, decidedly sparse puncturation, in combination with its colouring and smaller size, readily distinguishes it.

South Australia (Kangaroo Island). In S.A. Museum.

L. consanguineus, sp. nov. Ovatus; sat nitidus; niger, supra nonnihil cœruleo-iridescens, antennis (clava picea excepta) palpisque rufis, pedibus plus minusve picescentibus; supra sat glaber; pronoti marginibus omnibus pilis brunneis elongatis fimbriatis, propygidio pygidioque sparsim pilosis; subtus pilosus; antennis 9-articulatis; clypeo antice late rotundato vix subtruncato, leviter reflexo, crebre subtilius sat profunde (nec squamose) punctulato; fronte sat æquali, fere ut clypeus (sed antice magis subtiliter) punctulata; prothorace valde transverso, supra (basin versus) vix perspicue canaliculato, antice minus angustato, leviter subtilius (in disco sparsim latera versus magis crebre) punctulato, lateribus sat arcuatis; elytris manifeste geminato-striatis, interspatiis fortius sat crebre punctulatis; propygidio pygidioque subopacis, illo leviter sparsius, hoc magis crebre magis fortiter, punctulato; tibiis anticis extus tridentatis (dentibus intervallis subæqualibus divisis); tarsorum posticorum articulis basalibus 2 sat æqualibus. Long., $3\frac{3}{4}$ l.; lat., $2\frac{1}{5}$ l.

A very broad species, bearing much superficial resemblance to several other species, from most of which it is distinguished by the vestiture of its pronotum, that segment being glabrous except on the margins, which are fringed by long, erect pilosity. As the basal joint of its hind tarsi is possibly a trifle shorter than the second joint it seems desirable to indicate the characters that (apart from the hind tarsi) distinguish it from those species of the third group which are not very differently coloured. From all of them known to me it differs, *inter alia*, by the form of its clypeus and the very much feebler and sparser puncturation of its pronotum. The unique type is a male.

South Australia (Tintinarra); in S.A. Museum.

L. puer, sp nov. Ovatus; sat opacus; niger, elytris (his nonnihil iridescentibus) cum propygidio pygidioque piceis vel rufescentibus, antennis (clava picea excepta) palpis pedibusque rufis, elytris basin versus obscure nigricantibus; supra sat glaber, sed capite piloso pronoti marginibus omnibus pilis erectis perlongis fimbriatis propygidio pygidioque sparsim pilosis; subtus pilosus; antennis 9-articulatis (stipite perbrevi); clypeo antice late rotundato (fere subtruncato), sat fortiter reflexo, crebre subtiliter fere ut frons (hoc sat æquali) punctulato; prothorace fortiter transverso, æquali, subtilius subobsolete punctulato, inter puncturas nonnihil ruguloso vel subgranuloso, antice minus angustato, lateribus sat arcuatis; elytris manifeste geminato-striatis, interspatiis fortiter (fere subgrosse) vix crebre punctulatis; propygidio sat fortiter minus crebre punctulato, sat nitido; pygidio sparsius sat grosse punctulato, nitido; tibiis anticis tridentatis (dentibus intervallis subæqualibus divisis); tarsorum posticorum articulo basali quam 2^{us} vix breviori.

Maris quam feminæ antennarum flabello paullo longiori, tarsis anticis longioribus et robustioribus; maris pygidio longitudinaliter leviter (feminæ nullo modo) carinata. Long., $2\frac{1}{5}$ l.; lat., $1\frac{1}{5}$ l.

This very small *Liparetrus* seems not very close to any other species known to me, and clearly distinct from all those described by Macleay. I suspect that Macleay would have placed it in the *discipennis* group near *holosericeus*, Macl., which, however, he places in that group only with doubt. *Holosericeus* is a larger insect, differently coloured, and is glabrous above. It is, moreover, from a widely distant locality. It may be noted that there are a few hairs on the disc of the pronotum of *puer*, but they are quite inconspicuous compared with the strong frill of long pilosity across the front margin.

South Australia (Eucla district).

L. Perkinsi, sp. nov. Ovatus; minus nitidus; niger, sat iridescens; elytris antennis palpisque rufo-testaceis, pedibus plus minusve rufescentibus; supra sat glaber, subtus pilosus; antennis 9-articulatis; clypeo antice dentibus 3 fortibus acutis recurvis armato, nitido, subsquamose vix crebre punctulato, fronte coriacea crebre subtiliter punctulata; prothorace fortiter transverso, vix perspicue canaliculato, supra fere ut frons sed minus crebre punctulato, antice fortiter angustato, lateribus fortiter rotundatis; elytris subfortiter geminato-striatis, interspatiis subfortiter vix crebre punctulatis; propygidio pygidioque æqualibus, æqualiter ut frons sculpturatis; tibiis anticis extus fortiter tridentatis (dentibus intervallis subæqualibus—sed superioribus 2 nonnihil approximatis—divisis); tarsorum posticorum articulo basali quam 2^us^ manifeste (vix multo) longiori. Long., $2\frac{3}{4}$-$3\frac{1}{5}$ l.; lat., $1\frac{3}{5}$-$1\frac{7}{10}$ l.

The unusual character of three sharp recurved teeth projecting from the front of the clypeus distinguishes this species from nearly all its congeners. The two species to which Macleay attributes that character have their head and pronotum villose. I do not find any marked sexual characters in any of the eight specimens that I have seen of this insect, though I think (from slight abdominal differences) that both sexes are present.

North Queensland. (Sent by Mr. R. C. L. Perkins.)

L. alienus, sp. nov. Elongato-ovatus; minus nitidus; niger, antennis (clava picea excepta) palpis elytris pedibus feminæque abdomine rufis; supra totus (propygidio pygidioque albido-pilosis exceptis) pilis sat elongatis nigris erectis minus dense vestitus; subtus cinereo-pilosus; antennis 9-articulatis; clypeo subnitido, squamose punctulato, antice truncato (angulis obtusis); fronte æquali, ut pronotum coriacea sparsim sat grosse punctulata; prothorace fortiter transverso, æquali, antice sat angustato, lateribus arcuatis; elytris sat elongatis, sparsim subseriatim subgrosse nec profunde punctulatis, haud striatis; propygidio pygidioque subnitidis, coriaceis, sparsius leviter subgrosse punctulatis; tibiis anticis extus bidentatis; tarsorum posticorum articulo basali quam 2^{us} vix breviori.

Maris antennarum clava quam feminæ manifeste longiori, tarsis anticis paullo longioribus pygidio subtus producto sic ut segmenta ventralia brevissima sunt in medio. Long., $1\frac{3}{4}$-$2\frac{1}{2}$ l.; lat., 1-$1\frac{1}{5}$ l.

I am not sure that this species might not properly be regarded as the type of a new genus allied to *Liparetrus*. Its long elytra almost covering the propygidium in both sexes and its depressed elongate appearance, together with its peculiar sculpture and vestiture, render it very isolated in this genus. I cannot, however, discover any definite structural character that is not paralleled in some unquestionable *Liparetrus*, unless it be the abdominal character of the male (*i.e.*, the pygidium folded under so as to narrow, as if crowded together, the ventral segments on the middle line). This, however, does not seem sufficient to justify the creation of a new genus. It should be noted that in both sexes the front tarsi are remarkably short, being (even in the male) less than half as long as the hind tarsi; and that the erect hairs on the elytra are disposed in longitudinal rows.

Western Australia. (Beverley; Mr Lea.)

L. rotundicollis, sp. nov. Sat breviter ovatus; minus nitidus; niger vel piceo-niger, iridescens, antennis palpisque rufis, pedibus (et nonnullorum exemplorum pygidio) plus minusve rufescentibus; totus cinereo-pilosus (capite pronotoque fulvo-pilosis exceptis); antennis 9-articulatis; clypeo nitido, crebre subgranulatim punctulato, antice truncato; fronte sat æquali fere ut clypeus punctulata; prothorace fortiter transverso, antice sat angustato, æquali, supra confertim subtiliter ruguloso, lateribus fortiter rotundatis; elytris obsolete geminato-striatis, interspatiis crebre fortius punctulatis; propygidio pygidioque fortiter crebrius punctulatis; tibiis anticis extus bidentatis (dente superiori subobsoleto); tarsorum posticorum articulis basalibus 2 sat æqualibus inter se. Long., $2\frac{4}{5}$-$3\frac{1}{2}$ l.; lat., $1\frac{3}{5}$-$1\frac{4}{5}$ l.

I have seen two specimens of this insect, and do not find any defined sexual characters among them. They are probably females, and it is not unlikely that the male has some distinctive character in the ventral segments and clypeus. The species described above is very different from all its allies (*inter alia*, by the very close, strong, subrugulose puncturation of its elytra, and its colouring), and may safely be described without the knowledge of both sexes. It is not unlike *L. nudipennis*, Germ., superficially, but is very distinct from that species by, *inter alia*, the pilosity of its elytra.

South Australia.

L. ventralis, sp. nov. (Mas.). Breviter ovatus; sat opacus; niger, antennis palpis elytris (his anguste nigrocinctis) tibiis anticis tarsisque omnibus brunneo-testaceis; totus albido-pilosus; antennis 9-articulatis; clypeo nitido minus crebre, fronte sat crebre, rugulosis; prothorace fortiter transverso, antice sat angustato, supra minus crebre punctulato, vix ruguloso, haud canaliculato, lateribus sat rotundatis: elytris vix perspicue geminato-striatis, interspatiis leviter minus subtiliter punctulatis; propygidio leviter sat crebre, pygidio sat profunde minus crebre, punctulatis; tarsorum posticorum articulo basali quam 2^{us} dimidia parte longiori; tibiis anticis unidentatis; segmento ventrali apicali antice longitudinaliter obtuse bicarinato, ad apicem deorsum acute bispinoso. Long., $2\frac{1}{2}$ l.; lat., $1\frac{3}{5}$ l.

This species differs from all the others described, of the same group, by its combination of bicolorous elytra, front tibiæ without any trace of an external tooth above the apical projection, and hind tarsi with basal joint much longer than the second joint. It is rather close to *L. assimilis*, Macl., from which (I have examined the presumable type, unique, in the Macleay Museum) it differs by the uniform whitish colour of its vestiture, *assimilis* having much very dark brown pilosity, as well as by the much longer basal joint of its hind tarsi.

North Queensland.

L. gravidus, sp. nov. Sat late ovatus; minus nitidus; niger, antennis palpis, elytris (his obscuro-cinctis) et (pilus minusve) pedibus testaceis vel ferrugineis; capite, pronoto elytris (basin versus), propygidio pygidioque (hoc cum propygidio etiam setis adpressis albidis vestito) pilis brunneis vestitis; corpore subtus cinereo-piloso; antennis 9-articulatis; clypeo antice truncato, cum fronte (hac sat æquali) pronotoque crebre ruguloso; prothorace fortiter transverso, supra obsolete canaliculato, antice fortiter angustato, lateribus arcuatis; elytris obsolete geminato-striatis, interspatiis leviter nec crebre punctulatis; propygidio pygidioque confertim subtiliter rugulosis; tibiis anticis extus bidentatis; tarsorum posticorum articulis basalibus 2 inter se sat æqualibus.

Maris clypeo quam feminæ magis elongato magis abrupte truncato, antennarum flabello paullo longiori, tarsis anticis multo longioribus. Long., $4\text{-}4\frac{1}{2}$ l.; lat., $2\frac{1}{5}\text{-}2\frac{1}{2}$ l.

Rather closely allied to *L. luridipennis*, Macl., but larger and differently coloured (the elytra more ferruginous, and with a better defined, dark bordering), the upper tooth of the front tibiæ much stronger, and (especially) the basal region of the elytra pilose.

Western Australia (Swan River) : Mr Lea.

L. cinctipennis, sp. nov. Breviter ovatus; minus nitidus; niger, antennis (clava picea excepta) palpis et elytris (marginibus late nigris exceptis) ferrugineis, pedibus plus minusve picescentibus; supra sat glaber, pronoto antice et ad latera piloso-fimbriato, propygidio pygidioque setis adpressis albidis vestitis; subtus cinereo-pilosus; antennis 9-articulatis; clypeo antice truncato, cum fronte (hac sat æquali) pronotoque confertim subtiliter ruguloso; prothorace fortiter transverso, æquali, antice sat fortiter angustato, lateribus arcuatis: elytris obsolete geminato-striatis, interspatiis leviter nec crebre punctulatis; propygidio pygidioque crebre sat subtiliter rugulosis; tibiis anticis extus bidentatis (dente superiori minuto vel subobsoleto); tarsorum posticorum articulo basali quam 2^{us} vix longiori.

Maris quam feminæ clypeo magis abrupte truncato, antennarum flabello parum longiori, tarsis anticis paullo robustioribus. Long., 3 l.; lat., 2 l.

Easily distinguishable from *L. luridipennis*, Macl., and *gravidus*, Blackb., by, *inter alia*, the non-pilose disc of its pronotum and the deep black, much wider, and more sharply defined bordering of its elytra.

Western Australia (Perth).

L. minor, sp. nov. (Mas.)—Ovatus; minus nitidus; piceus, vix rufescens, clypeo antennis (clava picea excepta) palpis pedibus elytrisque testaceo-brunneis: supra glaber; subtus sparsim pilosus; antennis 9-articulatis; clypeo nitido sparsim punctulato, antice tridentato (dente mediano sat acuto); fronte crebre subtiliter subaspere punctulata, sat æquali; prothorace sat fortiter transverso, antice fortiter angustato, supra subtilius sparsim leviter punctulato, postice obsolete impresso, lateribus sat fortiter rotundatis; elytris obsolete geminato-striatis interspatiis sparsius sat fortiter punctulatis; propygidio pygidioque crebre punctulatis; tibiis anticis extus, 1-dentatis; tarsorum posticorum articulo basali quam 2^{us} manifeste breviori. Long., 2 l.; lat, $1\frac{1}{5}$ l.

The clypeus of the female is probably less strongly tridentate than that of the male, but in the male the median tooth is so well defined that it is not likely to be unrepresented in the female. The front tibiæ have no distinct tooth (scarcely even an inequality) above the apical projection. All the species placed by Macleay among those having the clypeus tridentate in the male and which bear any superficial resemblance to this insect, have the basal joint of their hind tarsi longer than the second joint. It should be noted that although in my unique example of this insect the propygidium and pygidium are glabrous, I judge from the nature of the sculpture and the analogy of allied species that those parts are probably abraded, and that in a fresh specimen they might bear some sparse vestiture.

Queensland; Port Mackay (Mr. Lower).

L. brevipes, sp. nov., fem. Breviter ovatus; subnitidus; brunneo-testaceus, antennarum clava capiteque piceo-nigris, prothorace testaceo-rufo; supra glaber; subtus cinereo-pilosus; antennis 9-articulatis; clypeo antice rotundato, ut frons (nac sat æquali) transversim crebre ruguloso; prothorace fortiter transverso, antice sat angustato, supra obsolete canaliculato, subtilius sat crebre punctulato, lateribus arcuatis; clytris sat fortiter geminato-striatis, interspatiis sat fortiter vix crebre punctulatis; propygidio pygidioque fortiter sat crebre punctulatis; tibiis anticis extus 1-dentatis; tarsis brevibus, posticorum articulo basali quam 2^us^ parum breviori. Long., $2\frac{4}{5}$; lat., $1\frac{4}{5}$ l.

An exceptionally wide species, and with unusually short tarsi. It is not very close to any other species known to me except the next species to be described (*L. Blanchardi*, sp. n.), but bears considerable superficial resemblance to *L. lætus*, Blackb., which, however, *inter alia*, has antennæ consisting of only eight joints, and front tibiæ conspicuously bidentate externally.

Western Australia (Perth).

L. Blanchardi, sp. nov., fem. Sat breviter ovatus; minus nitidus; brunneo-testaceus, fronte et (angustissime) elytrorum basi nigris, sterno paullo infuscato; supra fere glaber (pygidio sparsius brevissime villoso); subtus cinereo-pilosus; antennis 9-articulatis; clypeo nitido leviter squamose punctulato, antice subtruncato (latissime rotundato); fronte sat æquali, subtilius minus crebre punctulata; prothorace fortiter transverso, antice fortiter angustato, supra postice vix manifeste canaliculato, sat crebre minus subtiliter punctulato, lateribus fortiter rotundatis; elytris leviter geminato-striatis, interspatiis sat fortiter sat crebre punctulatis; propygidio pygidioque crebre minus fortiter punctulatis; tibiis anticis extus

1-dentatis; tarsis modice elongatis, posticorum articulis basalibus inter se sat æqualibus. Long., 2 l.; lat., $1\frac{1}{5}$ l.

Somewhat closely allied to the preceding. Disregarding the somewhat considerable differences in colouring, it differs, *inter alia*, by the sculpture of its head, the much more strongly rounded sides of its pronotum, and its considerably longer tarsi.

Queensland (Port Mackay).

L. Leai, sp. nov. Ovatus; minus nitidus; niger, antennis (clava excepta) palpis et elytris (his anguste piceo-cinctis) brunneo-testaceis, pedibus picescentibus; supra fere glaber, propygidio pygidioque setis adpressis albidis vestitis; subtus cinereo-pilosus; antennis 9-articulatis; clypeo (ut frons, hac sat æquali) transversim ruguloso, antice subtruncato; prothorace fortiter transverso, antice angustato, supra postice vix canaliculato, leviter sat crebre vix subtiliter punctulato, lateribus arcuatis; elytris leviter geminato-striatis, interspatiis sat fortiter vix crebre punctulatis; propygidio pygidioque sat crebre sat fortiter (hoc quam ille magis fortiter) punctulatis; tibiis anticis extus 1-dentatis; tarsorum posticorum articulis basalibus 2 inter se sat æqualibus. Long., 3 l.; lat., $1\frac{3}{5}$ l.

I believe that both sexes of this species are before me; if so the sexual characters are slight, consisting in a slight additional robustness in the front tarsi (and especially the front claws) of the male. It is possible, however that the specimen I regard as the female may be a somewhat feebly developed male. This species bears much superficial resemblance to *L. ovatus*, Macl., but differs, *inter alia*, by its front tibiæ having no external tooth above the apical projection and its pronotum having no dorsal channel except a faint impression close to the base (which is entirely wanting in very few *Liparetri*).

Western Australia: Perth (from Mr. Lea).

L. rugatus, sp. nov., fem. Late ovatus; minus nitidus; niger, antennis (clava obscura excepta) palpis elytris (his basin versus nigricantibus) abdomineque obscure rufis, pedibus picescentibus; supra in pronoto propygidio pygidioque pilis erectis vestitus; subtus cinereo-pilosus; antennis 8-articulatis; clypeo crebre sat fortiter punctulato, antice truncato, fronte sat æquali, fere ut clypeus punctulata; prothorace fortiter transverso, antice sat angustato, supra æquali, inæqualiter (prope apicem et basin fere ut frons, in disco magis grosse minus crebre) punctulato, lateribus arcuatis; elytris vix manifeste geminato-striatis, interspatiis fortiter crebre subrugulose punctulatis transversim rugatis; tibiis anticis extus 3-dentatis (dentibus intervallis subæqualibus divisis); tarsorum posticorum articulis basalibus 2 inter se sat æqualibus. Long., $3\frac{1}{2}$ l.; lat., $2\frac{1}{5}$ l.

This species is evidently allied to *L. ferrugineus*, Blanch., from which it is easily distinguishable by, *inter alia*, the much closer and stronger puncturation of its elytra, and the very evidently greater length of the basal joint of its hind tarsi.

North Queensland.

L. insolitus, sp. nov. Ovatus; vix nitidus; niger, antennis (clava excepta) palpis, elytrisque (his ad basin anguste nigricantibus) ferrugineis, pedibus et nonnullorum exemplorum pygidio picescentibus; supra (elytris—nisi ad basin summam—capiteque exceptis) pilis erectis fulvis vestitus; subtus cinereo-pilosus; antennis 7-articulatis; clypeo sat subtiliter subsquamose punctulato; fronte leviter inæquali, quam clypeus magis subtiliter magis crebre vix squamose punctulata; prothorace fortiter transverso, antice fortiter angustato, supra minus perspicue canaliculato, subgrosse nec profunde vix crebre punctulato, lateribus modice arcuatis; elytris sat fortiter geminato-striatis, interspatiis sat fortiter sat crebre punctulatis; tarsorum posticorum articulo basali quam 2^{us} parum breviori; tibiis anticis extus tridentatis.

Maris clypeo antice abrupte truncato (fere subemarginato); tarsis anticis sat elongatis; propygidio sparsim dupliciter (subtiliter et subfortiter), pygidio magis fortiter magis crebre, punctulatis.

Feminæ clypeo antice minus abrupte truncato, tarsis anticis brevioribus, propygidio pygidioque confertim rugulosis. Long., $3\frac{1}{2}$-4 l; lat., 2-$2\frac{1}{4}$ l.

This species may be described as superficially a close ally of *L. phœnicopterus*, Germ., having antennæ consisting of only seven joints. No other known to me of the species with similar antennæ (seven-jointed) bears the least resemblance to it.

Western Australia: Swan River (Mr. Lea).

Microthopus.

I diagnosed the genus *Macleayia* in Tr.R.S.S.A., 1887, and in the same volume added a note as to the possibility of its identity with Burmeister's genus *Microthopus*. Since that time I have had the opportunity of examining large numbers of *Liparetroid Coleoptera*, from Western Australia, and as I have not met with any insect more likely to be *Microthopus*, I have recently reconsidered the question of the identity with it of *Macleayia*, and am now of opinion that the two genera cannot be separated. The discrepancy between *Macleayia* and the diagnosis of *Microthopus* consists in the flabellum of the antennæ of the male of *Macleayia* being five-jointed, while it is said to be three-jointed in *Microthopus*. The extreme variability of the antennal structure, however, among many Australian *Melolonthides* that seem to present no other difference likely to be generic, seems to forbid the acceptance of that as a valid generic character. Indeed, having now seen what I believe to be the male of my *M. hybrida* (the second species that I attributed to *Macleayia*), I am fairly confident that in that insect the flabellum of both sexes is three-jointed. Therefore, I do not regard *Macleayia* as more than a subgenus of *Microthopus*, containing only one described species (*singularis*, Blackb.), while two described species (*hybrida*, Blackb., and *castanopterus*, Burm.), are of *Microthopus* in the strict sense. It is even possible that *hybrida* is a variety of *castanopterus*, as there does not seem to be any good character to separate them, apart from colour; but it would not be safe to pronounce them specifically identical without examining a specimen agreeing in all respects with Burmeister's description.

Burmeister distinguishes *Microthopus* from *Liparetrus* by characters that are quite insufficient now that the species of the latter genus have been found to be so numerous and varied in structure, viz., its more elongate elytra and less convex pygidium. It is well differentiated, however, by a character that I have already referred to (Tr.R.S.S.A., 1898, p. 31), as of great value for the generic distribution of the Australian *Melolonthides*, viz., the sculpture of the elytra, which in *Microthopus* (but in no *Liparetrus* known to me), consists of well-defined, uniform striation.

Automolus.

In Tr.R.S.S.A., 1898, p. 31, I suggested the possibility of the species on which this Tasmanian genus was founded being congeneric with some of those of which Macleay formed his second section of *Liparetrus*. I am now, after a much more extensive study of *Liparetroid Lamellicornes*, very confident that my conjecture was correct. As is so frequently the case in respect of the *Melolonthides* of Australia, the genera involved in this discussion have been rendered more difficult to identify by the absence of knowledge, on the part of their founders, of the extreme variability of the antennæ of the insects in question. Burmeister gives "nine-jointed antennæ" as a generic character of *Automolus*, and Macleay makes "antennæ eight-jointed" the essential character of his second section of *Liparetrus*. As I have already remarked, authors have so obviously been in the habit of assuming it unnecessary to count the joints carefully in more than one of an aggregate (of Australian *Melolonthides*) of evidently closely allied species, that there is no reason whatever for deciding against the identity of two generic names merely because the insects they are applied to have antennæ differing in the number of joints And, in the case of the species under discussion, the further consideration must not be overlooked that they have antennæ of which the stipes is extremely short and difficult to examine. In the present case the really reliable distinction of most of the species included by Macleay in his second section of *Liparetrus* from all of those which he places in the first section is to be found in the structure of the front tibiæ—which have two adjacent external teeth close to the apex, and one (a very small one) close to the base (the margin of the tibiæ between them being straight or all but straight)—a structure which I have seen in no *Liparetroid* species that is not obviously a close ally of these insects (*e.g.*, *Automolus* (*Liparetrus*) *poverus*, Blanch.). That structure is assigned by Burmeister to the front tibiæ of *Automolus*: and the assignment to it of nine-jointed antennæ need occasion no difficulty in associating it with species having similar tibial structure and eight-jointed antennæ, because on the one hand Burmeister might be almost excusable if he miscounted the joints of such obscure antennæ, and, on the other hand, at least one of the species before me with the tibial structure indicated above, has nine-jointed antennæ.

As regards Burmeister's species (*A. angustulus*), the description is in general certainly suggestive of my *Automolus* (*Liparetrus*) *alpicola*. I am, however, confident in saying that the antennæ of the latter have only eight joints, and I have not met with it, nor seen it, from Tasmania. These considerations combined lead me to the opinion that *A. angustulus*, Burm., is a species that I have not seen, and which has not been redescribed by any author. I regard *Automolus* as a valid genus.

ABSTRACT OF PROCEEDINGS

OF THE

Royal Society of South Australia

(Incorporated)

FOR 1904-5.

ORDINARY MEETING, NOVEMBER 1, 1904.

THE PRESIDENT (J. C. VERCO, M.D., F.R.C.S.) in the chair.

EXHIBITS.—A. H. C. ZIETZ, F.L.S., C.M.Z.S., a large number of the preserved skins of the Australian honey-eaters. The PRESIDENT exhibited three volutes from the lobster pots, Victor Harbour, the markings beautifully preserved, named respectively *Voluta exoptanda*, *V. papillosa*, *V. fulgetrum*. These shells had been taken into the pots by the later occupiers—hermit crabs—in search of food.

PAPERS.—"New Species of South Australian Marine Mollusca," by J. C. VERCO, M.D., F.R.C.S. DR. VERCO, in introducing his paper, called the attention of the meeting to some interesting features in some of the molluscs therein described, the *Glycimeris sordidus*, the shell of which shows periods of rest, which are not found in its very near ally, *G. pectenoides*. In this latter shell, in the older stages, growth ceases, and the mantle contracts. *Modiola pœnetecta*, almost covered with epidermis, whilst *M. australis* is much less so. In these species a very marked difference exists in the filaments of the epidermis. *Trigonia bednalli*, probably a variety of *margaritacea*, a genus now found only in Australian seas, but remarkable as found fossil from very early geological ages. DR. VERCO also drew attention to very marked differences between *Ovula*, of which a very fine specimen was shown, and *Cypræa*.

ORDINARY MEETING, APRIL 4, 1905.

THE PRESIDENT (J. C. VERCO, M.D., F.R.C.S.), in the chair.

NOMINATION.—DOUGLAS MAWSON, B.Sc., B.E., Lecturer in Mineralogy and Petrology in the University of Adelaide, as a Fellow.

EXHIBITS.—A. H. C. ZIETZ, F.L.S., C.M.Z.S., exhibited a number of flies collected near Adelaide, all well-known

European species, including the European blowfly *(Musca vomitoria)*. This is the first record of this species for Australia. J. G. O. TEPPER, F.L.S., gave an interesting account of the growth, development, and nature of the gadfly, and exhibited a very prolific plant of the Umbelliferous order, probably *Ferula*, growing near Adelaide.

PAPERS.—"An Outline of a Theory of the Genesis of Motion in Living Bodies," by T. BRAILSFORD ROBERTSON, introduced by Professor E. C. STIRLING, F.R.S. "On the Formation known as Glacial Till of Cambrian Age in South Australia," by J. D. ILIFFE, B.Sc.,and HERBERT BASEDOW. "New Species of South Australian Marine Mollusca" (part 2), by J. C. VERCO, M.D., F.R.C.S. "Additions to the Cambrian Fauna of South Australia," by R. ETHERIDGE, JUN., Hon. Fellow. "South Australian Nudibranchs and an Enumeration of the known Australian Species," by HERBERT BASEDOW and CHARLES HEDLEY, F.L.S. "On the Naticoid Genera, Lamellaria, and Caledoniella, from South Australia, " by HERBERT BASEDOW. "Report on the Mollusca collected by Herbert Basedow, on the S.A. Government N.W. Expedition, 1903," by CHARLES HEDLEY, F.L.S. "Description of New Australian Lepidoptera," by OSWALD B. LOWER, F.E.S. (Lond.).

ORDINARY MEETING, MAY 2, 1905.

THE PRESIDENT (J. C. VERCO, M.D., F.R.C.S.), in the chair.

BALLOT.—DOUGLAS MAWSON, B.Sc., B.E., Lecturer in Mineralogy and Petrology in the University of Adelaide, was elected a Fellow.

NOMINATIONS.—GEORGE BROOKMAN, Gentleman, as a Fellow; CHARLES HEDLEY, F.L.S., and THOMAS GILL, I.S.O., Under-Treasurer, as Hon. Members. G. M. THOMSON, F.L.S., F.C.S., as a Corresponding Member

EXHIBITS.—MR. EDWIN ASHBY, bird skins from Kangaroo Island. Amongst these may be mentioned *Calyptorhyncus viridis* (Viell), Leach's cockatoo and egg, the red-rumped ground wren *(Hylacola cauta)* (Gould), *Ptilotis cratitia*, *P. lencotis*, *Meliornis australasiana*, *M. novæ hollandiæ*, *Acanthorhynchus tenuirostris*, *Glycyphila fulvifrons*, all honey-eaters; *Strepera melanoptera*, *Platycereus elegans*, and others. The absence of several species of birds, found in Southern Yorke Peninsula, from Kangaroo Island, and the presence of others, unknown in the vicinity of Adelaide, but common to the Victorian side, would, according to Mr. Ashby, seem to indicate that the last connection of the island with the mainland was at its eastern end. Mr. ZIETZ, F.L.S., C.M.Z.S., male and female of the king quail *(Excalfactoria* *australis)*, from near Victor Harbour, and, for comparison with Mr. Ashby's specimens, *Calyptorhynchus naso*, cock and hen and two eggs, from MacDonnell Ranges, also *C. furnereus* and *C. banksii*. Mr. J. G. O. Tepper, F.L.S., exhibited tsetse flies.

Mr. Howchin, F.G.S., then opened the discussion on Messrs. Iliffe and Basedow's paper on the Cambrian glaciation in South Australia. In a carefully considered address he showed that the beds in question had no resemblance to a crush conglomerate, as advocated by the essayists, but that they answered in every particular to a glacial till laid down by floating ice. The paper was a crude attempt to explain phenomena with which the writers had insufficient acquaintance. Mr. D. Mawson, B.Sc., B.E., in supporting Mr. Howchin, said that from a petrological examination of these rocks there was no evidence in support of the theory of their being crush conglomerates produced by cataclastic action.

Papers.—"South Australian Decapod Crustaceans," part 2, by W. H. Baker. "Description of Vertebræ of *Genyornis newtoni*," being part 3 of "Memoirs on Fossil Remains of Lake Callabonna," by Professor E. C. Stirling, M.D., F.R.S., and A. H. C. Zietz, F.L.S., C.M.Z.S.

Ordinary Meeting, June 6, 1905.

The President (J. C. Verco, M.D., F.R.C.S.) in the chair.

Nomination.—Dr. Rogers, M.A., as a Fellow.

Ballot.—The following were elected:—George Brookman, Gentleman, of North Gilberton, as a Fellow; Charles H. Hedley, F.L.S., Naturalist, Australian Museum, Sydney; and Thomas Gill, I.S.O., Under-Treasurer, as Hon. Members; and G. M. Thomson, F.L.S., F.C.S., Chemist and Bacteriologist, Dunedin, New Zealand, as a Corresponding Member.

Exhibits.—A. H. C. Zietz, Assistant Director of the Museum, a very large and beautiful collection of Australian finches' skins. Mr. Zietz described the birds, their nests, and also mentioned the parts of Australia in which the various species were found.

Papers.—"An Aroid New for Australia," by J. H. Maiden, F.L.S., Director of the Botanic Gardens, Sydney. "Further Researches on the Alpha Rays of Radium," by Professor W. H. Bragg, M.A.

Ordinary Meeting, July 4, 1905.

The President (J. C. Verco, M.D., F.R.C.S.), in the chair.

Ballot.—Dr. R. S. Rogers, M.A., Adelaide, was elected a Fellow.

Exhibits.—Dr. Verco, several specimens of *Atlanta*, and one of *Carinaria australis* (Quoy & Gaimard), which add two species, two genera, and a new order to the Nucleobranchiata of South Australia. *Gibbula coxi* (Angas) and *G. lehmanni* (Menke), which had hitherto been confounded. *Astele subgranularis* (Danker). This, which had been described from Bass's Straits, is a half-grown individual of *A. subcarinatum* (Swanson). Several examples of *Crassatellites ponderosa* (Gmelin), hitherto known as *C. castanea*, of Reeve, to illustrate differences of shape and weight and colouration. J. G. O. Tepper, F.L.S., described a new species of mantis *(Fischeria quinquelobatus)*, captured during the N.W. Government expedition, and Phasmides, *Lonchodes caurus*, *Cryptocrania cornuta*, *Acrophylla nubilosa*, *A. paula*, *Necrosia bella*, and *Bacillus peristhenella*, all taken in the same expedition. Douglas Mawson, B.Sc., B.E., then gave an address on "Theories of the Earth's Origin." Introducing the subject, Mr. Mawson stated that the harmonies of the solar system proclaim for the individual planets a common origin. Theories dealing with the past history of our own planet must, therefore, relate to the others, so that it is necessary, at the outset, to be thoroughly acquainted with cosmical geology in all its aspects. To this end the physics of the solar system, together with a brief description of the constituent factors, was then shortly summarised. The nebular theory was propounded by Kant, and given mathematical form by Laplace in his "Mechanique Celeste," over a century ago. The original theory was later strenuously upheld by Herbert Spencer and John Fiske, whose logic failed to disclose its several inaccuracies. This theory traces the beginning and development of the solar system from an original gaseous nebula, an exceedingly tenuous and intensely heated cloud of matter extending in a spheroidal form, beyond the orbit of Neptune, the outermost planet. Of late years such serious objections have been raised to this theory, that it has been generally discredited. Sir Norman Lockyer, in 1890, brought forward his meteoric hypothesis. Reasoning from his extensive investigations in spectrum analysis, he states his views as follows:—"Nebulæ are really swarms of meteorites, or meteoric dust in the celestial spaces. The meteorites are sparse, and the collisions among them bring about a rise of temperature sufficient to render luminous their chief constituents." Professor Chamberlin, of the University of Chicago, has, during the last five or six years, propounded a theory to explain the development of the heavenly bodies depending upon mechanical principles essentially different from those embodied in previous arguments. He explains his "planetesimal hypothesis," as he calls it, in the following terms:—"The prevailing form of the smaller nebulous areas of the heavens is a spiral, in most of which two arms are discernible. Such a form would be developed from any nebulous body were another of sufficient mass to pass close to it, in the way that, say, comets sweep around the sun. It is further thought that the gaseous matter of the arms formed by such a disruptive approach would solidify into tiny planetesimals, which, in course of time, becoming concentrated by their mutual attractive forces, would produce relatively large masses of matter (the planets), whirling in the same direction, around the parent body (the sun)." Mr. Mawson then shortly referred to some of the leading points of difference in the geological development of an earth, built up, after the "planetesimal hypothesis," of aggregations of cold particles, and not originally intensely heated, as required by the nebular hypothesis.

Ordinary Meeting, August 1, 1905.

The President (J. C. Verco, M.D., F.R.C.S.), in the chair.

Exhibits.—A. H. C. Zietz, F.L.S., C.M.Z.S., a block of opal of a variety known as "pineapple opal," from its shape. Unlike ordinary opal it is composed of large crystals. The specimen was found at the White Cliffs opal fields. The mineralogist of the Australian Museum, in Sydney, declared this variety to be a pseudomorph after Glauberite. He also exhibited another mineral of very similar structure, which has not yet been analysed. This was found at the Blinman Mine, embedded in clay. Mr. Zietz also exhibited two British slugs, found in an Adelaide garden, *Limax arborum*, which in England lives in birch trees, and *Limax gagatus*. The President, several molluscs, illustrating the change of form in the same species as it passes through the four stages of growth—embryonic, adolescent, mature, and the senile. *Latirus aurantiacus*, gradually developing in weight, in the rudeness of the nodules, and in the size and cave-like appearance of the perforation. *Voluta adcocki* (Tate), in which, at a certain stage of growth, a change took place in the colour pattern. A *Brachites*, from Port Lincoln, in which the minute valves of the embryo gradually open out and become connected by shelly matter, in the form of a large, tapering tube, resembling coral. Dr. Verco stated that a protoconch, found alone, had been described as a separate genus *(Sinusigera)*, but when older specimens were collected it was shown to be a *Purpura;* also that in some species the protoconch was sinistral, while later developed portions of the shell were dextral.

PAPER.—"Description of New Australian Lepidoptera," by OSWALD B. LOWER, F.E.S., Lond.

ANNUAL MEETING, OCTOBER 3, 1905.

The President (J. C. VERCO, M.D., F.R.C.S.), in the chair.

The annual report and balance sheet were read and adopted.

ELECTION OF OFFICERS.—J. C. Verco, M.D., F.R.C.S., as President; Professor E. H. Rennie, D.Sc., F.C.S., and Rev. Thomas Blackburn, B.A., as Vice-Presidents; Walter Rutt, C.E., as Hon. Treasurer.

ELECTION OF MEMBERS OF COUNCIL.—Dr. Cleland and W. B. Poole.

ELECTION OF AUDITORS.—J. S. Lloyd and David Fleming.

PAPERS.—"On the Recombination of Ions in Air and other Gases," by Professor W. H. BRAGG, M.A. "Notes on Some Decapod Crustaceæ" (No. III.), by W. H. BAKER. "Description of Australian Curculionidæ, with Notes on Previously Described Species (Part III.), Subfamily Otiorhynchides," by ARTHUR M. LEA. "Description of a New Species of Mantidæ and of Six New Species of Phasmidæ, collected in the North-West Region of South Australia," by J. G. O. TEPPER, F.L.S. "Further Notes on the Australian Coleoptera," by REV. THOMAS BLACKBURN, B.A.

ANNUAL REPORT, 1904-5.

The Council has to report that the work of the Society in the various departments of science has been maintained. The following papers have been read or laid on the table:—"New Species of South Australian Marine Mollusca," by J. C. Verco, M.D., F.R.C.S., parts ii. and iii. "Additions to the Cambrian Fauna of South Australia," by Robert Etheridge. "An Outline of a Theory of the Genesis of Motion in Living Bodies," by T. Brailsford Robertson. "On the Formation known as the Beds of Glacial Till of Cambrian Age in South Australia" by J. D. Iliffe, B.Sc., and Herbert Basedow. "South Australian Nudibranchs and an Enumeration of the Known Australian Species," by Herbert Basedow and Charles Hedley, F.L.S. "On Naticoid Genera, Lamellaria, and Caledoniella, from South Australia," by Herbert Basedow. "Report on the Mollusca collected by Herbert Basedow, on the S.A. Government N.W. Expedition, 1903," by Charles Hedley, F.L.S. "South Australian Decapod Crustaceans," parts ii. and iii., by W. H. Baker. "Description of Vertebræ of Genyornis Newtoni, being part iii. of Memoirs on Fossil Remains from Lake Callabonna," by Professor E. C. Stirling, M.D., F.R.S., C.M.G., and A. H. C. Zietz, C.M.Z.S., F.L.S. "An Aroid New for Australia," by J. H. Maiden. "Further Researches on the Alpha Rays of Radium," by Professor W. H. Bragg, M.A. "Description of New Australian Lepidoptera, with Synonymic Notes, No. xxiii.," by Oswald Lower, F.E.S. (Lond.). "On the Recombination of Ions in Air and other Gases," by Professor W. H. Bragg, M.A. "Description of Australian Curculionidæ, with Notes on Previously Described Species, part iii., Subfamily Otiorhynchides," by A. M. Lea. "Descriptions of New Species of Mantidæ, and of Six New Species of Phasmidæ, collected in the N.W. Regions of South Australia by H. Basedow," by J. G. O. Tepper, F.L.S. "Further Notes on the Australian Coleoptera," No. xxxv., by the Rev. Thomas Blackburn, B.A.

Among the new periodicals received this year the following are, perhaps, worthy of mention:—The Maryland Geological Survey, Report of the South African Association for the Advancement of Science, and the Journal of the National Museum, Monte Video.

The publications of this Society are well distributed throughout the civilised world. Exchanges are made with 25 learned Societies in the United Kingdom, with 52 in Europe, 33 in the U.S. of America, 7 in Canada, 5 in South and Central America, and 6 in India, Japan, and the Pacific. Some 15 or 20 more of the publications are sent to the other States of the Commonwealth and New Zealand.

The Society now includes 12 honorary and 9 corresponding members, 65 fellows, and 2 associates.

For some time past the financial position of the Society has been far from satisfactory. Actuated by a desire to help us out of our difficulties, the President (Dr. Verco) has very kindly offered to give £1,000 towards the formation of an endowment fund, provided that the additional sum of £2,000 shall be first obtained elsewhere. The Council hopes that some help will be forthcoming to enable the Society to take advantage of this most generous offer.

The space reserved for books and literature in our present quarters is hopelessly inadequate. The Government has recently been approached with a view of securing better accommodation in this respect for the Royal and other local Societies. It is hoped that something may shortly be done in this matter.

THE TREASURER IN ACCOUNT WITH THE ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED)

Dr.	£	s.	d.	£	s.	d.
October 1st, 1904.						
To Balance				99	14	6
" Subscriptions—						
Royal Society	58	5	0			
Malacological Section ...	0	17	6			
Microscopical Section ...	6	12	6			
				65	15	0
" Donations—						
Dr. Verco, to illustrate Transactions	116	9	0			
Mr. H. Basedow, to illustrate Transactions ...	7	0	0			
Mr. J. Dennant, to illustrate Transactions ...	9	0	0			
				132	9	0
" Government Grants—						
On Subscriptions ...	56	14	9			
For Printing Reports on Scientific Investigations in South Australia ...	150	0	0			
				206	14	9
" Sale of Transactions ...				4	11	0
" Bank Interest				4	1	10
				£513	6	1

Cr.	£	s.	d.	£	s.	d.
By Transactions—						
Printing	81	16	11			
Illustrating	130	15	0			
Publishing	10	4	8			
				222	16	7
" Memoirs—						
Printing	18	15	0			
Illustrating	48	7	3			
				67	2	3
" Grants—						
Field Naturalists' Section ...	10	0	0			
Malacological Section ...	1	0	0			
Microscopical Section ...	5	0	0			
				16	0	0
" Wages—Caretaker				3	0	0
" Printing, Postage, and Stationery				10	10	6
" Advertising				3	8	8
" Exchange on Cheques ...				0	2	0
" Balance—						
In Savings Bank, September 30, 1905 ...	189	4	0			
In Treasurer's hands ...	1	2	1			
				190	6	1
				£513	6	1

Audited and found correct,

J. S. Lloyd, F.I.A.S.A., } Auditors.
David Fleming,

Walter Rutt, Treasurer.

Adelaide, October 1, 1905.

DONATIONS TO THE LIBRARY

FOR YEAR 1904-5.

TRANSACTIONS, JOURNALS, REPORTS, ETC.

Presented by the respective Editors, Societies, and Governments.

AUSTRIA AND GERMANY.

Berlin—Königl. Preuss. Meteor. Instits. Bericht, 1903. Veröffentlichungen der Ergebnisse, 1899, Heft. Do. do., der Niederschlags-Beobachtungen, M. and J. U., 1898. Abhandlungen der . . . Band 2, Nos. 3, 4.

——— Königl. Preuss. Akademie der Wissenschaften zu Berlin. Sitzungsberichte, 1903, Nos. 19-40; 1904, Nos. 25-55

——— Deutsches Meteorologisches Jahrbuch, 1903, Heft. 2.

——— Berliner Gesellschaft für Anthrop. Ethnol. und Urgeschichte, Zeitschrift für Ethnologie—Jahrgang, 35, Heft. 6; do., 36, Heft. 3, 4.

——— Gesellschaft für Erdkunde, Zeitschrift der, 1902, No. 9; 1903, Nos. 1, 5, 8, 9, 10; 1904, Nos. 1-8, 10; 1905, Nos. 1, 2.

Fribourg—Berichte der Naturforschenden Gesellschaft zu Fribourg, Band 40.

Göttingen—Königl. Gesellschaft der Wissenschaften zu Göttingen Math. Phys. Klasse, 1904, Heft. 1, 2, 4, 6; 1905, Heft. 3; do. do., Geschaftliche Mittheilungen, 1904, Heft 2; 1905, Heft. 1.

———— Nachrichten von der Konigl. Gesellschaft der Wissen. und der Georg., August, 1904, Heft. 3, 4, 5.

Heidelberg—Berichte uber Land—und Forstwirtschaft in Deutschostafrika, Band 2, Heft. 4.

Kiel—Schriften Naturwissenschaften Vereins für Schleswig-Holstein, Band 1-12.

München—Sitzungsberichte der K.B. Akademie der Wissenschaften zu München, Math. Phys. Klasse, 1905, Heft. 1. Abhandlungen der do. do., Band 22, Abteil. 1, 2.

Nürnberg—Abhandlungen Naturhistorischen Gesellschaft zu Nürnberg, Band 15, Heft. 2.

Vienna—Kaiserliche Akademie der Wissenschaften in Wien Sitzung, der Math. Naturwiss., 1904, Nos. 10-13, 19-24; 1905, Nos. 1-10, 15-17.

——— Do. do., Anzeiger Math. Naturwiss., Nos. 25-27, 1904; 1903, Nos. 2, 3; 1904, Nos. 2-15; 1905, Nos. 1, 2, 6-9, Jahrgang, 1904.

——— Arbeiten des K.K. Gradmessungs Bureau-Astron., Band 13.

——— K. Königlichen Zool.-Botanischen Gesellschaft in Wien, 1903, Band 53, Heft. 1-10.

——— Annalen K.K. Naturhistorischen Hofmuseums, Band 18, Nos. 2, 3, 4; Band 19, Nos. 1, 2, 3.

Würzburg—Sitzungs.-Berichte Physikalisch—Medicinischen Gesellschaft zu Würzburg, 1904, Nos. 1-10.

Australia and New Zealand.

Adelaide—Public Library, Museum, and Art Gallery, Annual Report, 1903-4.

——— Woods and Forest Department, Annual Progress Report, 1903-4.

——— Royal Geographical Society, Proceedings, 1903-4, vol. vii.

——— Adelaide Observatory, Meteorological Observations, 1899, 1900, and 1901.

——— Department of Mines, Supplement, 1905; Review half-year ending December, 1904.

Brisbane—Royal Society of Queensland, Proceedings, vol. xviii.

——— Department of Agriculture, Botany Bulletin, No. 16.

——— Department of Mines. Geol. Survey Report. Map No. 187, Reports Nos. 184-195.

——— Department of Public Lands, North Queensland Ethnography, Bulletin No. 7, 1904.

——— Queensland Museum, Annals, No. 6.

Geelong—Geelong Naturalist, Proceedings, Second Series, vol. i., Nos. 2, 4.

Melbourne—Victoria Department of Agriculture, Journal, vol. ii., parts 2, 4, 7, 10; vol. iii., parts 1-5.

——— Australasian Institute of Mining Engineers, Transactions, vol. x.

——— Royal Society of Victoria, Proceedings, vol. xvii., parts 1, 2.

——— Mines and Water Supply, Secretary's Annual Report, 1903.

——— Department of Mines, Geological Survey, Bulletin, Nos. 14, 15, 17. Memoirs, vol. i., part 3.

Melbourne—Victorian Yearbook, 1903.
——— Victorian Geographical Journal, vol. xxii., 1904.
——— Victorian Naturalist, vol. xx., Nos. 5, 6; vol. xxi., Nos. 5, 7, 8, 9, 10, 12; vol. xxii., Nos. 1, 2.
Hobart—Department of Mines, Progress Report, 1904.
Perth—Department of Mines, Report, 1903, 1904.
——— Geological Survey, Bulletin, Nos. 11-20.
——— W.A. Mining Industry, Standard, 8/12/04.
Sydney—Department of Mines and Agriculture, Geol. Survey, Monograph No. 13; Memoirs, vol. vii., part 4, etc.; Records, vol. vii., part 4 and Map; vol. viii., part 1, 1904.
——— Agricultural Gazette, vol. xv., parts 5, 9, 11, 12, and index; vol. xvi., parts 1, 2, 3, 4, 5, 6, 8, 9, 10.
——— University Calendar, 1905.
——— Botanic Gardens.
——— Linnean Society, vol. xxix., No. 115; vol. xxx., Nos. 117, 118, Supplement, and Rules.
——— Australian Museum, Nests and Eggs of Birds Breeding in Australia, Cat. 1, vol. i.
——— Records do. do., vol. v., No. 5; vol. vi., part 1.
——— Forest Flora of New South Wales, vol. ii., parts 2, 3, 4, 5, 6.
——— Fisheries of New South Wales, Report of Commissioners, No. ii., 1902.
——— Rabbit Pest: Its Cause and Cure, by W. Rodier.
——— Naturalists' Club, Memoirs, Synopsis of Fisheries of New South Wales, Nos. 1 and 2.
——— Atoll of Funafuti, Meteorological Observations, Section 2.
Wellington—New Zealand Mines Department, Annual Report, Nos. xxxvi. and xxxvii.
Dunedin—Australasian Association for the Advancement of Science, vol. x., 1904.

Belgium and Holland.

Brussels—Société Royale Zoologique Malacologique de Belgique, Annales de la, tomes 37 and 38.
——— Société d'Etudes Coloniales, Bulletin, First Year, No. 12, December, 1904.
——— Musée Royal d'histoire Naturelle de Belgique, Extrait des Mémoires, tome 2, 1903.
——— Société Entomologique de Belgique, tomes, 46 and 47.
Liege—Société Royale des Sciences, Memoires, tome 5.
Batavia—Koninklijke Natuurkundige Vereenigen in Nederl.-India, Tijdschrift, D. 63.

Canada.

Montreal—Canadian Record of Science.
Ottawa—Geological Survey, Annual Report., vol. xiii., with maps.
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LIST OF FELLOWS, MEMBERS,

ETC.,

OCTOBER, 1905.

Those marked (L) are Life Fellows. Those marked with an asterisk have contributed papers published in the Society's Transactions.

Any change in the address should be notified to the Secretary.

Date of Election.

HONORARY FELLOWS.

1893. *COSSMAN, M., Rue de Maubeuge,, 95, Paris.
1897. *DAVID, T. W. EDGEWORTH, B.A., F.R.S., F.G.S., Prof. Geol., Sydney University.
1888. *DENNANT, JOHN, F.G.S., F.C.S., Inspector of Schools, Camberwell, Victoria.
1876. ELLERY, R. L. J., F.R.S., F.R.A.S., Gov. Astron., the Observatory, Melbourne, Victoria.
1890. *ETHERIDGE, ROBERT, Director of the Australian Museum of New South Wales, Sydney.
1905. GILL, THOMAS, I.S.O., Under-Treasurer, Adelaide.
1893. GREGORIO, MARQUIS DE, Palermo, Sicily.
1905. *HEDLEY, CHAS. H., Naturalist, Australian Museum, Sydney.
1855. HULL, H. M., Hobart, Tasmania.
1892. *MAIDEN, J. H., F.L.S., F.C.S., Director Botanic Gardens, Sydney, New South Wales.
1898. *MEYRICK, E. T., B.A., Elmswood, Marlborough, Wilts, England.
1876. RUSSELL, H. C., B.A., F.R.S., F.R.A.S., Gov. Astron., Sydney, New South Wales
1894. *WILSON, J. T., M.D., Prof. of Anatomy, Sydney University.

CORRESPONDING MEMBERS.

1881. BAILEY, F. M., F.L.S., Colonial Botanist, Brisbane, Queensland.
1881. *CLOUD, T. C., F.C.S., London, England.
1880. *FOELSCHE, PAUL, Inspector of Police, Palmerston, N.T.
1893. *McKILLOP, Rev. DAVID, Daly River Mission, N.T.
1886. NICOLAY, Rev. C. G., Fremantle, W.A.
1883. *STIRLING, JAMES, Melbourne, Victoria.
1893. STRETTON, W. G., Palmerston, N.T.
1905. THOMSON, G. M., F.L.S., F.C.S., Dunedin, New Zealand.

FELLOWS.

1895. *ASHBY, EDWIN, Royal Exchange, Adelaide.
1902. *BAKER, W. H., Glen Osmond road, Parkside.
1901. *BASEDOW, HERBERT, Kent Town.
1887. *BLACKBURN, Rev. THOMAS, B.A., Woodville.
1886. *BRAGG, W. H., M.A., Prof. of Mathematics, University of Adelaide, S.A.
1905. BROOKMAN, GEORGE, North Gilberton.
1883. *BROWN, H. Y. L., F.G.S., Gov. Geologist, Adelaide.

1882. BROWNE, L. G., Davenport Chambers, Currie street, Adelaide, S.A.
1899. BROWNE, T. L., Marlborough Chambers, Adelaide.
1893. BRUMMITT, ROBERT, M.R.C.S., Gilberton.
1904. BRUNSKILL, GEORGE, Rotorua, Auckland, New Zealand.
1904. CHRISTIE, WILLIAM, Adelaide.
1879. *CLELAND, W. L., M.B., Ch.M., J.P., Colonial Surgeon, Resident Medical Officer Parkside Lunatic Asylum, Lecturer in Materia Medica, University of Adelaide.
1895. CLELAND, JOHN B., M.D., Adelaide.
1876. (L) COOKE, EBENEZER, Commissioner of Audit, Adelaide.
1887. *DIXON, SAMUEL, Bath street, New Glenelg.
1902. EDQUIST, A. G., Hindmarsh.
1886. FLEMING, DAVID, Barnard street, North Adelaide.
1904. GARTRELL, JAS., Burnside.
1904. GORDON, DAVID, Gawler place, Adelaide.
1880. *GOYDER, GEORGE, A.M., F.C.S., Analyst and Assayer, Adelaide.
1896. GREENWAY, THOS. J., Adelaide.
1904. GRIFFITH, H., Hurtle square, Adelaide.
1896. HAWKER, E. W., F.C.S., Adelaide.
1899. *HIGGIN, A. J., Assistant Lecturer on Chemistry, University of Adelaide.
1891. *HOLTZE, MAURICE, F.L.S. Director Botanic Gardens, Adelaide.
1883. *HOWCHIN, WALTER, F.G.S., Lecturer on Geology and Palæontology, University, Adelaide.
1902. ILIFFE, JAS. DRINKWATER, B.Sc., Prince Alfred College, Kent Town.
1893. JAMES, THOMAS, M.R.C.S., Moonta.
1902. JEFFREYS, GEO., Gilbert Place, Adelaide.
1900. *JOHNCOCK, CHAS. F., Morphett Vale.
1898. *KOCH, MAX, Port Pirie.
1897. *LEA, A. M., Gov. Entomologist, Hobart, Tasmania.
1884. LENDON, A. A., M.D. (Lond.), M.R.C.S., Lecturer on Forensic Medicine and on Chemical Medicine, University and Hon. Physician, Children's Hospital, North terrace, Adelaide.
1856. *LLOYD, J. S., Alma Chambers, Adelaide.
1888. *LOWER, OSWALD B., Broken Hill, New South Wales.
1905. MAWSON, DOUGLAS, B.Sc., B.E., University, Adelaide.
1874. MAYO, GEO. G., C.E., Tatham street, Adelaide.
1897. *MORGAN, A. M., M.B., Ch.B., Angas street, Adelaide.
1884. MUNTON, H. S., North terrace, Adelaide.
1859. (L) MURRAY, DAVID. Adelaide.
1883. PHILLIPPS, W. H., Adelaide.
1886. POOLE, W. B., Savings Bank, Adelaide,
1904. REISSMANN, CHARLES, M.A., M.D. (Cantab.), B.Sc. (Lond.), etc., Adelaide.
1885. *RENNIE, EDWARD H., M.A., D.Sc. (Lond.), F.C.S., Professor of Chemistry, University of Adelaide.
1905. ROGERS, R. S., M.A., M.D., Flinders Street, Adelaide.
1869. *RUTT, WALTER, Chief Assistant Engineer, Adelaide.
1891. SELWAY, W. H., Treasury, Adelaide.
1893. SIMSON, AUGUSTUS, Launceston, Tasmania.
1857. *SMEATON, THOMAS D., Mount Lofty.
1900. SMEATON, STIRLING, B.A., C.E., Engineer-in-Chief's Office, Adelaide.
1871. SMITH, ROBERT BARR, Adelaide.

1881. *Stirling, Edward C., C.M.G., M.A., M.D., F.R.S., F.R.C.S., Professor of Physiology, University of Adelaide, Director of S.A. Museum.
1904. Taylor, William, St. Andrews, North Adelaide.
1886. *Tepper, J. G. O., F.L.S., Entomologist, S.A. Museum. [Corresponding Member, 1878.]
1897. *Torr, W. G., LL.D., M.A., B.C.L., Brighton.
1894. *Turner, A. Jefferis, M.D., Brisbane, Queensland.
1902. Vandenbergh, W. J., Barrister and Solicitor, J.P., Adelaide.
1889. Vardon, Hon. Joseph, M.L.C., J.P., Gresham Street, Adelaide.
1878. *Verco, Joseph C., M.D., F.R.C.S., Lecturer on the Principles and Practice of Medicine and Therapeutics, University of Adelaide.
1883. Wainwright, E. H., B.Sc. (Lond.), St. Peter's College, Hackney, Adelaide.
1878. Ware, W. L., J.P., Adelaide.
1859. Way, Right Hon. Sir Samuel James, Bart., P.C., D.C.L., Chief Justice and Lieutenant-Governor of South Australia, Adelaide.
1904. Whitbread, Howard, Currie street, Adelaide.
1902. *Woolnough, Walter George, D.Sc., F.G.S., University, Sydney.
1886. Zietz, A. H. C., F.L.S., C.M.Z.S., Assistant Director, South Australian Museum, Adelaide.

Associates.

1901. Collison, Edith, B.Sc., Medindie.
1904. Robinson, Mrs. H. R., "Las Conchas," Largs, South Australia.

APPENDICES.

FIELD NATURALISTS' SECTION

OF THE

Royal Society of South Australia (Incorporated).

TWENTY-SECOND ANNUAL REPORT OF THE COMMITTEE.

For the Year Ending September 30, 1905.

Last October the Field Naturalists' Section of the Royal Society celebrated the twenty-first anniversary of its inception. The function was highly successful, but amidst the congratulations there was an element of regret from the fact that the Society was about to lose the services of its indefatigable Hon. Secretary (Mr. W. H. Selway), owing to his projected departure for England.

The same number of evening meetings and excursions have been held as last year, and the members maintained an equal interest, both at the meetings and in the field work. Last year's attendance was a decided improvement on the previous year's, and this has been maintained.

The meetings held during the season were as follows: —

1904.

October 19. Conversazione, Twenty-first Anniversary.

November 29. Last evening meeting for the season. Scientific results of three days' excursion to Blumberg.

1905.

April 18. Paper by Miss E. Benham, "Some Changes in Vegetable Cells Connected with the Formation of the Embryo." Resignation of Mr. W. H. Selway as Hon. Secretary, presentation to him, and election of Mr. E. H. Lock to the position.

May 16. "Geological Notes," by Mr. Douglas Mawson, B.Sc., B.E.; "Microscopical Notes," by Mr. E. J. Bradley.

June 20. Discussion on subject of Chairman's annual address, "Animal Instinct or Reason," by Mr. E. H. Lock.

July 18. "A Visit to Tuggerah Lakes," by Mr. J. W. Mellor.

August 15. "Visit to Tasmania," by Mr. F. R. Zietz and Mr. J. W. Mellor.
September 19. Annual meeting.

The subjects under discussion were of the usual scientific order, but rather more of the educational element than during the previous year. This phase of work is to be commended. Miss Benham's paper upon "Vegetable Cells," with illustrative diagrams, was distinctly educational in character, and the same remark applies to the address upon "Geological Observations," by Mr. Douglas Mawson. Mr. J. W. Mellor and Mr. F. R. Zietz were good enough to give members a glimpse of the "Tuggerah Lakes" and of various places in Tasmania. Both of these addresses were exceedingly interesting, and on the subject of ornithology very instructive.

An evening was devoted to the scientific results of the three days' excursion to Blumberg, when Mr. A. Zietz dealt with the bird life; Mr. Griffith, Coleoptera; Mr. J. G. O. Tepper, botany; Mr. S. Smeaton, geology. Mr. E. H. Lock introduced a discussion on "Animal Instinct or Reason." The subject was a new form of study at the meetings, and proved interesting.

The conversazione to celebrate the twenty-first anniversary of the Section was a great success. The exhibition of natural history specimens would have done credit to a museum, and the regret was expressed that it could not be on view for more than one evening. It demonstrated the fact that the members of the Section have been doing a great amount of work in making private collections.

A very instructive and interesting feature of the evening meetings has always been the exhibits. These have not been so numerous as at some of the meetings of previous years, and it is hoped that members will not allow this practice to lose its interest. Perhaps the most striking feature of exhibits has been the keen interest taken in the collection of orchids. The Chairman of the Section has created quite a new enthusiasm in this branch of botanical study. His explorations in field work, ably assisted by Mrs. Rogers, have resulted in a splendid collection, taken at all times of the year, and the members will congratulate them upon having added three species not previously recorded by the Section, and one apparently not recorded at all in Australia. In the same direction, note must also be made of the records of Mr E. Ashby, who has from time to time sent in specimens and records of orchids as they appeared in the vicinity of Blackwood.

The field excursions were as follows:—

1904.

Oct. 1. Gandy's Gully.
Oct. 15. Typical orchard, Mylor.
Oct. 29. National Park.
Nov. 12. Blumberg (three days).
Dec. 17. Last excursion for the season, Norton's Summit.

1905.

Feb. 18. Dredging excursion, Port River.
June 3. Blackwood (Viaducts).
June 17. Belair (National Park).
July 15. Black Hill.
Aug. 12. Teatree Gully.
Sep. 1 Scott's Creek (three days' camp).
Sep. 23. Coromandel Valley.

The excursion to Gandy's Gully was a new field for exploration, and the record shows that while it would seem difficult to find new places for excursions, there are yet a number of places not yet visited that would well repay the trouble of finding them.

The Typical Orchard at Mylor was revisited after a lapse of some two years, and the object lesson of fruit culture here was well demonstrated.

National Park was twice visited, and, although well known to most of the members, it was found that this ground is by no means exhausted.

The annual three days' excursion in November was held this year again at Blumberg. The same hospitality that was extended to the Section on a previous visit was again heartily given by the residents, and a new programme having been laid out for excursions, the engagement was highly successful and enjoyable.

The Port River was again visited, and the results to the Microscopists were successful, while an additional interest was realised in noting the progress of the construction of the Outer Harbour.

Blackwood is regarded as the most prolific field for botanical collecting, and this year an excursion to the neighbourhood of the Railway Viaducts proved a new source of interest to those attending.

Blackhill and Teatree Gully are both well known to the members; but they never fail to produce something worth the effort of exploring. Both places were visited, and also the vicinity of Norton's Summit. The latter, however, was more in the nature of a picnic to close the list for 1904.

On the 1st of September the members ventured upon a new departure in arranging a three days' Camp at Scott's

Creek, which had not been previously visited by the Section. The result of this experiment is best summed up in the wish expressed by several members "that arrangements should be made for another excursion in November of a similar character." The matter is now under consideration.

Next Saturday the vicinity of Sturt River at Coromandel Valley will be visited, to complete the list of twelve excursions for the year under review.

It is very gratifying to note that, during the year, seventeen names have been added to the list of membership.

It is a coincidence, that, in April of 1904, the Chairman (Dr. E. Angas Johnson) resigned his position to make a visit to England. In the same month of the following year (1905) the Secretary resigned for the same purpose. Both vacancies were filled by Mr. Lock, which may also be regarded as an unusual circumstance. In the resignation of Mr. Selway the Section was deprived of the services of the most indefatigable worker the Section had ever had, and his services were appropriately acknowledged by a suitable presentation of a Floral Address.

SEVENTEENTH ANNUAL REPORT OF THE NATIVE FAUNA AND FLORA PROTECTION COMMITTEE OF THE FIELD NATURALISTS' SECTION OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA, FOR THE YEAR ENDING SEPTEMBER, 1905.

At a meeting of the Committee, held in November last, on the occasion of the retirement of their Chairman from the Commissionership of the National Park, a resolution was passed, as follows:—"That the Committee exceedingly regret the resignation of Mr. Dixon as a Commissioner of the National Park, and wish to place on record their appreciation of the able manner in which he has represented them while upon the Board." It was at the same time decided that Mr. Ashby should be recommended for appointment in his place. This suggestion was sent on to the authorities, but without avail, another gentleman being appointed. The Committee therefore, have now no representative upon the Board. As it was through the persistent exertions of the Committee that the National Park was established, they consider that they have a good claim to representation, and they are further strongly of opinion that at least one Commissioner should be a naturalist.

An application having been made for a lease of the Cape Borda Lighthouse Reserve for a cattle station, the Secretary to the Marine Board courteously wrote, asking whether any reason could be adduced why, in the interests of the fauna, it should not be granted. On the Committee representing to the Marine Board the desirability of protecting the indigenous kangaroos and wallabies on the reserve, the application was refused.

Referring to the resolution passed by the International Ornithologists' Congress recently held in London—"The Congress appeals most strongly to the Government of the Commonwealth of Australia to pass legislation to prevent the wholesale destruction of penguins and all those birds boiled down for oil in the lands under its rule"—a letter has been received from the Crown Lands Office, seeking information as to whether further protection to these birds is desirable in South Australia. The Committee recommend that instructions should be given to the lighthouse-keepers at various stations, and especially at the Neptune Islands, to as far as possible prevent the destruction of penguins, mutton birds, and all other birds during their respective close seasons, and that the police in outlying districts should also be specially directed to enforce the observance of the Birds' Protection Act.

SAML. DIXON, Chairman.

Adelaide, September 19, 1905.

FIELD NATURALISTS' SECTION OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA.

Statement of Receipts and Expenditure for Year ending September 30, 1905.

Dr. Receipts.	£	s.	d.	Expenditure. Cr.	£	s.	d.
To Cash in hand, September 30, 1904 ...	3	2	11	By Advertising	0	11	9
" Subscriptions for 1904-5	11	7	6	" Printing	3	18	6
" Grant from Royal Society	10	0	0	" Conversazione	12	6	0
" Surplus from excursions	1	16	0	" Postages	4	19	9
				" Stationery, etc.	0	15	0
				" Caretaker	1	5	0
				" John Hill & Co.	0	13	0
				" Cash in hand, September 30, 1905 ...	1	18	2
	£26	6	5		£26	6	5

Audited and found correct.

Walter D. Reed, } Auditors.
J. S. Lloyd, }

Adelaide, September 29, 1905.

E. H. Lock, Hon. Secretary.

MALACOLOGICAL SECTION

OF THE

Royal Society of South Australia (Incorporated).

ANNUAL REPORT FOR 1904-5.

The Committee has to report that there are now thirteen members of the Section. During the past year eleven meetings were held, at which the average attendance was seven.

Steady progress has been made in the routine work of revising the census of South Australian gastropods, and, following Zittel's classification, all the species have been dealt with, from the *trochidæ* to the *naticidæ*. In addition, four papers have been contributed to the transactions of the Royal Society—two by Dr. J. C. Verco, entitled "Notes on South Australian Marine Mollusca, with Descriptions of New Species, parts i. and ii."; one by Mr. H. Basedow, in collaboration with Mr. C. Hedley, "South Australian Nudibranchs, and an Enumeration of the known Australian Species"; and another by Mr. H. Basedow on "New Species of South Australian Lamellaria and Caledoniella."

The following is a copy of the balance sheet:—

Receipts and Expenditure for 1904-5.

Receipts.

Dr.	£	s.	d.
To balance brought forward	0	6	3
" Subscriptions	1	10	0
" Grant from Royal Society	1	0	0
	£2	16	3

Expenditure.

Cr.	£	s.	d.
By Postages and Sundries	0	14	1
" Honorarium to Caretaker for 1904 and 1905	1	0	0
" Balance in hand	1	2	2
	£2	16	3

R. J. M. Clucas, Hon. Secretary and Treasurer.

MICROSCOPICAL SECTION

OF THE

Royal Society of South Australia (Incorporated).

ANNUAL REPORT FOR 1904-5.

CHAIRMAN—D. FLEMING.

COMMITTEE—W. B. POOLE, D. GORDON, W. FULLER.

HON. SECRETARY—E. J. BRADLEY, Dover Street, Malvern.

The second year's work of the Section has been successful in promoting the objects contemplated, viz., the encouragement of microscopical research as a means of intelligent recreation. Satisfaction is felt at the action of the Council of the Adelaide University in establishing, at the request of Mr. Gordon and a number of our members, a class for the study of microscopical technique. The average attendance at the evening meetings has been 15, whilst the total number of members on the roll at present is 43.

The following meetings and excursions have been held during the session:—

September 27, 1904—Annual general meeting.

October 22—Excursion to Port docks and swamps.

October 25—Paper on "Foraminifera," by MR. E. J. BRADLEY.

November 22—Paper on "Nodules on Roots of Legumes," by MR. W. B. POOLE.

February 18, 1905—Dredging excursion to Port River and Outer Harbour.

March 28—Paper on "Some Changes in Vegetable Cells in Connection with the Formation of the Embryo," by MISS BENHAM.

April 25—Examination of live material obtained from the River Murray by the Boys' Field Club.

May 23—Examination of Mr. G. Crase's collection of show objects.

June 29—MR. S. SMEATON, B.A., gave an explanation of the "Functions of Hairs of Plants" and "Lori of Ferns," and exhibited a large collection prepared by Mr. T. D. Smeaton. MR. W. P. DOLLMAN gave a practical demonstration of "Microphotography."

July 25—Question Box Evening—MR. E. J. BRADLEY gave an exhibition of slides illustrating the "External Anatomy of the Honey Bee."

August 19—Excursion to ponds at Blackwood.

August 22—MR. W. B. POOLE gave a demonstration and paper on "Cutting, Staining, and Mounting Plant Sections," with an explanation of the structure of plant stems.

September 23—Excursion to ponds at the Black Road, O'Halloran Hill, and also Happy Valley Reservoir.

DAVID FLEMING, Chairman.
EDGAR J. BRADLEY, Hon. Secretary.

MICROSCOPICAL SECTION OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA.

BALANCE-SHEET, SESSION 1904-5.

Receipts.

	£	s.	d.
Cash in hand at beginning of Session ...	1	16	5
Grant from Royal Society	5	0	0
Subscriptions, 1904-5	6	12	6
	£13	8	11

Expenditure.

	£	s.	d.
Postage	1	17	0
Printing	2	3	6
Stationery	0	6	5
Subscriptions paid to Treasurer of Royal Society	6	12	6
Duty Stamp	0	0	1
Attendance (Caretaker)	1	5	0
Balance in hand	1	4	5
	£13	8	11

EDGAR J. BRADLEY, Hon. Secretary.

Audited and found correct.

S. SMEATON, } Auditors.
THEO. GODLEE, }

GENERAL INDEX.

[Generic and specific names printed in italics are described as new.]

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TRANSACTIONS AND PROCEEDINGS

AND

REPORT

OF THE

ROYAL SOCIETY of SOUTH AUSTRALIA

(INCORPORATED).

VOL. XXX.

[With Twelve Plates and Twelve Figures in the Text.

EDITED BY WALTER HOWCHIN, F.G.S.

Adelaide:

W. C. RIGBY, 74, KING WILLIAM STREET.

DECEMBER, 1906.

Parcels for transmission to the Royal Society of South Australia from Europe and America should be addressed "per W. C Rigby, care Messrs. Thos. Meadows & Co., 34, Milk Street Cheapside, London."

Royal Society of South Australia

(INCORPORATED).

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HIS EXCELLENCY SIR GEORGE R. LE HUNTE, K.C.M.G.

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E. ASHBY.
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Auditor:

J. S. LLOYD, F.I.A.S.A.

CONTENTS.

Appendices.

On the Ionisation of Various Gases by the α Particles of Radium.

By W. H. Bragg, M.A., Elder Professor of Mathematics and Physics in the University of Adelaide.

[Read April 3, 1906.]

In a paper "On the Recombination of Ions in Air and other Gases" (Tr.R.S.S.A., vol. xxix., p. 187), Mr. Kleeman and I have described the preliminary steps of an enquiry into the total ionisation produced in different gases by the α particle of radium, and the influence thereon of the physical conditions of the experiment. With the assistance of Mr. J. P. V. Madsen, B.Sc., I have made a number of experiments in continuation of the enquiry. It is necessarily a lengthy one, and in some respects difficult, so that on many of the points involved no definite conclusions are yet within reach. On others, results have been obtained which are, I think, of some interest and importance. In this paper I propose to describe the work which has been done; and, in addition, to make some reference to *(a)* the magnetic deflection of the α particle, *(b)* its acquirement of a positive charge.

As described in the paper referred to, the total ionisation of a gas can be measured in terms of the product of the co-ordinates of a certain point on the ionisation curve. The true measure is, of course, the area between the curve and the axes of co-ordinates. But experiment shows that all ionisation curves due to radium in radio-active equilibrium are of the same form, and differ from each other only in the application of some factor to all their ordinates or all their abscissæ. Thus the product of the co-ordinates of some standard point is proportional to the area of the whole curve, and may be taken as a relative measure of the total ionisation.

In all the experiments to which I am about to refer the α particles cross at right angles a shallow ionisation chamber whose upper electrode is a brass plate and the lower a brass gauze; the distance between the electrodes is about 3 mm. An electromotive force of 300 volts is usually applied to the gauze, giving an electric force of 1,000 volts per cm. This is usually sufficient to ensure saturation, that is to say, to avoid all errors due to diffusion, general recombination and initial recombination. When it is insufficient, the proper correction is found and applied. The ionisation chamber is enclosed within a vessel which is satisfactorily airtight except at higher temperatures, and this again within an electric oven. The gas under observation can thus be subjected to various pressures and temperatures. In the case of such substances as benzene and carbon tetrachloride a temperature of from 60° to 90° is necessary to ensure a convenient gas-density. There is, however, this drawback to the use of high temperatures, that the insulators begin to lose their efficiency, and the joints cease to be quite airtight. I find it necessary to use glass as an insulator instead of sulphur, for the latter cracks under the unequal expansions due to alteration of temperature. In the case of vapours, a certain quantity of air usually finds its way into the apparatus, for, as just mentioned, the joints leak somewhat at the higher temperatures. The amount so entering is sometimes determined by opening a communication between the vessel and an evacuated bulb, and weighing the quantity of mixture drawn off. The bulb and connections are placed within the oven, and communication is made by opening a pinchcock, worked by a key, projecting outside the oven. In this way condensation in cold tubes is avoided. This method is not always employed, for as soon as the stopping power of the gas is sufficiently well known the proportion of the mixture is much more easily, and, I think, at least as accurately determined by observation of the range of the α particles therein.

The insulation leak is determined by measuring the deflection of the electrometer first for ten seconds, and then for twenty. With no leak the latter should be double the former. This is never quite the case, and the correction factor can be obtained from a comparison of the two values. The factor to be applied to a ten-second leak varies from about 1·03 at 40° C. to about 1·10 at 70° C.; at 90° C. it is much higher.

The total ionisation is measured in terms of the product RI. The ordinate R is the range of the α particle, due to that product of radium whose speed is next to that of RaC. In air at 760 mm. pressure and 20° C., R = 4·83 cm. very nearly. The abscissa I is the ionisation produced in the chamber described when the radium layer is at a distance of 4·83 cm. from the middle of the chamber; or, more correctly, it is proportional to the ionisation that would be produced in a very shallow chamber at that distance. The effect is wholly due to the α particles from RaC, the chamber being out of range of all the others.

These two quantities R and I differ materially from each other in two respects. To take the less important consideration first, the former quantity lends itself readily to exact measurement, the latter does not. The range of the α particle in a gas can be measured to an accuracy of 1 or 2 %

by a few minutes' observation, and to a much higher degree with greater care; it is, perhaps, the easiest of the measurements made in these experiments. By far the greatest difficulties which I find in the determination of the stopping power of a gas lie in the purification and analysis of the gas.

On the other hand, the abscissa I is much more difficult to measure. It is affected by variation in the sensitiveness of the electrometer, by leakage through the insulators, by variation of the dimensions of the apparatus, and its true value is not given unless enough electric force is applied. None of these things affects the range. But it is not merely in the details of measurement that these two quantities differ. They appear as physical constants to be in distinct categories; so far, that is to say, as can be observed at present. The stopping power of an atom is a constant of the atom, unaffected by its association with other atoms in molecular structure, independent of pressure and temperature. In a paper by Mr. Kleeman and myself ("Phil. Mag.," Sept., 1905), we gave a list of the stopping powers of various substances, and since then we have made many other experiments in the same direction. In no case have we found a departure from the additive law which was not within the errors of experiment. That is to say, the range of the α particle in a given gas can always be predicted from the composition of the gas molecule. Not only so, but the stopping powers of the various atoms are very nearly proportional to the square roots of their weights, so that a simple, if approximate, law covers all the phenomena. It even seems justifiable now to go one step further. If the list in the paper quoted be examined, or the more comprehensive list in Table A, it will be found that the stopping powers are systematic even in their slight departures from the square root law. For, whilst dependent mainly on the square roots of the weights they have a leaning towards the weights themselves. We did not call attention at the time to this fact, for we thought it might be a spurious effect. But it has appeared so regularly in all further determinations that it seems right to note it, and to attempt an explanation of its physical meaning.

If we assume the correctness of the explanation already given of the square root law, viz., that the α particle spends energy for the most part on tearing away electrons from their attachment at the edges of the atom discs, then the natural complement to this is the further assumption that electrons in all parts of the atom disc may be disturbed to vibration by the passage of the α particle, which latter, therefore, spends a small amount of energy in simple proportion to the weight of the atom. If w be the atomic weight, the stopping power of an atom should, therefore, be capable of expression by the formula:—

$$a\sqrt{w} + bw,$$

where the former term is usually by far the most important. The close agreement of the figures in the second and fifth columns of Table A shows that this is very nearly the case.

TABLE A.

Stopping Powers of Various Gases.

Gas.	Experimental Value. Air = 1.	Proportional to $\sqrt{w}$. Air = 1.	Proportional to w. Air = 1.	$\cdot118 \times \sqrt{w} + \cdot003 \times w$.
H_2 ...	·243	·264	·0695	·242
O_2 ...	1·055	1·054	1·11	1·04
N_2O ...	1·46	1·52	1·53	1·49
CO_2 ...	1·47	1·51	1·53	1·48
CS_2 ...	2·18	1·95	2·71	1·96
C_2H_2 ...	1·11	1·17	·905	1·13
C_2H_4 ...	1·35	1·44	·975	1·37
C_6H_6 ...	3·37	3·53	2·71	3·39
C_5H_{12} ...	3·59	3·86	2·50	3·66
CH_3Br ...	2·09	2·03	3·28	2·11
CH_3I	2·58	2·35	4·90	2·52
C_2H_5Cl ...	2·36	2·31	2·23	2·30
C_2H_5I ...	3·13	3·06	5·40	3·20
$CHCl_3$ ...	3·12	2·95	3·81	3·00
$C_4H_{10}O$ ...	3·40	3·67	2·57	3·51
CCl_4 ...	4·02	3·59	5·41	3·68

TABLE B.

Stopping Powers of Various Metals.

Metal.	Experimental Value. Air = 1.	Proportional to $\sqrt{w}$. Air = 1.	Ratio of two preceding Columns.
Al ...	1·45	1·37	1·06
Fe ...	2·26	1·97	1·15
Ni ...	2·46	2·20	1·12
Cu ...	2·43	2·10	1·16
Ag ...	3·17	2·74	1·16
Sn ...	3·37	2·88	1·17
Pt ...	4·16	3·68	1·13
Au ...	4·45	3·70	1·20
Pb ...	4·27	3·78	1·13

The fifth column in Table A shows the application of the formula $a\sqrt{w} + bw$. Its close agreement with the second column is remarkable, considering that only two constants are employed. The formula does not seem to apply to the metals, which rather follow a simple square root law. This is certainly a difficulty.

As regards pressure and temperature, I have not yet found any effect produced by variation of these conditions. The quantity RP/T appear to be a constant, P being the pressure and T the absolute temperature. This implies that the stopping power of an atom or molecule is independent of P and T. Examples of the fact that RP is constant while T is constant are given in the paper "On the Recombination of Ions in Air and other Gases." The following experimental result will serve as an illustration of the fact that R is proportional to T when P is constant. The ionisation vessel filled with air was raised to a temperature of 90° C., the pressure being 763 mm. R was then found to be 5·98. Now, when P = 760 mm., and T = 20° C., R = 4·83.

$$\text{And } \frac{4\cdot 83 \times 363 \times 760}{5\cdot 98 \times 293 \times 763} = 1\cdot 005.$$

It has, of course, been pointed out by several observers that the ionisation effects of radium are largely independent of pressure and temperature and of physical and chemical conditions generally. This, however, does not cover the present statement, which refers to the stopping power of the atom, a quantity which has not previously been the subject of measurement, so far as I am aware.

To sum up, the range of the α particle in a given gas is in the first place easily measured, and in the second place simply related to the constitution of the gas and independent of its state. It is a delightful contrast to some other radioactive quantities, and often gives a welcome foothold in difficult places.

The quantity I is in quite a different class. It is much more difficult to measure accurately, as I have already described. But there appears to be a more important difference in that the total ionisation of a gas is not simply dependent on the weights of the atoms of which it is composed. Molecular structure counts for something. Perhaps also the various atoms do not yield ions in simple proportion to the energy spent on them, but this point is not yet sufficiently clear.

An example of this want of uniformity has already been given in the paper to which reference has been made. It was shown that RI in ethyl chloride is much greater than RI in air. The difference must be yet a little greater than that shown, as no allowance was made for the small quantity of air mixed with the heavy gas. Again, RI in standard pentane (mostly C_5H_{12}) is nearly half as much again as in air, and the same is almost certainly true of benzene (C_6H_6); but this vapour is harder to treat than pentane, since a high temperature is necessary. Generally speaking, the more complex gases yield the greater number of ions. But the yield does not depend only on the number of atoms in the molecule. Acetylene (C_2H_2) yields 25% more than air; yet CO_2, with only one atom less, yields but 5% more; and ethylene (C_2H_4) yields the same as acetylene, though it has two atoms more. Of course, in the last case, the atoms added are very light; and H_2 itself has, according to my experiments, a slightly lower value (for RI) than air. Rutherford also found this to be the case.

On the other hand, the influence of complexity can be illustrated by the cases of acetylene and ethylene, as compared to benzene and pentane.

In order to bring out the significance of these comparisons, it should be pointed out that the α particle spends exactly the same amount of energy in every gas (Bragg, "Phil. Mag.," November, 1905). Thus, in different gases different numbers of ions are produced for the same expenditure of energy. It is quite clear, however, that this does not imply that the α particle finds it easier to produce ions in some gases than others. For if so there would be some influence on the stopping power of atoms dependent on the number of ions produced. But the stopping power is connected to the atomic weight by a simple law, and the number of ions produced is not. Plainly, the energy spent by an α particle in an atom, and the resulting ionisation are not directly connected; there is an intervening link.

Either the ions made by the α particle produce others in some cases, or some of the ions made never emerge from the atoms. There is something which prevents the simplicity of the law governing the expenditure of energy by the α particle from repeating itself in the amount of ionisation produced. I think it is increasingly clear from our experiments that there is a secondary ionisation within the molecule itself. The ions first made, or possibly X-ray pulses accompanying ionisation, have in some cases enough energy to make fresh ions before leaving the molecule. Thus, for example, one molecule of C_6H_6 is found to rob the α particle of just as much energy as three molecules of C_2H_2. But more ions are made out of the one C_6H_6 than out of the group of three acetylene molecules. This may be explained on the grounds that the 12 atoms are crowded together, so that an ion projected under ionisation from one of the atoms strikes one of the others with an energy undiminished by motion through the field of the positive from which it was originally separated, and therefore sufficient to make a new ion. In further consequence the ions emerging from a C_6H_6 molecule move more slowly than those from a C_2H_2, and are more liable to initial recombination. This is in agreement with experiment: it is far harder to saturate benzene than acetylene.

The secondary ionisation would appear to take place within rather than without the molecule, because the amount of it does not depend upon the distance of the molecules from one another. The total ionisation is independent of the pressure. It is certainly not due to the electric field, for if it were there would be no saturation value of the current.

I subjoin the details of one or two of the many experiments which Mr. Madsen and I have made. We hope to give a fuller description at some future time.

DETERMINATION OF STOPPING POWER AND OF RI IN PENTANE.

Electrodes, 3 mm. apart (nearly). Volts applied = 300.
Temperature of apparatus = 35° C.
Apparatus charged with vapour from standard pentane.

Distance from Ra to Middle of Ionisation Chamber.	Leak in 10 secs.	Pressure inside Apparatus.
2·8	1982	
2·9	1431	41·15 cm.
3·0	1192	
3·1	1171	
3·2	1193	
3·3	1227	41·15 cm.
Thin Cu foil over Ra	108	

These being plotted, it is found that R = 2·95, I = 1044, the copper leak having been deducted.

Thus, R = 2·95 in this mixture of pentane and air, at a pressure of 41·15 cm., and a temperature (observed) of 308° (absolute). But at a pressure of 760 cm. and 293° absolute, R in air is 4·83. Hence the mixture stops—

$$\frac{4\cdot83}{2\cdot95} \cdot \frac{7600}{4115} \cdot \frac{308}{293} = 3\cdot14 \text{ times as much as air.}$$

A special set of readings at 3·2 cm. is now taken, three for ten seconds and three for twenty seconds. The means are 1196 and 2325 respectively. Comparing these, it is found that the ten-second reading should be multiplied by 1·03 in order to allow for leakage by the insulators.

Again, a set is taken with 600 volts between the plates, and it is found that the mean reading, when the copper leak is deducted, is 1134. At the same time the reading for 300 volts, copper leak being deducted, is 1088. Thus saturation is nearly complete.

A quantity of the gas is now drawn over into an exhausted bulb, whose temperature (that of the oven) is 311 (absolute); the pressure is observed to be 34·5. The weight of this gas is ·2536 gr. It is then calculated from a knowledge of the capacity of the bulb that the mixture weighs 2·22 times as much as air. From this it is found that to every molecule of pentane there are ·23 molecules of air, assuming the pentane molecule to weigh 2·5 times as much as the average air molecule. If s = stopping power of pentane, we have, therefore—

$$\frac{\cdot 23 + s}{1\cdot 23} = 3\cdot 14$$

$$\therefore\ s = 3\cdot 59.$$

Again—

$$RI = 2\cdot 95 \times 104\cdot 4$$
$$= 308, \text{ uncorrected.}$$

Correcting for want of saturation—

$$RI = 308 \times \frac{1134}{1088}$$
$$= 321.$$

On the same day and under the same conditions RI for air = 231. The leakage correction is found to be the same for both, and need not be applied. Now, as far as consumption of energy is concerned, ·23 molecules of air are equivalent to ·23/3·59 molecules of pentane = ·065. Hence, if all the energy had been spent on pentane molecules, the value for RI would have been—

$$1\cdot 065 \times 321 - \cdot 065 \times 231$$
$$= 342 - 15$$
$$= 327.$$

Finally—

$$\frac{\text{Total ionisation in pentane}}{\text{Total ionisation in air}} = \frac{327}{231} = 1\cdot 41.$$

Determination of Stopping Power and RI in Acetylene (C_2H_2).

Same conditions as previous experiment. Apparatus charged to atmospheric pressure with gas; when tested gas was found to contain less than 2% of impurities. Temperature of apparatus = 37·5° C. Barometer = 763 mm.

Distance from Ra to Middle of Ionisation Chamber.	Leak in 10 secs.
4·2	1430
4·3	1276
4·4	1024
4·5	818
4·6	698
4·7	688
4·8	701
4·9	698
Cu over Ra	46
At 5·2 for 300 volts nett leak =	688
and „ 600 „ „ =	706

Plotting these values it is found that R = 4·57, I (less copper leak) = 635. Hence, RI, corrected for want of saturation = 298.

Hence—

$$\frac{\text{Total ionisation for } C_2H_2}{\text{Total ionisation for air}} = \frac{298}{231} = 1{\cdot}29.$$

Also stopping power—

$$= \frac{483}{457} \cdot \frac{760}{763} \cdot \frac{3105}{2930} = 1{\cdot}11.$$

In the paper by Mr. Kleeman and myself, to which I have already referred, it was pointed out that Rutherford had found it more easy to obtain the saturation current from a gas when it was removed from the influence of the ionising agent. We observed that this could be easily explained by supposing initial recombination to be completed before the gas was subjected to the electric field. Nevertheless, as I now see, it is otherwise no essential feature of the initial recombination hypothesis that the act of recombination should take place within any set time. The one important point is that the recombination takes place between two ions originally forming parts of one molecule. It is quite conceivable that for a certain time the positive and negative may remain "semi-detached," their recombination in suspense until precipitated by some change of conditions. It is curious that Mr. Madsen, working in this laboratory, has not been able to confirm Professor Rutherford's experiment, and his results point to a prolonged existence of these pairs. He finds it hard to saturate a mixture of air and ether vapour which has been ionised by radium and then drawn away into a separate ionisation chamber. It is not easy to reconcile this result with that of Professor Rutherford; and it will be necessary to repeat the experiment under varying conditions.

The point is of considerable interest, for the existence of these pairs would help to explain much of the mechanism of phosphorescence. They would appear to be connected with the clusters of J. B. B. Burke, which were produced by ionisation, gave rise to phosphorescent glow, contained energy, yet were not electrified. It is of interest in this connection that the photograph which Sir William and Lady Huggins made of the phosphorescent glow of radium showed the bands of the gas in which the salt was embedded. Rutherford also has shown that the α particle can no longer cause phosphorescence when it has lost its power of ionisation.

The Magnetic Deflection of the α Particle.

In the "Physikalische Zeitschrift" for October 15 is a paper by M. Becquerel, "Uber einige Eigenschaften der α Strahlen des Radiums." The author discusses the theory that the α rays gradually lose their velocity as they spend their energy on the ionisation of the media through which they pass, a theory which I put forward about two years ago,* and which has the support of much experimental evidence accumulated by Professor Rutherford,† and by Mr. Kleeman and myself.‡

He maintains that the theory is unsuccessful in explaining the experiments which he has himself performed, and in particular he describes one experiment which he has devised as a crucial test, and which he considers to show that the theory is incorrect.

It is as follows *(loc. cit.*, p. 688) :—

The α rays from a small quantity of radium salt are allowed to stream upwards through a narow slit and fall upon a photographic plate. A powerful magnetic field deflects them slightly to one side. The field is reversed when the experiment is halfway through, and as a result two images of the slit appear, slightly separated, upon the plate. Now, M. Becquerel covers half the slit with a thin sheet of aluminium, and, according to the theory which I have advanced, the α rays which pass through the sheet are thereby retarded. Consequently, M. Becquerel argues, these α rays should be more bent to one side than those which have not

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* Australasian Association for the Advancement of Science, Report, Dunedin, January, 1904.

† "Phil. Mag.," July, 1905.

‡ "Phil. Mag.," December, 1904, and September, 1905.

passed through the aluminium, and the images on the plate should show a break, the lines being more widely separated in one half of the picture than in the other.

But M. Becquerel is under a misapprehension on this point. Paradoxical as it may appear at first sight, no such break ought to appear, and the photographic result is quite in accordance with the theory that the α particles lose speed as they pass through matter.

In order that this may be clear, it is necessary first to consider the order of the deflections of the α rays in the magnetic field, on the various theories that have been proposed.

Suppose that an α particle is projected from O in the direction O N, with velocity v_0, and that the action of a field H causes it to describe the curved path O A.

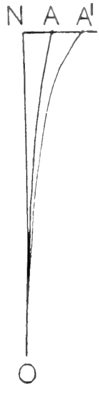


Fig. 1

In the first place, let the velocity be constant throughout, and the path be therefore circular, as M. Becquerel supposes. Then, since the curvature is small, A N $=a^2/2\rho$ where A N $=a$ and ρ is the radius of curvature.

$$\therefore\ AN = \frac{He}{mv_0} \cdot \frac{a^2}{2}$$

In the second place let the velocity diminish as the distance from O increases; and let us take the extreme case, where the velocity vanishes at a distance a from O. Let the path in this case be OA$'$. It does not make very much difference what law of diminution of velocity we adopt: let us suppose, as my experimental results seem to indicate, that the particle spends its energy at a rate which is inversely proportional to the square of its speed. In this case:

$$\tfrac{1}{2} m \frac{dv}{ds} = kv^{-2}, \text{ s being measured from } O,$$

and therefore $v^4 \propto (a - s)$

so that $\dfrac{v^4}{v_0^{\,4}} = \dfrac{a-s}{a}$.

$$\text{Thus } \rho = \frac{mv_0}{He}\left(1 - \frac{s}{a}\right)^{\frac{1}{4}};$$

and we obtain easily that, if $\rho = ds/d\psi$,

$$\psi = \frac{4a}{3}\left\{1 - \left(1 - \frac{s}{a}\right)^{\frac{3}{4}}\right\}\frac{He}{mv_0}.$$

Now, provided that $\int \psi ds$ is small, this quantity is very nearly equal to A′N, the total deflection of the ray.

But this integral

$$= \int_0^a \frac{4a}{3}\left\{1 - \left(1 - \frac{s}{a}\right)^{\frac{3}{4}}\right\} ds \frac{He}{mv_0}$$

$$= \frac{He}{mv_0} \cdot \frac{4a^2}{7},$$

and this quantity is very small, since it is only slightly greater than A N.

Finally then we have that

$$A'N/AN = 8/7.$$

It is easily found that if we had supposed the α particle to spend its energy uniformly along its path, we should have obtained the result:—$A'N/AN = 4/3$.

It will thus be clear that, on any reasonable hypothesis as to the particular law of diminution of velocity, the actual path of the particle differs very little from a circle. In the extreme case which I have considered, the small deviation therefrom at the end of the path is small compared to the widths of the images in M. Becquerel's photograph. If the particle ceases to ionise whilst its velocity is still great, as has been shown by Professor Rutherford, the variation is still less.

Let us now consider the circumstances of M. Becquerel's experiment.

As a first approximation, suppose the widths of the groove containing the radium salt and of the slit to be negligible.

If no magnetic field is acting, all the α particles move in the vertical line O N. The range of the particles from RaC is very nearly 7·0 cm.: from which it follows that the number which pass any given point P is proportional to the defect of O P from 7·0 cm., or in other words that the number n which end their flight on any unit of length of O N is a constant. The other three groups of α particles have, as their furthest distances of penetration, 4·8, 4·2, and 3·5 cm. respectively. Thus, between 4·8 and 4·2 $2n$ α particles end their flight on each unit of length, between 4·2 and 3·5 the number is $3n$, and from that point up to the radium $4n$. The radium salt is supposed to be deep enough to supply all these, *i.e.*, its depth is taken to be at least ·002 cm. Suppose now a powerful magnetic field to be brought into play, the direction of the lines of force being normal to the plane of the paper. The paths of the α particles are curved to one side, and the curvature is greater the nearer the particle is to the end of its course. Let O A and O Q represent two such paths. Their separation from each other is considerably exaggerated in the figure. If all the paths were drawn the locus of Q would be seen to be a curve, whose curvature in contrast to that of the path of any one particle would be greater the further the distance from A. This is in agreement with M. Becquerel's experiments, as I have previously pointed out.*

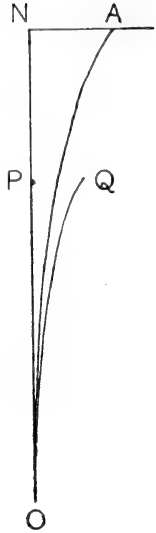


Fig. 2

The width of the trace upon the paper of all the paths of the α particles is very small, and is almost too fine to be shown on a diagram.

It is perhaps well to point out that there is no break in this trace at the critical points 4·8, 4·2, and 3·5. It is quite smooth from end to end. These points mark the extreme distance to which various bundles of α rays penetrate; but the deflection of an α ray which ends its course at a given point is independent of the particular radioactive material from which it has come; the only varying characteristic of an α particle is its velocity.

We must now take into account that the widths of the slit and the groove are not negligible, as is clearly to be seen from the photograph under consideration. There is

* "Phil. Mag.," December, 1904, p. 737. Jahrbuch d. Rad. u. Elektr., 1905, p. 14.

consequently, so to speak, a large penumbra. Thus the trace upon the plane of the paper of all the α rays is such as is represented in Fig. 3, the deflections being all exaggerated so as to be capable of depiction.

Now suppose an aluminium plate is placed, as in M. Becquerel's experiment, over the slit, so that the α particles have to pass through it on the way to the photographic plate. M. Becquerel supposes that there ought therefore to be an increased displacement of the photographic image. But this is not so. The path of any one α particle is slightly deflected, but the whole trace is not appreciably disturbed. The aluminium diminishes the range of every α particle by the same amount, but the only result is to cut off all the rays which would have gone past a certain point, say Q, and to cause them to take the places of those rays which fell short of Q; these latter being further shortened. This does not in the least affect the position of the outer edge of the trace upon the photographic plate; and though there must be a slight movement of the inner edge, so that the trace is somewhat narrower, the change is so small that it could not possibly be detected, as a glance at the photograph will show. Magnetic dispersion of the α rays does exist: it has been directly shown by Rutherford,* and, as I think, indirectly by M. Becquerel's own experiments, in the peculiarities of the curvature of his photographic traces. But it could not be shown in the manner of the experiment which M. Becquerel now describes. That would be analogous to the search for evidence of the motion of the stars in the line of sight in the displacement of the visible spectrum as a whole, whereas the measurement to be made is of the displacement of some Fraunhöfer line in the spectrum, *i.e.*, of one set of waves which can be isolated for consideration. It is here that Rutherford's experiment is differentiated from that of M. Becquerel. The former employed as a source of rays a wire coated with a thin layer of RaC emitting α particles of uniform velocity, which is analogous to confining one's attention in the star problem to

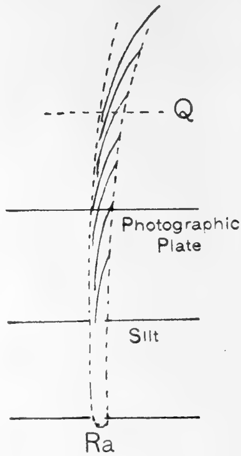


Fig. 3

* Also quite recently by Mackenzie. "Phil. Mag." November, 1905.

waves of one length. Moreover, Rutherford passed his α particles for some considerable distance through a vacuum whilst yet under the influence of the magnetic field. Thus the evidence of the increase of curvature in their paths, originally caused by the loss of velocity in penetrating matter, was accumulated. But if, as in M. Becquerel's experiment, the path is in the air, then any appreciable increase of curvature closely precedes the cessation of all evidence of motion, and the result must be in any case almost beyond detection.

M. Becquerel remarks that there is no evidence in his photographs of the greater precision of the outer line of the trace, which I had anticipated. But the photograph which he now publishes shows that there is too much penumbra for such an effect to be visible.

THE POSITIVE CHARGE OF THE α PARTICLE.

Considerable discussion has recently taken place as to the mode in which the α particle acquires its positive charge. It has been pointed out more than once that it may be explained as the result of ionisation by collision (Rutherford, address to St. Louis Congress, 1904; Bragg, "Phil. Mag.," December, 1904), and that the same hypothesis will explain the deposit of the radium emanation on the negative electrode (Bragg and Kleeman, December, 1904). In the case of the emanation, an explanation, which I understand to be similar, has been carefully worked out by Mackower ("Phil. Mag.," November, 1905).

Rutherford has shown that the α particle is charged at the moment of leaving the radium salt. But I do not think that this result is in any way prejudicial to the collision theory. He evaporated a very weak solution of radium on a plate, and supposed that as a result he had an excessively thin layer, so that the particle made very few collisions before emergence. But when such deposits are examined under a microscope it is seen that the salt is gathered in little heaps, and there is no true layer at all. The bulk of the α particles pass through hundreds of atoms before emergence, and there is ample opportunity for ionisation by collision.

We find that the α particle spends energy in causing the expulsion of electrons from the atoms of any gas which it traverses. The tables of stopping powers given above show that the expenditure of energy follows the same law when the atoms are massed in a solid. We conclude that the solid is ionised in the same way as the gas. We should therefore expect to find slow-moving electrons issuing from radium itself, and from both sides of any solid screen through which the particles pass. Surely these are the effects observed by J. J. Thomson, Rutherford, and others. This has already been suggested by Soddy ("Nature," March, 1905).

THE α PARTICLES OF URANIUM AND THORIUM.

By W. H. BRAGG, M.A., Elder Professor of Mathematics and Physics in the University of Adelaide.

[Read April 3, 1906.]

This paper is divided into two parts. The first contains a discussion of the magnitude of the ionisation current due to a layer of radio-active material scattered on the floor of an ionisation chamber, and covered by a uniform sheet of metal foil. The result is expressed in a formula which is somewhat complicated in its general form, but is capable of simplification under suitable conditions. Account is taken of the variation of ionisation with velocity. The second contains an account of experiments which show:—

(a) That the values of the current in various cases, calculated from the formula, agree very well with the results of observation.

(b) That the ranges of the α particles of uranium and thorium are very nearly, perhaps exactly, equal to the range of the α particle of radium.

(c) That the rate at which thorium atoms break down is ·19 of the similar rate for uranium.

PART I.

The method which was used by Mr. Kleeman and myself in the determination of the ranges of the α particles emitted by radium and its products does not lend itself to the corresponding determinations in the cases of uranium and thorium. It is a necessary feature of the method that all α particles except those moving normally to the horizontal layer of radio-active material should be prevented from reaching the ionisation chamber, below which the radium is placed. This is done by the use of a bundle of vertical tubes, which stop all α particles other than those moving in the desired direction. But this limitation diminishes very greatly the number of effective α particles, and in the cases of uranium and thorium the effect is reduced below the limits of convenient measurement. This is the case even when a large surface of radio-active material is employed. In order to determine the ranges of uranium and thorium another method must be devised.

I have, therefore, calculated the ionisation due to a radio-active layer over which a screen has been placed. The result is a function of the relation of the stopping power of the screen to the range of the particle; so that if experiment is made the one can be found in terms of the other. The stopping power of the screen may be made the subject of a direct measurement, and so the range of the α particle can be determined. I find it better, however, to compare the range of the uranium or thorium with that of radium, working the experiment by a substitution method; for the range of radium is known with some accuracy, and the method itself is accurate enough when employed in comparing ranges, but a little uncertain in its application to direct determinations, as will be explained later.

Experiments of this kind have already been made by several observers, notably by Professor Rutherford and Miss Brooks ("Phil. Mag.," July, 1900). But at the time when they were made it was believed that the α rays were absorbed according to an exponential law; it was not known that each α particle possessed a definite range or penetrating power. Consequently the results were not in all cases expressed in such a way as to render them available for the calculation of the range. I have, therefore, found it convenient to repeat them.

In the following theoretical treatment of the question the following cases are considered:—

(a) When the layer of radio-active material is so thick that the α rays from the bottom of it are unable to reach the air above. Such a thickness is of the order ·002 cm.

(b) When the layer is extremely thin.

(c) When the layer is thicker than in *(b)*, but not so thick as in *(a)*.

(d) When the radio-active material is in the form of small spheres scattered over the floor of the ionisation chamber.

The first and second are really special cases of the third. Uranium and thorium are conveniently treated under *(a)*, induced activities under *(b)*, and radium under *(c)*.

CASE *(a)*.

Ionisation produced in air above a thick layer of radio-active material, on which sheets of absorbing material are laid.

Let the surface of the radio-active material be of unit area. Let the full range of the α particle be R, and the range lost by passing normally through the absorbing sheet be D.

Let the stopping power of the radio-active material per radio-active atom be s. This means that if an α particle passes parallel to the axis along a cylinder containing only as much matter as goes with one radio-active atom of the radio-active material, the loss of range is on the average s times the loss when an average air molecule is substituted for the radio-active matter. The length of the cylinder is, of course, immaterial.

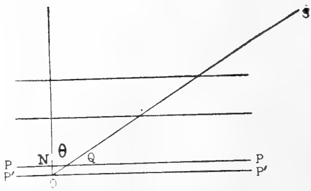
The α particles emerging into the air will penetrate to distances depending on the quantity of matter traversed before emerging. Consider, in the first place, all those whose ranges in air after emergence lie between r and $r+dr$. These move at various inclinations to the normal to the surface of the layer; the number depends on the inclination, and may be reckoned as follows:—

Consider only those whose inclinations to the normal lie between θ and $\theta+\delta\theta$. All these come from a layer of a certain thickness at a certain depth below the surface. The depth does not concern us, but the thickness does, for we need to know the number of radio-active atoms in the layer.

Let n be the number of radio-active atoms in a c.c. of the material. Let n_0 be the number of molecules in a c.c. of air. The molecules are not uniform, of course, but are averaged for our purpose.

Then an α particle loses the same range in traversing a distance δr in air as in traversing a distance $\frac{n_0}{ns}.\delta r$ in the radio-active material. Hence, if PP' is the layer in question, O the radio-active atom, OS the course of the α particle, then $OQ=\frac{n_0\delta r}{ns}$ and

$$ON = \frac{n_0\delta r}{ns} \cdot \cos\theta.$$



This last expression is also the volume of the layer from which the α particles come, since we are considering unit area of the material; and therefore the number of radio-active atoms in it is $\frac{n_0\delta r \cos.\theta}{s}$.

Let each molecule emit N α particles per second. N is a very small fraction. Then the number emitted by each particle between the inclinations θ and $\theta + \delta\theta$ is

$$N.\frac{2\pi \sin\theta\delta\theta}{4\pi} = \frac{N \sin\theta\delta\theta}{2}.$$

Hence, finally, the number of α particles whose ranges in air after emergence lie between r and $r+\delta r$, and which have inclinations to the normal varying from θ to $\theta+\delta\theta$, is

$$\frac{N \sin\theta n_0 \cos\theta\delta r\delta\theta}{2s}$$

The limits of θ are O, and such a value of θ that the α particles which come from the very surface of the radio-active material and move at this inclination to the normal have a range r in the air after penetrating the absorbing sheet. This value of θ is given by the equation $D\sec\theta + r = R$.

Integrating between these limits we find that the total number of α particles whose ranges lie between r and $r+\delta r$

$$= \frac{Nn_0}{4s}\left\{1 - \frac{D^2}{(R-r)^2}\right\}\delta r$$

Each of these moves over a range r in air. If, as a first approximation, it be supposed that in doing so it makes lr ions, then we find that the whole ionisation (i) is obtained by integrating this expression with respect to r, having inserted the factor lr, between the limits $R-D$ and O. The result is

$$i = \frac{Nln_0}{8s}\left\{(R-D)(R-3D) + 2D^2 \log\frac{R}{D}\right\}$$

If I = the ionisation when $D=O$, then

$$I = \frac{Nln_0}{8s} R^2$$

Hence

$$i/I = \left(1 - \frac{D}{R}\right)\left(1 - \frac{3D}{R}\right) + \frac{2D^2}{R^2}\log.\frac{R}{D}$$

From this formula a curve may be plotted showing the relation between i/I and D/R.

This result is obtained on the assumption that the ionisation caused by the α particle is proportional to the distance traversed, in other words that the ionisation is independent of the particle's velocity. This is not actually the case. I have shown ("Phil. Mag.," Nov., 1905) that the ionisation is inversely proportional to the square of the velocity. Assuming, therefore, that the ionisation produced is proportional to the energy expended, we may say that $\delta e = k\delta r / e$, where e is the energy possessed by the particle and k is a constant. Hence e is proportional to $\sqrt{(r + d)}$, where d is also a constant. In the paper referred to I have shown that $d = 1{\cdot}33$ cm. Thus the ionisation produced by the α particle in traversing the last r cm. of its course may be put equal to

$$l\,(\sqrt{(r + d)} - \sqrt{r})\ *$$

where l is a constant and $d = 1{\cdot}33$.

Hence the whole ionisation due to such particles as have ranges between r and $r + \delta r$ is equal to

$$\frac{Nln_0}{4s}\left\{1 - \frac{D^2}{(R-r)^2}\right\}(\sqrt{(r+d)} - \sqrt{r})\,\delta r$$

This must be integrated between the limits of $R - D$ and O.

The final result is

$$\frac{4si}{Nln_0} = \frac{2}{3}(R - D + d)^{\frac{3}{2}} - \frac{2}{3}d^{\frac{3}{2}} - R\sqrt{d} - D\sqrt{(R + d - D)}$$

$$+ 2D\sqrt{d} + \frac{D^2}{\sqrt{(R+d)}}\log.\frac{\sqrt{R}\left\{\sqrt{(R+d)} + \sqrt{(R+d-D)}\right\}}{\sqrt{D}\left\{(\sqrt{(R+d)} + \sqrt{d})\right\}}$$

The value of I, the current when the material is uncovered, is obtained by putting $D = O$. This gives

$$\frac{4sI}{Nln_0} = \frac{2}{3}(R + d)^{\frac{3}{2}} - \frac{2}{3}d^{\frac{3}{2}} - R\sqrt{d}$$

The value of i/I is therefore no longer a function of D/R merely, as in the simpler formula found for the case when the variation of ionisation with speed is neglected. Consequently the curves for various values of R are not all of the same form. It appears on trial, however, and it might reasonably have been expected, that the form of the curve is altered but little, even when R is altered considerably. Curve A was plotted for the case $R = 3$, and serves very well in the cases of uranium and thorium. It lies very close, as can be found on trial, to the curve obtained from the simpler formula of the case when the variation of ionisation with velocity is neglected.

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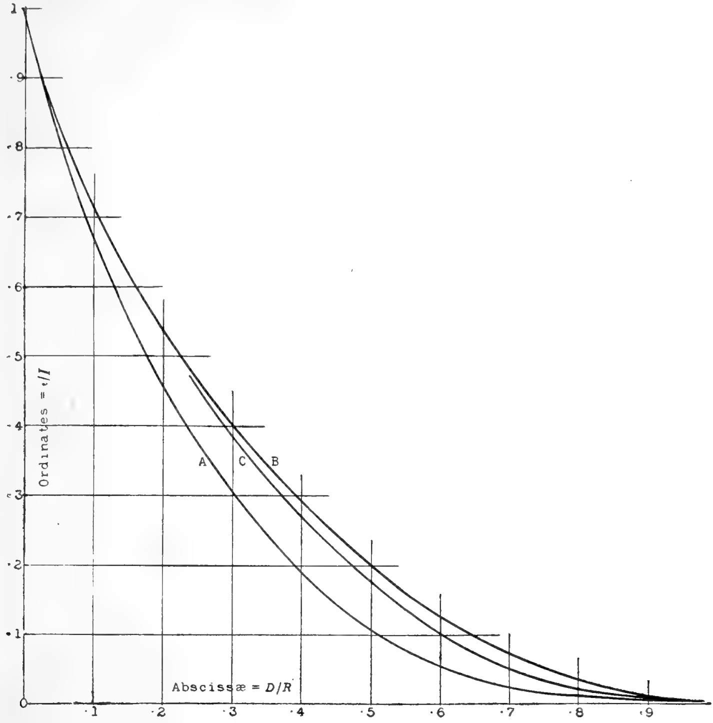
* Even if there be errors in the theory which leads to this formula, the present argument is not injured, for the formula correctly represents the actual facts.

The following co-ordinates have been used in drawing the curve :—

D/R	·067	·110	·167	·250	·333	·443	·568	·667	·833
i/I	·773	·657	·532	·378	·262	·148	·069	·030	·010



CASE (*b*).

Thin layer of radio-active material.

The limits for θ are now θ_1 and θ_2 where

$$D \sec \theta_1 + r = R, \text{ and } (D + D') \sec \theta_2 + r = R.$$

D′ being the air equivalent of the layer of radio-active material. Hence, the total number of particles whose ranges lie between r and $r + dr$, is

$$\frac{Nn_0}{4s}\left\{\left(\frac{D+D'}{R-r}\right)^2 - \left(\frac{D}{R-r}\right)^2\right\}\delta r = \frac{Nn_0 DD'}{2s} \frac{\delta r}{(R-r)^2}$$

where D'^2 is neglected.

In this case we find that the whole ionisation (i) is given by

$$\frac{2si}{Nln_0D'}=$$

$$\sqrt{(R+d-D)}-\sqrt{(d)}-\frac{D}{\sqrt{(R+d)}}\log.\frac{\sqrt{R}\left\{\sqrt{(R+d)}+\sqrt{(R+d-D)}\right\}}{\sqrt{D}\left\{\sqrt{(R+d)}+\sqrt{d}\right\}}$$

and the ionisation due too the uncovered material by

$$\frac{2s\,I}{N\,ln_0D'}=\sqrt{(R+d)}-\sqrt{d}.$$

If we had supposed the ionisation to be independent of the velocity, we should have obtained the result

$$i/I=1-\frac{D}{R}+\frac{D}{R}\log.\frac{D}{R}.$$

In this case the effect of neglecting the variation of ionisation with velocity is more serious. For instance, if in the simpler formula we put $D/R=\cdot25$, we find that $i/I=\cdot40$; whereas, if we use the fuller formula, and put $D=\cdot75$, $R=3$, we find that $i/I=\cdot448$.

These formulæ are applicable to measurements of the range due to induced activity, since it is to be supposed that the active deposit is extremely thin. Curve B is plotted from the fuller formula of the two, for the case in which $R=7$. As usual, d is put equal to 1·33.

The following co-ordinates have been used in drawing the curve:—

D/R	·061	·124	·250	·357	·500	·690	·833
i/I	·807	·612	·467	·335	·193	·077	·023

CASE (c).

Moderately thin layer of radio-active material.

Let the air equivalent of the thickness of the material be D'. This must be considered in two parts.

(i.) Where r is such that $D+D'+r$ is less than R, the limits of θ are $\cos^{-1}\frac{D+D'}{R-r}$ and $\cos^{-1}\frac{D}{R-r}$; and the limits of r are $R-D-D'$ and zero.

(ii.) Where r is such that $D+D'+r$ is greater than R, the limits of θ are $\cos^{-1}\dfrac{D}{R-r}$ and zero, and the limits of r are $R-D$ and $R-D-D'$.

Hence

$$\frac{4si}{Nln_0}=\int_{R-D-D'}^{R-D}\left\{1-\left(\frac{D}{R-r}\right)^2\right\}\left\{\sqrt{(r+d)}-\sqrt{d}\right\}dr$$

$$+\int_{o}^{R-D-D'}\left\{\left(\frac{D+D'}{R-r}\right)^2-\left(\frac{D}{R-r}\right)^2\right\}\left\{\sqrt{(r+d)}-\sqrt{d}\right\}dr$$

$$=\frac{2}{3}(R-D+d)^{\frac{3}{2}}-\frac{2}{3}(R-D-D'+d)^{\frac{3}{2}}-2D'\sqrt{d}$$

$$-D\sqrt{(R+d-D)}+(D+D')\sqrt{(R+d-D-D')}$$

$$+\frac{D^2}{\sqrt{(R+d)}}\log.\frac{\sqrt{(D+D')}\left\{\sqrt{(R+d)}+\sqrt{(R+d-D)}\right\}}{\sqrt{D}\left\{\sqrt{(R+d)}+\sqrt{(R+d-D-D')}\right\}}$$

$$-\frac{D'^2+2DD'}{\sqrt{(R+d)}}\log.\frac{\sqrt{R}\left\{\sqrt{(R+d)}+\sqrt{(R+d-D-D')}\right\}}{\sqrt{(D+D')}\left\{\sqrt{(R+d)}+\sqrt{d}\right\}}$$

Curve C is plotted from this formula for the case when $R=3{\cdot}5$ and $D'={\cdot}5$. As usual, d is taken equal to $1{\cdot}33$.

The following co-ordinates have been used in drawing the curve :—

D/R	·057	·143	·200	·257	·380	·500	·714
i/I	·833	·642	·539	·449	·288	·174	·044

CASE (d).

The radio-active material in the form of small spheres.

This case is not realised in any of the experiments described in this paper, but is introduced in order to show how greatly the effects depend on the mode of arrangement of the radio-active material.

Suppose the sphere to be of such a size that its diameter is a few times greater than the range of the α particle in the radio-active material itself. It may then be supposed that the sphere emits equal numbers of α particles in all directions and at all ranges up to the maximum. Neglecting the variation of ionisation with velocity we find that the ionisation is proportional to

$$\int_0^{\cos.^{-1} D/R} \int_0^{R - D \sec. \theta} \sin \theta . \, r . \, d\theta . \, dr.$$

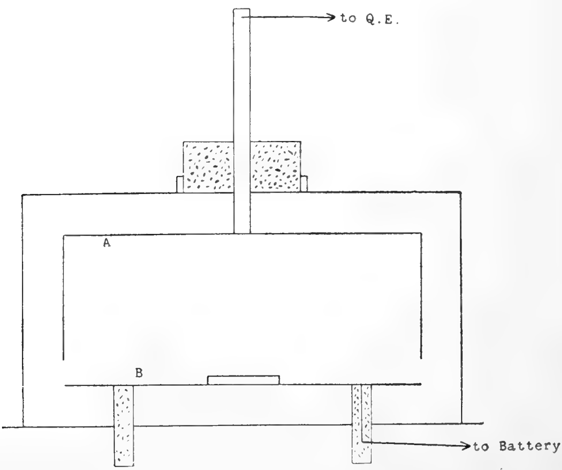
$$i.e., \text{ to } R^2 - D^2 + 2RD \log. \frac{D}{R}.$$

$$\text{Thus} \quad i/I = 1 - \frac{D^2}{R^2} + 2\frac{D}{R} \log. \frac{D}{R}.$$

If $D/R = {\cdot}25$ then $i/I = {\cdot}25$ nearly. In the case of a thin uniform layer we found above that if $D/R = {\cdot}25$, then $i/I = {\cdot}40$. Thus the effect of a screen in cutting down the ionisation effects depends very much on the mode of disposition of the radio-active material below it.

Part II.

The apparatus employed was of the usual form, and very similar to that described by Rutherford ("Radio-activity," 1905, p. 98). As shown in the figure the material was laid on the high potential plate B, at such a distance from the upper plate A that no α particle could reach it. Thus, every α particle ran to its extreme range; and, to make more certain of catching all the ions, the upper plate was extended downwards at the sides.



Uranium.

The uranium was used in the form of the green oxide, U_3O_8, and was freed for the time from Uranium X. This was not necessary, but convenient, as it diminished the β ray correction. The uranium was ground to a fine powder, and placed in a shallow depression turned in a metal plate, the diameter of the recess being 3·17 cm. and the depth 1-32 inch, which was far more than enough to make sure that the α rays from the lowest stratum could not get out. The surface of the material was carefully smoothed by the aid of a polished metal plate. A potential of 300 volts was used, which was nearly sufficient to saturate; more was not necessary, as only relative ionisations were in question. Aluminium foil was used as the absorbing layer, the weight and area of each piece being measured so as to obtain the product of the density ρ and the thickness d. In the following table the first column gives the value of ρd of the foil used, and the second the corresponding current, being the mean of five readings of the leak for ten seconds.

I.	II.	III.	IV.	V.
$\rho d \times 10^6$	i	i/I	*From curve A.*	$\rho\delta$ *of full range* $\times 10^5$
0	1044	1·000	—	—
317	811	·768	·071	448
633	635	·595	·139	462
949	494	·456	·205	463
1265	376	·339	·275	460
1620	275	·239	·353	458
1930	201	·165	·425	455
2610	97	·062	·580	449
3290	55	·021	·718	458
+ 2 layers of tinfoil	34	0	—	—

The last line shows that when two layers of tinfoil were added to the aluminium foil already covering the uranium the leak was reduced to 34. Each layer of foil was equivalent to about 17 mm. of air, and the aluminium to about 21, so that the whole cut off the α rays completely, for their range was known to be not more than 3·5 cm. This leak of 34 was therefore due to β rays, and the normal leak of the apparatus. The third column shows the result of subtracting 34 from all the figures of the second column, and reducing to a decimal fraction of I (the maximum current). The numbers so obtained were then considered as so many ordinates of the thick layer curve A; and the corresponding abscissæ found and placed in the fourth column. It was then possible to obtain from each reading a determination of the ρd of that aluminium sheet which the α particles of uranium could just penetrate. For example, the table shows that when $\rho d = \cdot000949$, $i/I = \cdot456$. The abscissa of curve A corresponding to this ordinate is ·205. Consequently the ρd of full range is equal to $\cdot000949/\cdot205 = \cdot00463$. The figures in the last column show the result of this calculation in the case of each observation. Their close agreement shows that the experimental results fit accurately a curve derived from the theory given above, and is good evidence of the soundness of the calculation.

The mean of the values in the last column is ·00456.

Radium.

A very small quantity of radium bromide was dissolved in water and evaporated on a platinum plate. It was then raised to a bright red heat, in order to expel the emanation. Some RaC still remained, but this fell to a negligible value in a few hours, as was shown by the fact that the ionisation current due to the newly prepared layer declined to about half value in that time. It was then re-heated so as to drive off such fresh emanation as had been formed since the previous heating. It has been shown by Kleeman and myself ("Phil. Mag.," Dec., 1904), that a layer so heated is very nearly free from all the radio-active products of radium.

The same aluminium foils were used as in the previous experiment. The results are given in the following table:—

I.	II.	III.	IV.
$\rho d \times 10^6$	i/I	*From curve C*	ρd *of full range* $\times 10^5$
317	·775	·077	412
633	·634	·145	437
949	·522	·209	453
1265	·430	·270	468
1617	·331	·345	468
1933	·261	·405	477
2613	·150	·528	493
3289	·072	·650	507

There is here not quite such good concordance between the figures shown in the last column as there was in the case of uranium. This is not, perhaps, a matter for surprise. Assuming that the theory of Part I. of this paper is correct, then, if the observed results are to fit the calculated curve exactly, the active material under consideration should emit only α particles of one range (*i.e.*, of one velocity on leaving the parent atom, though not, of course, of one velocity on leaving the surface). Although the radium in this case was nearly free from its radio-active descendants, yet a small trace must have remained. The effect would be to make the value of the current a little too large at all times, but especially when the absorbing sheet was so thick as to stop almost entirely the α particles from the radium itself; so that the last readings of the last column would be too high, which is the case. A more important explanation of the want of concordance of the first and last results with the rest seems to be that for some reason the first layers of aluminium foil which are laid over the material cut down the radiation more than they ought to do. This may in part at least be a consequence of the experimental arrangements. The aluminium foil cannot be made to lie very flat on the surface of the material, on account of its flimsy nature, and must have a little air space underneath it. Now, the air next the material is the seat of a relatively large amount of ionisation. Thus, the first layer may have an exaggerated importance. Another partial cause may arise from the fact that the first layer or two must cut off the easily absorbed radiation from the radio-active surface which has been shown to exist by J. J. Thomson and by Rutherford. I am not aware of any measurement of the amount of ionisation due to this radiation. If in this experiment only 4 per cent. of the whole ionisation current, when the material is uncovered, is supposed due to this cause; and if the foil whose ρd = ·000317 cuts off three-quarters of it, and the next addition of foil the remainder, then the figures in the last column become, in order, 488, 487, 487, 496, 486, 490, 502, 514. Thus the existence of a small quantity of radiation of this kind would explain the present discrepancies in the experiment. It will be seen later that a similar effect occurs with thorium. It is not so noticeable in the uranium experiment, as will be found on turning back to the table of results. Still, the first result is rather smaller than those which follow, and a separate measurement made with a very thin layer for which ρd = ·000133 gave a value for the full range equal to ·00426, which is much smaller than the rest.

It should be mentioned that the first and last readings are more liable to error than the others, since the ends of the curve are used in obtaining them.

On the whole, therefore, the radium measurements are liable to certain small errors whose magnitude can hardly be estimated as yet. But they are small, and they tend to balance each other, so that for our present purpose we may safely assume the mean of the results of the last column, viz., ·00466, to be the ρd of that sheet of aluminium, which can just be penetrated by the α particle of radium. If there are errors of experiment other than those discussed above they are common to the experiments with uranium and thorium, and disappear when comparison is made.

RaC.

A small piece of copper foil was rendered active by exposure at a negative potential to the emanation from one or two mmg. of radium bromide. Tinfoil was used as the absorbing layer. There was a special difficulty in the experiment due to the decay of the active matter. This was overcome by taking measurements of the current with the RaC uncovered before and after each measurement when foil was placed over the radiating material. The observations were equally spaced in point of time, so that the geometric mean of the two former measurements could be matched against the latter. The results are shown in the following table:—

I.	II.	III.	IV.
ρd in Sn foil $\times 10^5$	i/I	From Curve B	ρd of full range $\times 10^4$
477	·518	·217	220
960	·235	·459	209
1440	·072	·700	206

Thus the α particles from RaC can just penetrate a sheet of tinfoil whose ρd = ·0212. A separate experiment by the method employed by Kleeman and myself ("Phil. Mag.," Sept., 1905), showed that this was equivalent to 7·4 cm. of air. The actual range is 7·1 *(loc. cit.)*, so that the agreement can be considered satisfactory.

Thorium.

The material was used in the form of thorium oxide, which had been freed as far as possible from other radio-active substances by means of the processes described by Rutherford and Soddy. The treatment employed, which included heating to a bright red heat as the final stage, was judged to have been successful for the following reasons:—In the first place, the recovery of activity was not marked by an initial drop, so far as could be observed; in the second, the ionisation current rose at a rate which showed that it would be halfway to the final value in four days, the final value being about four times the initial. In the third place, no emanation came off the material when first prepared; even when no draught was employed the readings did not alter in 15 minutes; and, in the fourth place, the observed results fitted closely to the calculated curves, showing only a slight variation, as in the case of the radium.

The results of one experiment are shown in the following table:—

I. *pd of Al. foil* × 10^6	II. i/I	III. *From Curve A*	IV. *pd of full range* × 10^5
244	·813	·055	444
474	·670	·108	439
780	·544	·162	480
1061	·412	·227	468
1573	·271	·328	480
2073	·173	·417	499
2607	·106	·504	517

The mean of the figures in the last column is ·00477.

In another experiment the thorium was precipitated twice at intervals of two days, and then five times at intervals of twelve hours. The results were as follows:—

I. *pd of Al. foil* × 10^6	II. i/I	III. *From Curve A*	IV *pd of full range* × 10^5
534	·655	·114	470
1046	·425	·221	473
1633	·248	·347	471
2133	·154	·438	486

In this case the mean of the figures in the last column is ·00475. As in the case of radium, this result is probably a little too high, as it is impossible to get rid of all the radio-active products of thorium, and all these have ranges higher than thorium itself. For Rutherford has shown that the α particle of the induced activity of thorium has the same penetrating power as the α particle of the induced activity of radium, and some rough experiments which I have made with Th.X. go to show that, as in the case of Ra, the second and third active products have ranges intermediate between the first and fourth. *It may also be calculated from an experiment of Rutherford's ("Radio-activity," 2nd Ed., p. 263), that the range of the emanation α particle is about 6 cm.; but it is uncertain how much should be allowed for the stopping power of the mica sheet which he used.

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* NOTE.—An experiment by Schmidt (Phys. Zeit. No. 25, p. 897) has shown that RaA has two-thirds of the penetrating power of RaC. Hence its range must be the longer of the two intermediate ranges, determined by Kleeman and myself, viz., 4·83; and the range of the emanation must be 4·23. Thus in the radio-active sequence each explosion is more violent than the last.

The general conclusion is, therefore, that uranium, thorium, and radium eject α particles of nearly, if not exactly, the same speed. Considering the many parallelisms already known to exist between the processes of disintegration of these substances and their products, this new fact is certainly suggestive. It would be very interesting to know the ranges of Th.X. and Th. emanation.*

Relative Activities of Uranium and Thorium.

An expression is found in Part I. of this paper for the total ionisation over an uncovered deep layer of active material. By its aid we may find the relative numbers of α particles emitted by uranium and thorium when the ionisation currents due to known areas of the layers have been measured.

Since the ranges are so nearly alike, it is sufficient to use the simpler formula:—

$$I = \frac{N l' n_0}{8s} R^2$$

If, now, the suffixes U and T refer to uranium and thorium, we have

$$\frac{I_U}{I_T} = \frac{N_U R_U^2 s_T}{N_T R_T^2 s_U}$$

and therefore

$$\frac{N_T}{N_U} = \frac{I_T R_U^2 s_T}{I_U R_T^2 s_U}.$$

Each time that a thorium experiment was completed a comparison was made of the currents I_T and I_U. In the first case $\frac{I_T}{I_U}$ was found to be ·234 ; in the second ·234.

$\left(\frac{R_U}{R_T}\right)^2$ as may be seen from the results given above can be taken as equal to $\left(\frac{456}{476}\right)^2 = \cdot 916$.

* Experiments just completed go to show that the particle from Th.B. is rather more penetrating than that from RaC; and that the particle from Th Em. has a range of about three fourths of that from Th.B. It is already known that the range of the particle from RaA is ·68 of that from RaC. (April 4, 1906.)

Also $\dfrac{S_T}{S_U} = \dfrac{\sqrt{232} + 2\sqrt{16}}{\sqrt{239} + \frac{8}{3}\sqrt{16}} = \dfrac{23 \cdot 2}{26 \cdot 2}$

assuming the square root law (Bragg & Kleeman, "Phil. Mag.," September, 1905) to hold for uranium and thorium.

Hence, finally,

$$\frac{N_T}{N_U} = \cdot 234 \times \cdot 916 \times \frac{23 \cdot 2}{26 \cdot 2} = \cdot 190.$$

This result may be a little too small, since the range of the *a* particle of thorium may be slightly over-estimated. The square of the range enters into the formula of comparison, but on the other hand any *a* rays of long range which have not been removed from the thorium would make I_T too large. On the whole, therefore, the actual value cannot be far from ·20, *i.e.*, the uranium atoms break down very nearly five times as fast as the thorium.

I have preferred to make the method one of comparison of ranges rather than of absolute determination. For there are two or three difficulties in using it for the latter purpose. In the first place, as already said, it is not easy to make the thin aluminium leaf lie very close to the radiating surface, and the layers of air close to the surface contribute a relatively large number of ions. To make this error uniform I have used a net of very fine wires, with a mesh of $\frac{3}{8}$ of an inch, to keep the foils down. The net was, of course, placed over the bare surface also, when I was measured. Again, there is a disturbing effect due to the secondary ionisation of the absorbing sheet. Mme. Curie has called attention to effects of this kind (Rutherford, "Radio-activity," 1905, p. 189). I find that there is slightly more ionisation when, of the two layers of foil, Al. and Sn., the latter is on top. Using tinfoil, the range always comes out rather larger than when aluminium foil is employed; *e.g.*, the range of RaC when tinfoil was used was found to be 7·4 cm., and when aluminium foil was used 6·5 cm. The range of Ra, as found by the aid of aluminium foil, was 3·26, which is half the range of RaC, as it should be. I had no tinfoil thin enough to give an accurate measurement of the range of the *a* particle of Ra. Both measurements with aluminium foil are too low, and the one with tinfoil is too high. The tinfoil lies flatter on the surface than the aluminium, which may help to explain the difference, but it seems more probable that it is mainly due to the secondary ionisation.

One other difficulty lies in the way of an accurate determination of the range in air by this method. As has already been mentioned by Kleeman and myself ("Phil. Mag.," Sept., 1905), the loss of range of the α particle of RaC in going through a given sheet of material appears to be slightly greater than the loss of range of an α particle of RaA, and it is not yet quite clear whether this difference is real or apparent.

The difficulties which have just been mentioned occur only in the absolute determination of air ranges, and do not affect the accuracy of the comparison of the ranges of radium, uranium, and thorium.

I owe my grateful thanks to Dr. W. T. Cooke for his
have thought it better to allow it to stand without alteration.

NOTE.—Since the above was written I have received the February number of "The Philosophical Magazine," containing an article by Mr. N. F. Campbell on "The Radiation from Ordinary Materials." In finding the formulæ necessary to his investigation, Mr. Campbell has covered part of the ground gone over in Part I. of this paper. As the fuller treatment which I have given is required in my own work I have thought it better to allow it to stand without alteration.

In a footnote Mr. Campbell expresses his inability to see why I introduced an obliquity factor $\cos\theta$ into the preliminary calculations of my first paper on the α rays ("Phil. Mag," Dec., 1904). The mistake is mine. I did not discover it until I had occasion to consider the matter again in connection with this present investigation. By omitting the factor, Mr. Campbell has obtained the correct formula for the case which he has investigated.

DESCRIPTIONS OF AUSTRALIAN TINEINA.

By E. Meyrick, B.A., F.R.S., F.Z.S.

[Read April 3, 1906.]

Whilst preparing my material for the classification of the *Plutellidæ*, I have had occasion to turn out several dark corners of the *Tineina*, and have investigated the affinities of some neglected or misunderstood genera, besides discovering a few species accidentally overlooked hitherto. The results of this research are embodied in the following paper.

XYLORYCTIDÆ.

Chereuta, n.g.

Head smooth; tongue developed. Antennæ $\frac{2}{3}$-$\frac{4}{5}$, in male simple or minutely ciliated, basal joint moderate, without pecten. Labial palpi very long, recurved, second joint thickened with appressed scales, terminal joint as long as or longer than second, slender, acute. Maxillary palpi obsolete. Posterior tibiæ smooth, with expansible whorls of rough scales at origin of spurs. Forewings with 1b furcate, 2 from $\frac{4}{5}$, 7 to costa or apex, 8 absent, 11 from middle. Hindwings somewhat over 1, trapezoidal, apex obtuse, termen sinuate, cilia $\frac{1}{2}$-$\frac{4}{5}$; 3 and 4 connate, 5 parallel, 6 and 7 connate or stalked, 8 anastomosing with upper margin of cell towards base.

Type *C. tinthalea*. Allied to *Catoryctis*, from which it differs especially by the structure of vein 8 of hindwings. The species are relatively small dark insects, with a tendency to metallic colouring.

Chereuta tinthalea, n. sp.

Male, female, 12-13 mm. Head and thorax blackish, with a few white scales. Palpi black, basal joint white, second joint white except base and apex, terminal joint sprinkled with white. Antennæ blackish. Abdomen dark fuscous, segmental margins white. Forewings elongate-oblong, costa gently arched, apex obtuse, termen slightly sinuate or nearly straight, somewhat oblique; dark fuscous, coarsely irrorated with black, and more irregularly with white; the white scales appear to form an irregular line from costa beyond $\frac{2}{3}$ to tornus, and a terminal series of dots, but no other defined markings: cilia metallic purplish-bronze. Hindwings with 6 and 7 connate; dark bronzy-fuscous; cilia fuscous, with dark fuscous basal line.

Sydney and Shoalhaven, New South Wales, in October and January: two specimens. Characterized by the strong white irroration and metallic cilia.

Chereuta anthracistis, n. sp.

Male, 10 mm. Head and thorax dark metallic purplish-leaden-grey. Palpi dark bronzy-fuscous, towards base whitish. Antennæ dark fuscous, simple. Abdomen dark bronzy-fuscous, lateral margins spotted with white. Forewings elongate, costa gently arched, apex obtuse, termen rather obliquely rounded; dark bronzy-fuscous with coppery reflections, with a few scattered white scales: cilia dark fuscous. Hindwings with 6 and 7 connate; dark bronzy-fuscous; cilia dark fuscous, basal third blackish-fuscous.

York, West Australia, in November; one specimen.

Chereuta chalcistis, n. sp.

Male, female, 13-16 mm. Head and thorax metallic bronzy-grey, side-tufts yellowish. Palpi bronzy-grey, towards base whitish. Antennæ dark fuscous, in male minutely ciliated. Abdomen bronzy-fuscous, segmental margins broadly whitish. Forewings elongate, costa gently arched, apex obtuse, termen hardly rounded, oblique; fuscous, irrorated with dark fuscous and mixed with yellowish-brown; stigmata very obscurely indicated with dark fuscous scales, plical somewhat beyond first discal: cilia fuscous. Hindwings with 6 and 7 stalked; dark fuscous, darkest towards apex; cilia fuscous, with dark fuscous basal shade.

Albany, West Australia, in December; two specimens.

ŒCOPHORIDÆ.

I now divide this family into two main groups, viz., (A) having antennæ of male moderately or strongly ciliated (1 or more); and (B) having antennæ of male simple, or at most minutely ciliated (not over $\frac{1}{3}$). This second group is that which I formerly separated as a distinct family *(Depressariadæ)*; it is rather numerously represented in the Indian region, and I am now better acquainted with its extent. It is a natural assemblage, and I find some genera are referable to it, which I had placed elsewhere, notably *Eupselia* and *Thudaca*. The three genera, *Eupselia*, *Thudaca*, and *Doleromima*, though by no means very closely related together, agree in the possession of a very singular form of pupa—naked, angular, and seated erect upon the truncate tail, imitating a leaf—and it is therefore probable that some other genera of the group will be found to show the same character, which will be of interest as an indication of affinity.

A general classification of the family may be expressed by the following table, but the characters are not in all cases absolute:—

A. *Œcophorinæ.* Antennæ of male ciliated (1 or more).
  1. *Œcophorides.* Vein 7 of forewings to costa.
  2. *Eulechriades.* ,, ,, ,, apex.
  3. *Philobotides.* ,, ,, ,, termen.

B. *Depressarianæ.* Antennæ of male simple or minutely ciliated ($\frac{1}{3}$).
  1. *Depressariades.* Antennæ shorter than forewings.
  2. *Carcinides.* Antennæ as long as forewings.

The following is an ordered list of the Australian genera referable to the *Depressarianæ*:—

1. *Depressariades.*
   Machetis, Meyr.
   Sphyrelata, Meyr.
   Eupselia, Meyr.
   Eutorna, Meyr.
   Heterobathra, Low.
   Heterochyta, Meyr.
   Acolasta, Meyr.
   Leptosaces, Meyr.
   Bida, Walk.
   Thudaca, Walk.
   Enchocrates, Meyr.
   Pedois, Turn.
   Doleromima, Meyr.
   Binsitta, Walk.
   Ceratophysetis, Meyr.
   Ethmia, Hb.
2. *Carcinides.*
   Pholeutis, Meyr.
   Octasphales, Meyr.
   Peritorneuta, Turn.
   Scorpiopsis, Turn.

MACROBATHRA, Meyr.

Macrobathra hexadyas, n. sp.

Male, 12 mm. Head white, with three dark fuscous dots on forehead, and one on each side of crown. Palpi white, second joint with base and a subapical ring dark fuscous, terminal joint dark fuscous, with apex and a subbasal ring white. Antennæ ochreous-whitish ringed with dark fuscous. Thorax white, irregularly irrorated with dark fuscous. Abdomen fuscous. Forewings dark fuscous irrorated with white; markings ochreous-whitish; a moderate fascia from $\frac{1}{4}$ of costa to $\frac{1}{3}$ of dorsum, angulated and partially interrupted in middle; an oblique spot from middle of costa, and a triangular spot on dorsum before tornus, separated by cloudy, round, dark fuscous spot; a spot on costa at $\frac{5}{6}$, and a similar one opposite it on termen: cilia fuscous, ochreous-whitish opposite costal spot, and on a large terminal patch. Hindwings grey, darker towards apex; cilia light ochreous-grey.

Rosewood, Queensland, in September; one specimen. Quite distinct from any other; the form of the first fascia is a marked character.

BORKHAUSENIA, Hb.

Borkhausenia capnodyta, n. sp.

Female, 12-13 mm. Head whitish-ochreous, crown irrorated with dark fuscous. Palpi whitish-ochreous, terminal joint and lower half of second irrorated with blackish. Antennæ fuscous. Thorax fuscous, irrorated with blackish, apical half of patagia whitish-ochreous. Abdomen pale greyish-ochreous, sprinkled with fuscous. Forewings elongate, narrow, costa gently arched, apex pointed, termen extremely obliquely rounded; fuscous, irrorated with blackish; extreme base whitish-ochreous; stigmata large, round, cloudy, blackish, plical slightly beyond first discal, an additional similar spot on tornus; a suffused whitish-ochreous spot on costa at $\frac{3}{4}$, followed by some blackish suffusion: cilia pale fuscous, irrorated with blackish towards base. Hindwings grey, paler towards base; cilia whitish-fuscous.

Duaringa and Brisbane, Queensland, in September: two specimens. Not very near any other; might perhaps be placed next *B. epimicta*.

Borkhausenia asparta, n. sp.

Male, 11-13 mm. Head, palpi, and thorax white, sprinkled with pale fuscous. Antennæ white, ringed with dark fuscous. Abdomen pale fuscous. Forewings elongate, rather narrow, costa moderately arched, apex acute, termen slightly sinuate, extremely oblique; white, costal and dorsal areas irrorated with fuscous, leaving an irregular, broad, clear, central streak; two blackish dots beneath costa towards base, two transversely placed beneath costa before $\frac{1}{3}$, one beneath middle of disc, one towards costa at $\frac{}{5}$, and one in disc at $\frac{2}{3}$: cilia whitish. Hindwings pale grey; cilia ochreous-whitish.

Sydney, New South Wales: Albany, West Australia; in September and October, two specimens. Allied to *B. lagara*.

EULECHRIA, Meyr.

Eulechria textilis, n. sp.

Male, female, 13-17 mm. Head and thorax white, irrorated with dark fuscous. Palpi white, second joint with lower half and a subapical ring irrorated with dark fuscous, terminal joint more or less widely irrorated with dark fuscous towards base and apex. Antennæ white, more or less suffusedly ringed with dark fuscous. Abdomen grey. Forewings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded: white, irrorated with dark fuscous, tending to form longitudinal streaks; a blackish subcostal dash from base of costa; stigmata blackish, linear, plical obliquely beyond first discal, usually discal stigmata connected or absorbed by a fine blackish line, and a similar line along fold from base to plical stigma; some undefined dark fuscous marks before termen and apical portion of costa: cilia whitish, with two distinct lines of dark fuscous irroration. Hindwings with 3 and 4 often stalked or even sometimes coincident, 5 approximated at base to 4 or even connate: grey, lighter towards base; cilia light grey.

Sydney, Bathurst, Murrurundi, and Glen Innes (4,500 feet), New South Wales; Campbelltown, Tasmania; in November and December, ten specimens. This obscure, narrow-winged species of the *siccella* group is curious on account of the variable neuration of hindwings; but since some specimens are quite normal, it cannot be generically separated, and the resulting enlargement of characters does not affect my tabulation or render the genus less distinct.

PTOCHOSARIS, n. g.

Head with loosely appressed hairs; tongue developed. Antennæ $\frac{3}{4}$, in male moderately ciliated (1), basal joint moderate, without pecten. Labial palpi moderately long, slightly curved, subascending, second joint with loose, rough, projecting tuft of scales towards apex beneath, terminal joint less than half second, slender, acute. Posterior tibiæ clothed with long hairs above. Forewings with 2 from angle, abruptly curved, 3 absent, 4 approximated, 7 and 8 stalked, 7 to termen, 11 from middle. Hindwings $\frac{3}{4}$, ovate-lanceolate, cilia 2; 4 absent, 5 somewhat approximated to 3, 6 and 7 parallel.

Allied to *Saropla*, of which it is a degraded development, with similar palpi, but differing in the reduced neuration, and absence of basal pecten of antennæ.

Ptochosaris horrenda, n. sp.

Male, 10-11 mm. Head, palpi, antennæ, thorax, and abdomen fuscous, mixed with whitish. Forewings broad-lanceolate, acute: fuscous mixed with whitish. Hindwings grey.

Blackheath, New South Wales; Mount Lofty, South Australia; in October, two specimens. This is a most obscure and insignificant-looking insect.

ÆOLOCOSMA, Meyr.

This genus must certainly be transferred to the *Œcophoridæ*, and will equally certainly be placed amongst the *Philobotides*, but its exact position in that group is not so obvious. On a strict interpretation of structure, it appears to be nearest to *Oxythecta*, and it may be placed in the neighbourhood of that genus until more profound research or the discovery of new material discloses its true affinity. To the two species originally described I now add a third, but as it is closely related to one of them it does not help the situation.

Æolocosma cycloxantha, n. sp

Male, 8-9 mm. Head and thorax dark fuscous more or less mixed with ochreous-whitish. Palpi dark fuscous, second joint mixed with white. Antennæ blackish, obscurely spotted with white. Abdomen dark grey. Forewings elongate, costa moderately arched, apex round-pointed, termen extremely obliquely rounded; whitish, closely irrorated with dark fuscous, veins posteriorly lined with white; two light orange, dark-edged fasciæ enclosing a slender, direct, silvery-white median fascia, first narrow, even, second narrow on dorsum, widened throughout to costa, enclosing silvery-white discal and costal spots; a light orange line along lower part of termen: cilia fuscous, on termen with a strong black basal band, narrowed upwards, enclosing about five silvery-white dots. Hindwings rather dark grey; cilia grey.

Albany, West Australia, from September to December; five specimens. Very similar to *A. iridozona*, but the posterior simple V-shaped fascia of that species is replaced by a more complex marking.

EUPSELIA, Meyr.

This genus is distinguished from all others in this group known to me by the unusually short and weak labial palpi; the absence of vein 8 in the forewings is a frequent character in this group, whilst in the other section of the *Œcophoridæ* it is exceedingly rare, the single species of *Atelosticha* being the only known example.

Eupselia leucaspis, n. sp.

Male, female, 13-16 mm. Head ochreous-yellow, centrally whitish-tinged. Palpi whitish-yellow, second joint slightly sprinkled with fuscous. Antennæ dark fuscous. Thorax dark fuscous, apical half of patagia and posterior margin ochreous-white. Abdomen fuscous. Forewings elongate, slightly dilated posteriorly, costa moderately arched, apex obtuse, termen obliquely rounded; dark fuscous; an ochreous-white patch occupying basal $\frac{2}{5}$ except a costal streak; an ochreous-white fascia beyond middle, on lower half narrowed and bisected by a dark fuscous line or partially obscured with purplish; on each side of this fascia an obscure deep purple line, becoming obsolete towards costa; terminal area divided into two patches, very finely strigulated with whitish, anterior longitudinally, posterior transversely; a small whitish costal spot before apex, from which a dark fuscous line runs obliquely to termen beneath apex: cilia dark fuscous, round apex with a coppery-purple basal line, beneath apex with a coppery-purple sometimes black-centred basal dot, on lower half of termen with three small round black spots edged anteriorly with whitish and posteriorly with deep purple, separated by black interspaces. Hindwings ochreous-yellow; an irregular dorsal fascia of dark fuscous suffusion; a variable dark fuscous terminal fascia, sometimes broad at apex, sometimes very narrow, not reaching tornus: cilia fuscous, with dark fuscous basal line.

Quorn, South Australia; York, West Australia; in October and November; ten specimens. *E. philomorpha*, Low., must be near this, but I think distinct if the description is accurate; I have not seen a specimen.

Eupselia trithrona, n. sp.

Female, 15 mm. Head pale ochreous-yellowish. Palpi whitish-yellowish, towards base sprinkled with fuscous. Antennæ dark fuscous. Thorax dark purplish-fuscous, with anterior and posterior ochreous-whitish spots. Abdomen fuscous, mixed with whitish-ochreous. Forewings rather broad, costa rather strongly and unevenly arched, apex obtuse, termen nearly straight, rather strongly oblique: dark purple-bronzy-fuscous; a broad ochreous-white fascia from dorsum about $\frac{1}{3}$, rather narrowed upwards and not reaching costa; a moderate ochreous-white fascia beyond middle, narrowed and rather broadly interrupted in disc: cilia ochreous-whitish, mixed with dark fuscous, with dark fuscous subbasal line (imperfect). Hindwings light ochreous-yellow; large apical and small tornal patches of dark fuscous suffusion; cilia fuscous.

Sydney, New South Wales, in November; one specimen. In the species of this genus with yellow hindwings the extent of the dark fuscous margin is found to be extremely variable (apparently without reference to sex or locality) wherever sufficient material has been obtained, and it will therefore be reasonable to anticipate similar variability in such species as the present.

Eupselia hypsichora, n. sp.

Male, female, 12-13 mm. Head and antennæ dark fuscous. Palpi ochreous-whitish, mixed with blackish-fuscous. Thorax dark fuscous, with large ochreous-yellow patches on shoulders. Abdomen dark fuscous at base or sometimes more or less wholly suffused with ochreous-yellow. Forewings rather broad, costa rather strongly and unevenly arched, apex obtuse, termen obliquely rounded: dark fuscous, slightly purplish-tinged: a broad ochreous-yellow fascia from middle of costa, where it includes a dark fuscous dot, to dorsum, where it extends from $\frac{1}{3}$ to near tornus, narrowed upwards, edges slightly curved inwards: cilia dark fuscous. Hindwings dark fuscous, basal half sometimes more or less wholly suffused with ochreous-yellow; cilia fuscous, with dark fuscous basal line.

York, West Australia, in November; nine specimens, flying high around *Eucalyptus* in the afternoon sunshine. A specimen from Victoria, similar but larger (15 mm.), has basal area of forewings suffusedly mixed with yellow-whitish, and a whitish costal mark before apex; I am uncertain whether it is a distinct species or only a geographical form, but probably it will prove to be the latter.

Eupselia carpocapsella, Walk.

Dr. A. J. Turner has satisfactorily ascertained that *beatella*, Walk., is only a synonym of this, the species being variable.

Eupselia holoxantha, Low.

I have this species, which is a good and distinct one, from Mount Lofty, South Australia (Guest), and also from Victoria (Raynor).

EUTORNA, Meyr.

Head with appressed scales, sidetufts projecting over forehead; tongue developed. Antennæ $\frac{4}{5}$, in male serrate, minutely ciliated ($\frac{1}{4}$-$\frac{1}{3}$), basal joint moderately long, without pecten. Labial palpi long, curved, ascending, second joint thickened with dense appressed scales, sometimes roughly expanded towards apex above or with spreading apical tuft beneath, terminal joint as long as second or shorter, slender, acute. Forewings with 1b simple at base (upper fork obsolete), 2 from near angle, 6 to apex, 7 and 8 stalked, 7 to costa, 11 from before middle. Hindwings 1 or almost 1, elongate-ovate or broadly-lanceolate, cilia $1\frac{1}{5}$-2: 3 and 4 connate or approximated, 5 bent, 6 and 7 parallel, 6 to apex.

The variation in the scaling of the palpi of this genus is singular; I have no doubt that the various forms are all rightly included in the genus, which is well characterised by other structure, and has a peculiar and easily recognised facies; the species are, in fact, often so similar that the structure of the palpi affords the readiest specific distinction. There are two New Zealand species (on which the genus was founded) very similar and closely allied to the Australian, but not identical; and I now add ten Australian species:—

1. Second joint of palpi tufted beneath	2.
Second joint of palpi not tufted beneath	3.
2. Forewings with median white streak continued to apex	*leptographa.*
Forewings with median white streak not passing $\frac{2}{5}$	*intonsa.*

3. Forewings with one or more oblique streaks from costa .... 4.
   Forewings without oblique costal streaks .... 7.
4. Palpi with scales of second joint roughly expanded above .... 5.
   Palpi with scales of second joint appressed .... *spintherias*
5. Oblique costal lines white .... 6.
   Oblique costal lines formed by black scales only .... *pabulicola.*
6. Median white streak continued to apex .... *eurygramma.*
   Median white streak not passing $\frac{2}{5}$... *tricasis.*
7. Forewings streaked with whitish on veins .... *diaula.*
   Forewings not streaked on veins...... 8.
8. Terminal joint of palpi with dark fuscous submedian band .... *epicnephes.*
   Terminal joint of palpi without submedian band .... 9.
9. Terminal joint of palpi nearly as long as second .... *pelogenes.*
   Terminal joint of palpi little more than half second .... *phaulocosma.*

Eutorna leptographa, n. sp.

Male, female, 12-13 mm. Head whitish, mixed with pale brownish. Palpi with second joint ochreous-fuscous, white at base and apex, with long rough projecting tuft of scales beneath, terminal joint as long as second, whitish, anterior edge dark fuscous. Antennæ grey, suffused with white above. Thorax light ochreous-fuscous, partially suffused with whitish. Abdomen grey, sides and apex ochreous-whitish. Forewings elongate, rather narrow, costa moderately arched, apex round-pointed, termen extremely obliquely rounded; brownish-ochreous irrorated with fuscous, with a few dark fuscous scales; a white median longitudinal streak from base to apex, posteriorly sometimes suffused with whitish-ochreous, edged beneath by a blackish streak from near base to and a black dot at $\frac{2}{3}$, and above by a blackish streak from $\frac{1}{3}$ to $\frac{2}{3}$; a fine white streak, posteriorly blackish-edged, from $\frac{1}{4}$ of costa to median streak at $\frac{2}{3}$, produced along costa towards base, and an oblique white anteriorly black-edged streak from $\frac{2}{3}$ of costa towards apex, not reaching median streak, costal edge between these suffused with white: costa and termen towards apex suffused with black, except an apical white space: cilia whitish-ochreous, with two dark fuscous lines becoming obsolete towards tornus, round apex white between these. Hindwings $\frac{2}{3}$, cilia 2; 3 and 4 connate; grey, lighter towards base; cilia whitish-grey-ochreous, round apex paler with two faint grey shades.

Launceston and Campbelltown, Tasmania, in December and January; four specimens.

Eutorna intonsa, n. sp.

Male, female, 11-14 mm. Head and thorax brownish-ochreous, face whitish-ochreous. Palpi brownish-ochreous irrorated with fuscous, second joint with apex white, beneath with long rough triangular apical projecting tuft of scales, terminal joint whitish. Antennæ whitish, ringed with dark fuscous. Abdomen whitish-ochreous suffused with grey. Forewings elongate, narrow, costa moderately arched, apex round-pointed, termen very obliquely rounded; ferruginous-ochreous, more or less suffusedly mixed with fuscous and whitish, leaving an undefined median longitudinal streak of clear ground colour; a slender median white streak from base to $\frac{2}{5}$, edged beneath except at base by a blackish streak, and sometimes extended but without black edging to discal dot; a slender white oblique streak, edged above with dark fuscous, from $\frac{1}{3}$ of costa to upper extremity of a transverse white mark in disc at $\frac{2}{3}$, terminated beneath by an irregular black dot; an oblique white streak, edged anteriorly with dark fuscous, from before $\frac{3}{4}$ of costa, not reaching half across wing; some whitish suffusion towards apex; several irregular blackish marks on apical portion of costa and termen: cilia whitish-ochreous, with two ochreous-fuscous lines becoming dark fuscous on costa, obsolete towards tornus. Hindwings under 1, cilia $1\frac{1}{2}$; 3 and 4 connate: grey, paler towards base; cilia pale ochreous-grey, above apex with two darker shades.

Sydney and Bulli, New South Wales; Melbourne, Gisborne, Healesville, and Sale. Victoria; Campbelltown, Tasmania: from August to December, and in March, a common species.

Eutorna tricasis, n. sp.

Male, female, 12-16 mm. Head and thorax light reddish-ochreous, face whitish. Palpi whitish-ochreous, second joint long, becoming deeper ochreous towards apex, above with hairs roughly expanded towards apex, terminal joint half second. Antennæ whitish-ochreous ringed with dark fuscous. Abdomen whitish-ochreous. Forewings elongate, narrow, costa moderately arched, apex round-pointed, termen extremely obliquely rounded: bright ferruginous-ochreous, sometimes tinged with brown towards middle of costa: costal edge whitish towards base; a slender whitish median longitudinal streak from base to $\frac{2}{5}$, edged beneath with blackish except towards base: a fine whitish oblique streak, edged above with some black scales, from $\frac{1}{3}$ of costa to upper of two black whitish-circled dots placed transversely in disc at $\frac{2}{3}$; a fine oblique whitish anteriorly blackish-edged streak from before $\frac{3}{4}$ of costa, not reaching half across wing; a short white streak from apex beneath costa: several undefined black marks on apical portion of costa and termen: cilia ochreous-whitish, with two well-marked ochreous-fuscous shades becoming obsolete towards tornus. Hindwings under 1, cilia $1\frac{1}{2}$; 3 and 4 approximated: grey, lighter towards base: cilia whitish-ochreous-grey.

Brisbane and Toowoomba, Queensland; Murrurundi, Sydney, and Bathurst, New South Wales; Gisborne, Victoria; from September to December, ten specimens.

Eutorna eurygramma, n. sp.

Male, female, 14-16 mm. Head and thorax brownish-ochreous, somewhat whitish-mixed, face whitish-ochreous, patagia white. Palpi with second joint long, ochreous, deeper towards apex, densely scaled, hairs expanded above towards apex, terminal joint somewhat more than half second, whitish, anterior edge dark fuscous. Antennæ in male grey, in female whitish ringed with dark grey. Abdomen whitish-ochreous. Forewings elongate, narrow, costa moderately arched, apex round-pointed, termen extremely obliquely rounded; bright ochreous-brown; a median longitudinal white streak from base to apex, broadest anteriorly, edged beneath by dark brown or dark fuscous suffusion from near base to $\frac{2}{3}$, where it is nearly interrupted by a dark fuscous dot from beneath, then dilated into a small transverse spot, between this and an apical spot more or less suffused with ochreous and indistinct; a fine white partly black-edged sometimes posteriorly incomplete line from $\frac{2}{3}$ of costa beneath costa to apex: an undefined suffusion of blackish and white scales on termen: cilia ochreous, paler towards tornus, with two dark fuscous lines becoming obsolete towards tornus, between these white round apex. Hindwings under 1, cilia $1\frac{1}{2}$; 3 and 4 connate: grey, paler or whitish-grey anteriorly; cilia light grey.

Mount Kosciusko (6,000 feet), New South Wales; Gisborne, Victoria; also from Tasmania; in January and February, four specimens.

Eutorna pabulicola, n. sp.

Male, female, 13-15 mm. Head whitish-ochreous. Palpi with second joint ochreous, more or less infuscated, white at apex, with hairs roughly expanded above towards apex, terminal joint somewhat more than half second, white, tip fuscous. Antennæ greyish-ochreous, becoming whitish-ochreous towards base. Thorax pale brownish-ochreous. Abdomen whitish-ochreous. Forewings elongate, rather narrow, costa moderately arched, apex obtuse, termen extremely obliquely rounded; light brownish-ochreous, more or less sprinkled with fuscous or dark fuscous, veins more or less streaked with white, especially posteriorly; a fine undefined line of blackish scales on submedian fold from base to about middle, including well-marked black plical stigma; oblique lines of blackish scales from costa at $\frac{1}{3}$ and before $\frac{3}{4}$, not reaching middle, sometimes hardly traceable; second discal stigma black edged with white; some suffused black marks on apical portion of costa and termen except at apex: cilia whitish-ochreous, with two ochreous-brown lines becoming obsolete towards tornus, between these whitish round apex. Hindwings under 1, cilia $1\frac{1}{2}$; 3 and 4 separate; pale grey; cilia whitish-ochreous.

Brisbane, Queensland, common in September; Sydney, New South Wales, in June, July, January, and March; ten specimens.

Eutorna spintherias, n. sp.

Male, female, 10-12 mm. Head and thorax ferruginous-ochreous, face whitish-ochreous. Palpi with second joint ochreous, more whitish towards base, thickened with appressed scales, terminal joint rather shorter than second, whitish, anterior edge dark fuscous. Antennæ whitish, ringed with dark grey. Abdomen dark grey, apex whitish. Forewings elongate, rather narrow, costa moderately arched, apex round-pointed, termen very obliquely rounded; ferruginous-ochreous, in male suffused with brown posteriorly except on a median streak, in female wholly suffused with dark brown on posterior half; markings in male silvery-white, partly edged with blackish, in female bright silvery-metallic, suffusedly edged with dark fuscous; a median longitudinal streak from base to middle, in male edged beneath by a blackish-fuscous streak from near base to beyond middle; a slender oblique streak from costa before middle to $\frac{3}{5}$ of disc, in female continued along costa to base; a transverse-oval spot in disc at $\frac{2}{3}$; a subtriangular spot on costa before $\frac{3}{4}$; an irregular suffused apical spot: cilia light fuscous, with two dark fuscous lines becoming obsolete towards tornus, round apex white between these and ochreous-tinged at base. Hindwings under 1, cilia $1\frac{1}{2}$; 3 and 4 connate or approximated: grey, becoming darker posteriorly; cilia grey.

Healesville and Gisborne, Victoria; Deloraine, Tasmania; in November and December, eleven specimens. The difference in the sexes is curious, and at present appears quite unintelligible.

Eutorna diaula, n. sp.

Male, female, 13-14 mm. Head whitish-ochreous, side-tufts sometimes brownish. Palpi ochreous-whitish, second joint thickened with appressed scales, irrorated with fuscous, terminal joint $\frac{2}{3}$ of second. Antennæ pale ochreous ringed with fuscous. Thorax whitish-ochreous tinged with brownish. Abdomen whitish-ochreous, sometimes sprinkled with fuscous. Forewings elongate, narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; ochreous-whitish, densely irrorated with brown and dark fuscous except on veins, which appear as whitish lines; a fine line of blackish scales in submedian fold from base to plical stigma; stigmata small, blackish, plical slightly beyond first discal; some black scales towards apical part of costa and termen except at apex: cilia ochreous-whitish with two blackish-fuscous lines, becoming pale fuscous towards tornus. Hindwings under 1, cilia $1\frac{1}{2}$; 3 and 4 connate; grey, becoming paler towards base: cilia whitish-grey-ochreous, round apex more whitish, with two fuscous shades.

Casterton, Victoria; Launceston, Campbelltown, and George's Bay, Tasmania; from November to January, five specimens. I found the species commonly in Tasmania, but at the time supposed it to be only *pabulicola*, to which it is very similar.

Eutorna phaulocosma, n. sp.

Male, female, 15-16 mm. Head and thorax fuscous, finely sprinkled with whitish. Palpi fuscous, irrorated with dark fuscous, second joint thickened with appressed scales, slightly expanded towards apex above, terminal joint somewhat more than half second, whitish, apex fuscous. Antennæ fuscous, obscurely paler-ringed. Abdomen whitish-ochreous. Forewings elongate, rather narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; fuscous, with a few dark fuscous scales; stigmata dark fuscous, plical directly beneath first discal; some undefined dark fuscous dots on apical portion of costa and termen: cilia fuscous finely sprinkled with ochreous-whitish, becoming ochreous-whitish towards tornus. Hindwings under 1, cilia 1; 3 and 4 connate; pale grey; cilia whitish-grey-ochreous.

Mount Wellington, Tasmania, in January; three specimens.

Eutorna pelogenes, n. sp.

Male, 12-14 mm. Head and thorax whitish-fuscous. Palpi whitish, second joint irrorated with dark fuscous except apex, thickened with loosely appressed scales, terminal joint rather shorter than second. Antennæ pale greyish-ochreous, ringed with dark fuscous. Abdomen fuscous, apex whitish-ochreous. Forewings elongate, costa moderately arched, apex rounded-obtuse, termen obliquely rounded; whitish-fuscous, sprinkled with fuscous and dark fuscous; a blackish dot beneath costa near base; stigmata small, blackish, plical slightly beyond first discal, an additional dot beneath second discal; a row of undefined blackish dots round apex and termen: cilia whitish-fuscous, sprinkled with whitish, with two rather dark fuscous lines becoming obsolete towards tornus. Hindwings under 1, cilia $\frac{4}{5}$; 3 and 4 connate; grey, lighter towards base; cilia grey-whitish, with two faint grey shades round apex.

Healesville, Victoria, in November; three specimens.

Eutorna epicnephes, n. sp.

Male, female, 12-15 mm. Head and thorax dark reddish-fuscous finely sprinkled with whitish. Palpi ochreous-whitish irrorated with dark fuscous, scales of second joint roughly expanded above towards apex, terminal joint $\frac{2}{3}$ of second, pale yellowish, with dark fuscous apical and submedian bands. Antennæ whitish-ochreous ringed with dark fuscous. Abdomen light fuscous. Forewings elongate, rather narrow, costa moderately arched, apex round-pointed, termen very obliquely rounded; brown, irrorated with dark fuscous; a blackish dot beneath costa near base preceded by some whitish-ochreous scales; stigmata very obscure, dark fuscous; plical rather obliquely beyond first discal; some spots of dark fuscous suffusion on apical part of costa and termen: cilia fuscous, with a dark fuscous postmedian line. Hindwings $\frac{4}{5}$, cilia 1; 3 and 4 connate; fuscous, becoming whitish-fuscous towards base, darker towards apex; cilia fuscous, with a darker patch above apex.

Brisbane, Queensland; Sydney, New South Wales; Warragul, Victoria; in September and October, three specimens. Larva mines a flat blotch in leaves of *Pomaderris elliptica*, later emerging and feeding openly, in September. Pupa naked, rather stout, attached beneath a leaf by tail.

HETEROBATHRA, Low.

Head with appressed hairs, sidetufts spreading; tongue developed. Antennæ $\frac{4}{5}$, in male serrulate, simple, basal joint moderate without pecten. Labial palpi moderately long, curved, ascending, second joint reaching base of antennæ, thickened with dense appressed scales, terminal joint less than half second, slender, acute. Forewings with 2 from $\frac{5}{6}$, 3, 4, 5 approximated, 7 and 8 stalked, 7 to apex. Hindwings 1, elongate-ovate, cilia $\frac{3}{4}$; 3 and 4 connate, 5 rather approximated, 6 and 7 parallel.

This is a good genus, allied to *Eupselia*, though very different in appearance, and characterised by the peculiar palpi. Mr. Lower has kindly sent me examples of his *xiphosema* and *bimacula;* the following species is nearly related, especially to the latter species, but distinct.

Heterobathra tetracentra, n. sp.

Male, 18 mm. Head pale fuscous. Palpi dark fuscous, white towards base beneath. Antennæ fuscous. Thorax whitish-fuscous, irrorated with dark fuscous. Abdomen whitish-grey-ochreous, sprinkled with fuscous. Forewings elongate, costa strongly arched, apex obtuse, termen obliquely rounded; whitish-fuscous densely irrorated with dark fuscous; rather large roundish spots of dark fuscous suffusion in disc at $\frac{2}{5}$ and $\frac{2}{3}$; a patch beneath middle of disc between these appearing pale through obsolescence of dark fuscous irroration: cilia whitish-fuscous, with irregular subbasal fuscous line. Hindwings fuscous; cilia as in forewings.

Geraldton, West Australia, in November; one specimen.

HETEROCHYTA, n. g.

Head with appressed hairs, sidetufts projecting between antennæ; tongue developed. Antennæ $\frac{3}{4}$, in male minutely ciliated ($\frac{1}{3}$), basal joint moderately elongate, without pecten. Labial palpi very long, straight, porrected, second joint clothed with dense rough projecting hairscales above and beneath, terminal joint $\frac{1}{4}$-$\frac{1}{2}$ of second, moderate, acute or tolerably pointed. Forewings with 2 from $\frac{3}{4}$-$\frac{5}{6}$, 3 from angle, 7 and 8 stalked, 7 to apex. Hindwings 1, elongate-ovate, cilia $\frac{1}{2}$; 3 and 4 connate, 5, 6, 7 parallel.

Type *H. xenomorpha.* Nearly allied to the preceding genus, but the palpi are peculiar and characteristic, approaching those of *Pleurota.* The three species are readily separated by the colour of the stigmata and proportions of the palpi: —

Stigmata blackish	*xenomorpha.*
Stigmata pale reddish-ochreous	*pyrosema.*
Stigmata white	*asteropa.*

Heterochyta xenomorpha, n. sp.

Male, 19 mm. Head and thorax fuscous-whitish, shoulders greyer. Palpi 6, dark fuscous finely sprinkled with whitish, white beneath, terminal joint $\frac{1}{4}$, acute. Antennæ white ringed with fuscous. Abdomen pale fuscous mixed with whitish. Forewings elongate, moderate, costa strongly arched, apex obtuse, termen nearly straight, rather strongly oblique; 2 from $\frac{4}{5}$; fuscous very finely sprinkled with whitish points, with a very few scattered black specks; stigmata small, blackish, plical obliquely before first discal, second discal transversely double: cilia pale fuscous. Hindwings light fuscous; cilia whitish, towards base mixed with fuscous.

Perth, West Australia, in October; one specimen.

Heterochyta asteropa, n. sp.

Female, 33 mm. Head, palpi, and thorax fuscous very finely irrorated with whitish; palpi 6, terminal joint $\frac{1}{3}$, loosely scaled, tolerably pointed. Antennæ whitish ringed with fuscous. Abdomen elongate, fuscous mixed with paler. Forewings elongate, rather narrow, costa moderately arched, apex round-pointed, termen nearly straight, rather strongly oblique; 2 from $\frac{3}{4}$; fuscous, very finely sprinkled with whitish points, with some scattered whitish scales; discal stigmata ochreous-white: cilia fuscous mixed with whitish. Hindwings pale grey; cilia whitish, with pale grey median shade.

Sydney, New South Wales; Mount Lofty, South Australia; in August and September, two specimens.

Heterochyta pyrosema, Low.

(*Pleurota pyrosema*, Low, Proc. Linn. Soc. N.S.W., 1899, 109.)

Female, 31 mm. Very like *asteropa*, but palpi much shorter (4), second joint relatively much shorter and more broadly scaled, terminal joint half second, slender, acute; forewings with apex more obtuse, termen less oblique, 2 from $\frac{5}{6}$, 7 and 8 longer-stalked, discal stigmata pale reddish-ochreous; hindwings and cilia fuscous.

One specimen received from Mr. Lower.

Bida, Walk.

Head with appressed scales; tongue developed. Antennæ $\frac{3}{4}$, in male serrulate, minutely ciliated ($\frac{1}{3}$), basal joint moderate, without pecten. Labial palpi extremely long, recurved, second joint much exceeding base of antennæ, rough-scaled beneath, terminal joint as long as second, somewhat thickened with scales towards base, acute. Forewings with 2 from $\frac{4}{5}$, 7 and 8 stalked, 7 to apex, 11 from before middle. Hindwings 1, elongate-ovate, cilia $\frac{1}{3}$; 3 and 4 connate, 5-7 nearly parallel.

Allied to *Acolasta* and *Phaeosaces*, but differing from both in the rough scales of second joint of palpi, which are also exceptionally long.

Bida radiosella, Walk.

(*Psecadia radiosella*, Walk., Tin. 539; *Bida crambella*, ib. 824.)

Male, female, 23-29 mm. Head white. Palpi white, lower half of second and terminal joints fuscous. Antennæ fuscous. Thorax white, shoulders, inner edge of patagia, and two posterior marks fuscous. Abdomen whitish, with dorsal series of ferruginous patches. Forewings elongate, narrowed anteriorly, costa moderately arched, apex round-pointed, termen slightly sinuate, oblique; white; all veins marked with fine fuscous lines mixed posteriorly with blackish; three pale fuscous longitudinal streaks, first from base beneath costa to costa beyond middle, extending along it to near apex, second median, from base to apex, united with first at base, finely edged with dark fuscous beneath on basal third, and above from $\frac{1}{5}$ to $\frac{3}{5}$, third less marked, subdorsal, from near base to near tornus; indications of faint pale fuscous streaks between veins towards tornus: cilia white, with two light fuscous lines. Hindwings whitish-grey: cilia whitish, with two faint fuscous lines.

Blackheath, New South Wales; Melbourne, Victoria; Mount Lofty, South Australia; in November, three specimens.

Thudaca, Walk.

On account of the scales of the crown being drawn up into a raised tuft I formerly classed this genus with the *Tineidæ*, but am now satisfied that its real position is here; the neuration is typically *Œcophorid*, and the tendency to a raised tuft is found in some of the allied genera, such as *Pedois;* the peculiar pupa, as noted above, is also clear evidence. I described thirteen species, and no new ones have since been discovered.

Ethmia, Hb.

This name must be used instead of *Psecadia*, Hb. The Australian species referred to by Dr. Turner and myself as *hilarella*, Walk., is not the true *hilarella*, but must be known as *exhilarella*, Durr.; the two species are extremely similar in the female sex, but very different in the male; the true *hilarella* is a larger species, and the male has the hindwings mostly black, and clothed with rough hairs on the lower surface.

Pholeutis, n. g.

Head with appressed hairs; tongue developed. Antennæ 1, in male simple, basal joint moderate, without pecten. Labial palpi moderate, curved, ascending, second joint with appressed scales, not reaching base of antennæ, terminal joint shorter than second, acute. Posterior tibiæ clothed with long hairs. Forewings with 1b furcate, 2 from $\frac{4}{5}$, 7 to costa, 8 absent, 11 from middle. Hindwings under 1, elongate-ovate, cilia 1; 3 and 4 connate, 5-7 parallel.

Apparently somewhat intermediate between *Peritorneuta* and the group of *Pseudodoxia*, characteristic of the Indian region.

Pholeutis neolecta, n. sp.

Male, female, 10-12 mm. Head and thorax ochreous-brown. Palpi whitish-ochreous. Antennæ fuscous. Abdomen grey. Legs brownish-ochreous, anterior and middle tibiæ and tarsi white, tarsi spotted with dark fuscous. Forewings elongate, costa moderately arched, apex round-pointed, termen very obliquely rounded; ochreous-brown, thinly sprinkled with blackish; second discal stigma blackish, sometimes connected with tornus by a more or less defined direct fuscous or blackish bar, but this is sometimes wholly absent: cilia brownish-ochreous. Hindwings grey; cilia light greyish-ochreous.

Healesville, Victoria, in December: seven specimens. Though at first sight inconspicuous, this is a singular little insect; the colouring of the legs is quite exceptional.

SCORPIOPSIS, Turn.

This name appears to supersede *Cerycostola*, Meyr.; and I believe that *superba*, Turn., is a synonym of *pyrobola*, Meyr., the synonymy being as follows:—

Scorpiopsis pyrobola, Meyr.

(*Gonionota pyrobola*, Meyr., Proc. Linn. Soc. N.S. Wales, 1886, 1041; *Scorpiopsis superba*, Turn., Trans. Roy. Soc. S. Austr., 1894, 133; *Cerycostola pyrobola*, Meyr., Trans. Roy. Soc., S. Austr., 1902, 163.)

STENOMIDÆ.

I propose to constitute this a distinct family. It agrees in the main characters with the *Xyloryctidæ*, but differs in having veins 7 and 8 of the forewings separate. To this family I refer the genus *Agriophara*, now containing about twenty species; this is the only Australian genus at present known to me, but the New Zealand genus *Hypeuryntis* also belongs here. The family is very extensively represented in South America, which appears to be its home.

COPROMORPHIDÆ.

I have recently defined this family, which consists at present of only a few species, occurring in India, Australia, Africa, and the South Pacific islands. They are broad-winged insects, distinguishable from all other *Tineina* by the possession of a basal pecten of hairs on lower margin of cell in hindwings, such as is characteristic also of the *Epiblemidæ* amongst the *Tortricina*: from the *Epiblemidæ* themselves they are easily distinguished by the smooth head and falciform palpi:—

Forewings with 7 and 8 stalked .... *Hypertropha*.
,, ,, ,, separate .... *Copromorpha*.

HYPERTROPHA, Meyr.

I have described two species of this genus, and Dr. Turner has added a third, which I have not seen; two more are now given. The broad-winged *tortriciformis*, with transverse rows of raised metallic spots, is nearest in character to *Copromorpha*, and therefore probably earliest.

Hypertropha zophodesma, n. sp.

Male, 16 mm. Head and thorax dark fuscous finely sprinkled with whitish. Palpi whitish irrorated with dark fuscous. Antennæ fuscous. Abdomen bronzy-fuscous. Forewings moderate, costa moderately arched, apex round-pointed, termen concave, oblique; dark fuscous finely irrorated with whitish, partially slightly pinkish-tinged; an indistinct spot of white suffusion in disc before middle; a broad suffused blackish-fuscous fascia from $\frac{2}{3}$ of costa to tornus: cilia dark fuscous. Hindwings ochreous-yellow; a narrow rather dark fuscous fascia along termen throughout, becoming broader along dorsum; cilia pale fuscous, with darker basal line.

Victoria; one specimen, without further particulars (Raynor).

Hypertropha rhothias, n. sp.

Female, 16 mm. Head white. Palpi white, second joint sprinkled with dark fuscous except towards apex. Antennæ white, ringed with dark fuscous. Thorax white, somewhat sprinkled with fuscous. Forewings elongate, somewhat dilated, costa moderately arched, apex obtuse, termen slightly sinuate, oblique; blackish-fuscous, all scales narrowly tipped with white; a white basal patch extending on dorsum to near middle, and on costa to beyond middle, costal edge and five direct costal strigulæ fuscous; beyond this a bright ferruginous dorsal mark, followed by two series of raised purplish-golden-metallic spots terminated above by oblique edge of basal patch; a transverse white dorsal spot before tornus, narrowed upwards; two posterior transverse series of raised purplish-golden-metallic spots, first straight, not reaching costa, second curved outwards in middle, between these a suffused blackish discal patch; a triangular orange-ferruginous costal spot before apex, cut by a white oblique line from costa to termen beneath apex: cilia purplish-fuscous with rows of blackish points, with a subapical patch and bar below middle of termen white, and three small black basal spots on lower half of termen, separated by white interspaces, and followed by a deep purple line. Hindwings dark fuscous; a little ochreous-yellow suffusion towards termen below middle; cilia fuscous, with dark fuscous basal line, tips yellowish.

Sydney, New South Wales, in November; one specimen (Raynor). This may be regarded as intermediate between *tortriciformis* and *chlænota*, though narrower-winged than either.

Hypertropha tortriciformis, Gn.

Additional localities for this species are Murrurundi, Bathurst, and Tenterfield, New South Wales; Gisborne, Victoria; Quorn, Port Lincoln, and Mount Lofty, South Australia; and in Tasmania; from October to March.

Hypertropha chlænota, Meyr.

Also taken at Northampton, West Australia, in November.

Copromorpha, Meyr.

Antennæ in male unipectinated or lamellate-dentate. Labial palpi curved, ascending, second joint much thickened with dense rather rough scales, terminal joint shorter than second, rather stout, pointed. Forewings with tufts of scales on surface; 7 to termen, 7, 8, 9 approximated at base, or 8 and 9 sometimes stalked. Hindwings over 1, irregular-ovate; 3 and 4 separate or connate or short-stalked, 6 and 7 parallel.

The variation in the structure of antennæ and neuration is only specific.

Copromorpha prasinochroa, n. sp.

Male, 22-24 mm. Head and thorax ochreous-whitish mixed with light green, thorax anteriorly spotted with blackish. Palpi whitish mixed with pale greenish, hairs of second joint expanded towards apex above, terminal joint rather shorter than second, ochreous-whitish, with fuscous supramedian band. Antennæ lamellate, pale ochreous, basal joint whitish-ochreous. Abdomen pale ochreous sprinkled with fuscous. Forewings elongate, posteriorly dilated, costa moderately arched, apex obtuse, termen somewhat oblique, slightly rounded; 2 from $\frac{5}{6}$, 3, 4, 5 closely approximated at base, 8 and 9 stalked; light yellowish-green; costa irregularly strigulated with blackish; some small scattered transverse raised tufts, blackish anteriorly, ochreous-whitish posteriorly, especially in disc and along vein 1b; a larger similar transverse tuft in disc at $\frac{1}{3}$, produced anteriorly into an elongate blackish spot; two tufts transversely placed in disc at $\frac{3}{5}$, and two larger tufts beyond these but wider apart; subterminal and præterminal series of blackish dots, and an irregular blackish spot between these above middle: cilia light green, tips whitish. Hindwings with 3 and 4 connate; light grey; cilia pale greyish-ochreous, tips whitish.

Sydney, New South Wales; a specimen received from Mr. Geo. Masters, who had several, and informed me that it occurred in caves by the seashore, and I also have one taken by Mr. Lower, but never met with it myself. It is the only green species of the genus.

ELACHISTIDÆ.

Stagmatophora, HS.

This name must be used instead of *Pyroderces;* Mr. J. H. Durrant informs me that though both names were published in the same year, *Stagmatophora* has the priority.

Stagmatophora symbolias, n. sp.

Female, 15 mm. Head ochreous-brown, face more ochreous, a white spot on each side of forehead. Palpi very long and slender, second joint pale ochreous, terminal joint longer than second, white, anterior edge dark fuscous. Antennæ white ringed with dark fuscous. Thorax brown, with two posterior white marks and a fine white line on each side of back. Abdomen yellow-ochreous. Forewings very narrow, widest near base, apex caudate, acute; 5, 7, 8, 9 out of 6: deep ochreous; four very fine white black-edged longitudinal lines, first almost costal, from near base to $\frac{2}{3}$; second from beneath base of costa, gradually curved downwards to disc beyond $\frac{1}{4}$, third in disc from $\frac{1}{3}$ to $\frac{2}{3}$, fourth along submedian fold from base to tornus; a rather broad white streak along basal third of dorsum, attenuated posteriorly; a semioval white spot on dorsum about middle; a black dot above tornus; beyond this an ochreous-orange patch on termen, becoming brown-reddish towards costa, where it is margined by two dark fuscous externally white-edged marks; a purplish-fuscous apical spot, edged above by a blackish dash: cilia light bronzy-fuscous. Hindwings dark grey; cilia grey, becoming ochreous-yellowish towards tornus.

Brisbane, Queensland; one specimen. Probably nearest to *S. schismatias*, but quite distinct.

Limnœcia trissodesma, Meyr., Proc. Linn. Soc. N.S. Wales, 1886, 1047, was accidentally omitted from my paper on Elachistidæ.

Syntomactis, Meyr.

Syntomactis crebra, n. sp.

Male, female, 7-8 mm. Head whitish, irrorated with dark grey. Palpi whitish, second joint with six rings, third and sixth from base grey, others black, terminal joint longer than second. with eight rings, second, fifth, eighth, and sometimes third and sixth black, others grey. Antennæ grey, ringed with darker. Thorax dark grey sprinkled with whitish. Abdomen grey. Forewings narrower than in *cataspoda;* grey or rather dark fuscous irrorated with white, with a few scattered black scales; four more or less indistinct oblique fasciæ of dark fuscous suffusion, appearing on costa as distinct dark fuscous spots, in disc marked with tufts of raised scales mixed with blackish; a blackish dash in disc towards apex, and a blackish dot at apex: cilia grey, round apex darker and irrorated with whitish. Hindwings and cilia grey.

Sydney, New South Wales, in August and February; three specimens. Very like *S. cataspoda*, but obviously narrower-winged, and entirely without any ochreous markings or colouring in the forewings.

Heliodines, Stt.

Antennæ $\frac{4}{5}$, in male thick, simple. Labial palpi rather short, slightly curved, porrected or drooping, filiform, pointed. Posterior tibiæ smoooth-scaled. Forewings with 1b simple, 6 and 7 sometimes stalked, 7 to costa, 8 absent. Hindwings $\frac{1}{2}$, lanceolate, cilia 3; transverse vein partly absent, 4 absent, 6 and 7 approximated.

Based on one European species, with which the following is truly congeneric, differing structurally only in the shorter palpi, and in having veins 6 and 7 of the forewings separate, whilst in the typical species they are stalked; there is also much superficial resemblance.

Heliodines princeps, n. sp.

Male, 11 mm. Head and thorax dark bronzy-fuscous. Palpi short, drooping, purplish-fuscous, terminal joint longer than second, whitish-ochreous. Antennæ dark purplish-fuscous. Abdomen dark fuscous, beneath yellow-ochreous. Forewings elongate-lanceolate; 6 and 7 separate; bright deep orange; base suffused with dark bronzy-fuscous; a bar from costa at $\frac{1}{4}$, small transverse costal spots before middle and at $\frac{2}{3}$, similar dorsal spots before middle and before tornus, a dot beneath middle of disc, and a small round discal spot beyond middle dark purplish-leaden-metallic; apical fourth dark purplish-fuscous, including a purplish-leaden metallic streak from above tornus along termen to apex, and a short oblique mark on costa: cilia dark fuscous. Hindwings dark purplish-fuscous; cilia dark fuscous, on lower half of termen orange.

Brisbane, Queensland; one specimen.

DICASTERIS, n. g.

Head smooth; tongue developed. Antennæ $\frac{3}{4}$, basal joint moderate, with pecten. Labial palpi moderately long, curved, ascending, second joint with appressed scales, rather rough beneath, terminal joint shorter than second, acute. Posterior tibiæ with long hairs above. Forewings with upper fork of 1b nearly obsolete, 2 from $\frac{3}{4}$, 4 absent, 6 and 7 out of 8, 7 to costa, 11 from middle. Hindwings $\frac{3}{5}$, lanceolate, cilia 2; 4 absent, 2, 3, 5 parallel, 6 and 7 stalked.

A curious genus, of which the exact affinity is doubtful, but it appears to have some relation to the *Hoplophanes* group.

Dicasteris leucastra, n. sp.

Female, 12 mm. Head, palpi, antennæ, thorax, and abdomen dark fuscous, upper edge of palpi white. Forewings broad-lanceolate; dark fuscous; a rather broad erect ochreous-white mark from tornus, reaching more than half across wing: cilia fuscous, mixed with darker towards base. Hindwings dark fuscous; cilia fuscous.

Tasmania; one specimen, without further particulars (Raynor).

EUMENODORA, n. g.

Head smooth, sidetufts spreading behind; tongue developed. Antennæ $\frac{2}{3}$, in male simple, basal joint moderate. Labial palpi moderate, curved, ascending, with appresed scales, terminal joint shorter than second, acute. Posterior tibiæ clothed with long hairs. Forewings with 2-6 parallel, 7 and 8 stalked, 7 to costa, 11 from beyond middle. Hindwings $\frac{4}{5}$, narrow-lanceolate, cilia 2; veins 2-7 parallel.

This would seem to be an early unspecialized type.

Eumenodora encrypta, n. sp.

Male, 10 mm. Head, palpi, antennæ, and thorax dark bronzy-fuscous; second joint of palpi ochreous-whitish at apex, and towards base beneath. Forewings lanceolate; bronzy-fuscous irrorated with blackish-fuscous, with a few whitish scales: cilia fuscous, towards base irrorated with blackish-fuscous. Hindwings dark grey; cilia grey.

Brisbane, Queensland, in September; one specimen.

OPOGONA, Z.

This name must be substituted for *Lozostoma*, Stt., being earlier. With regard to this genus, I am indebted to Mr. J. H. Durrant for kindly calling my attention to the fact that I made a serious error in overlooking the existence of fairly-developed maxillary palpi (I probably mistook them for the sections of the tongue); the genus must certainly therefore be transferred to the *Tineidæ*, where it may be provisionally placed near *Hieroxestis*.

NOTODRYAS, Meyr.

Notodryas callierga, n. sp.

Male, 9 mm. Head, palpi, and thorax white. Antennæ grey, white towards base. Abdomen grey. Forewings with vein 6 separate; white; markings brown irrorated with blackish; an oblique mark from dorsum near base, reaching half across wing; an oblique fascia from dorsum beyond middle, reaching $\frac{2}{3}$ across wing; a spot on tornus, and a longitudinal mark in disc above it; some dark scales at apex: cilia white, towards base irregularly mixed with dark fuscous scales. Hindwings light grey; cilia white.

Port Lincoln (Louth Bay), South Australia, in November; one specimen. This differs from the other two species in the separation of vein 6 of the forewings, but is clearly congeneric.

TINEIDÆ.

NEPTICULA, Z.

Head rough. Tongue rudimentary. Antennæ $\frac{1}{2}$-$\frac{3}{4}$, in male simple, basal joint much enlarged and concave beneath to form eyecap. Labial palpi short, filiform, drooping. Maxillary palpi long, filiform, folded. Posterior tibiæ with bristles above, middle-spurs in or above middle. Forewings: 1b simple, cell usually open between 2 and 6, 3-5 absent, 7 to costa, 8 out of 7 or absent, 9 absent. Hindwings $\frac{1}{2}$-$\frac{2}{3}$, lanceolate, cilia 3-4; cell open between 2 and 6, 3-5 absent.

I now include this and the other genera with antennal eyecap in the *Tineidæ*. The present genus contains a number of minute species, usually overlooked by collectors; only from Mr. G. Lyell have I received a species. The larvæ mine galleries or blotches in leaves, and are without developed legs or prolegs, but with pairs of rudimentary ventral processes on segments 3, 4, and 6-11, or rarely wholly apodal. I have met with other larvæ of the genus besides those recorded, on *Eucalyptus*, *Banksia*, etc., but failed to rear them owing to the difficulty of preventing these stiff leaves from drying up. Pupa in a firm cocoon, usually outside the mine. I have not been able to examine the neuration of all the following species, as I could not spare material for denudation, and these tiny insects cannot be examined otherwise, though I can manage almost anything else; but in those which I have denuded the neuration was exactly like that of the European *N. tityrella* figured in my "Handbook." Some of the species are remarkable for the development of secondary sexual characters, in the form of black scales, especially on the hindwings, which are sometimes (probably in connection with this) unusually dilated in the male; these require careful attention. The whole genus is, however, difficult, and will probably be largely increased when Australian collectors learn to breed these insects, and also (which is equally difficult) to set them when bred: —

1.	Forewings with defined pale markings	2.
	Forewings wholly dark	7.
2.	Head ochreous, forewings with fascia or opposite spots	3.
	Head black, forewings with irregular markings	6.
3.	Forewings with entire fascia	4.
	Forewings with opposite spots	*planetis.*
4.	Fascia broad on dorsum, narrowed upwards	*anazona.*
	Fascia of uniform width	5.
5.	Fascia dull white	*primigena.*
	Fascia shining brassy-yellow-whitish	*leucargyra.*
6.	Forewings with dorsal area partly whitish-ochreous	*gilva.*
	Forewings with dorsal area wholly dark	*caenodora.*
7.	Face dark fuscous	*symmora.*
	Face ochreous	8.
8.	Eyecap in male with large dark fuscous scale-flap	*melanotis.*
	Eyecap wholly pale	9.
9.	Anterior tibiæ in the male very short, thickened with black scales	*funeralis.*
	Anterior tibiae normal, without black scales	10.
10.	Forewings with ground colour bronzy	*chalcitis.*
	Forewings with ground colour not bronzy	11.
11.	Undersurface of forewings in male with dark fuscous scales	*endocapna.*
	Undersurface of forewings without special scaling	12.
12.	Hindwings blackish towards base	*phyllanthina.*
	Hindwings not blackish	13.
13.	Cilia of hindwings mixed with dark grey towards base	*libera.*
	Cilia of hindwings not mixed with dark grey	*trepida.*

Nepticula leucargyra, n. sp.

Female, 3-4 mm. Head ferruginous-ochreous. Antennæ grey, eyecap white. Thorax dark purplish-bronze, abdomen dark fuscous. Forewings lanceolate; shining deep purplish-bronze; a moderate shining brassy-yellow-whitish direct fascia at $\frac{3}{5}$; cilia purplish-bronzy, outer half whitish. Hindwings dark fuscous; cilia grey.

Sydney, New South Wales; five specimens bred in September. Larva pointed behind, bright green; head small, blackish: mines an irregular contorted gallery in leaves of *Correa speciosa (Rutaceæ)* in July and August; cocoon white. Similar larvæ, probably of the same species, were also found on *Phebalium dentatum*, but not reared.

Nepticula anazona, n. sp.

Female, 4 mm. Head whitish-ochreous. Antennæ and eyecap ochreous-white. Thorax and abdomen dark bronzy-grey. Forewings lanceolate; shining bronzy-fuscous, irrorated with dark fuscous; a rather shining whitish direct fascia at $\frac{2}{3}$, broad on dorsum, and considerably narrowed towards costa: cilia light bronzy-fuscous, tips whitish. Hindwings and cilia light grey.

Brisbane, Queensland, in Sepember; one specimen beaten from *Tristania conferta (Myrtaceæ)*, which is probably the food-plant.

Nepticula primigena, n. sp.

Female, 4 mm. Head ochreous-yellow. Antennæ whitish-grey, eyecap white. Thorax and abdomen dark bronzy-grey. Forewings lanceolate; bronzy-grey irrorated with dark fuscous; a moderate dull white direct fascia at $\frac{2}{3}$: cilia whitish-fuscous, apical half white round apex beyond a blackish-fuscous median line. Hindwings and cilia light grey.

Sydney, New South Wales, in August; one specimen beaten from *Banksia serrata (Proteaceæ)*, which is probably the food-plant; I have met with *Nepticula* larvæ on this plant, but failed to rear them.

Nepticula planetis, n. sp.

Female, 5 mm. Head ferruginous-ochreous. Antennæ light grey, eyecap ochreouswhitish. Thorax grey irrorated with dark fuscous. Abdomen grey. Forewings lanceolate; grey, slightly purplish-tinged, irrorated with dark fuscous; rather small cloudy ochreous-whitish opposite spots on costa at $\frac{2}{3}$ and dorsum before tornus; cilia whitish-grey, basal half sprinkled with dark fuscous. Hindwings grey; cilia pale grey.

Sydney, New South Wales, in December; one specimen taken at light.

Nepticula cœnodora, n. sp.

Male, 6 mm. Head black. Antennæ grey, eyecaps ochreous-white. Thorax pale whitish-ochreous. Abdomen blackish-grey. Forewings lanceolate; dark purplish-fuscous; a rather broad pale whitish-ochreous costal streak from base to apex, lower edge twice subsinuate: cilia bronzy-grey. Hindwings blackish-grey; cilia grey.

Sydney, New South Wales; one specimen in October.

Nepticula gilva, n. sp.

Female, 6 mm. Head blackish. Antennæ grey, eyecaps whitish-ochreous. Thorax whitish-ochreous. Abdomen pale bronzy, becoming whitish-ochreous towards base. Forewings lanceolate; pale whitish-ochreous; two irregular fuscous patches irrorated with dark fuscous, first on dorsum at $\frac{1}{4}$, reaching half across wing, second on tornus, reaching nearly to costa, anteriorly sending an elongate projection to disc above middle: cilia ochreous-grey-whitish. Hindwings bronzy-grey; cilia ochreous-grey-whitish.

Sydney, New South Wales, in December; one specimen taken at light.

Nepticula symmora, n. sp.

Female, 4-5 mm. Head ochreous-yellow, face dark fuscous. Antennæ dark grey, eyecap whitish. Thorax purplish-fuscous. Abdomen grey. Forewings lanceolate: purplish-fuscous, irrorated with dark fuscous: cilia grey sprinkled with dark fuscous. Hindwings and cilia grey.

Adelaide, South Australia, in October; twenty specimens, amongst which it is remarkable that there is not a single male. I found the species flying in plenty over *Dodonæa viscosa (Sapindaceæ)*, which must certainly be the food-plant.

Nepticula melanotis, n. sp.

Male, 7 mm. Head ferruginous-ochreous. Antennæ dark grey, eyecap whitish-ochreous, furnished above with a large triangular dark fuscous flap of scales. Thorax and abdomen bronzy-grey. Forewings lanceolate; grey-whitish, densely irrorated with dark fuscous and blackish; cilia whitish-grey sprinkled with black: on undersurface a small patch of pale bluish-metallic scales on dorsum beyond middle. Hindwings broad-lanceolate, grey, suffused with violet-blackish-grey irroration except at apex and on a thinly-scaled longitudinal patch beneath costa towards middle, corresponding to bluish patch of forewings; anterior half of costa with a projecting fringe of long dark grey scales; cilia grey.

Sydney, New South Wales, in September; one specimen.

Nepticula funeralis, n. sp.

Male, 4 mm. Head yellow-ochreous. Antennæ whitish-fuscous, eyecap ochreous-whitish. Thorax grey mixed with dark fuscous. Abdomen dark grey. Anterior tibiæ very short, thickened above with blackish scales. Forewings lanceolate, costal edge on undersurface thickened and blackish;

grey irrorated with blackish: basal half of dorsum with projecting blackish scales: cilia grey sprinkled with black. Hindwings grey; a small patch of black scales towards base of dorsum; cilia grey, on middle of costa with an expansible group of long black scales, on basal half of dorsum mixed wtih blackish scales at base.

Sydney, New South Wales, in March; one specimen.

Nepticula endocapna, n. sp.

Male, female, 4-5 mm. Head yellow-ochreous or whitish-ochreous. Antennæ grey, eyecap whitish. Thorax dark grey mixed with whitish. Abdomen dark grey. Forewings lanceolate; fuscous-whitish irrorated with dark grey; undersurface in male clothed with dark purplish-fuscous modified scales except towards apex: cilia grey-whitish sprinkled with blackish. Hindwings grey, in male broader and clothed with dark purplish-fuscous modified scales except towards apex; cilia grey, in male basally mixed with dark grey scales on anterior half of costa, and with an expansible tuft of long dark fuscous scales from base of costa above.

Albany and York, West Australia, in November and December; eleven specimens. The species was common on a fence at Albany, beneath a row of *Eucalyptus*, which was almost certainly the food-plant.

Nepticula chalcitis, n. sp.

Female, 5 mm. Head ochreous-yellowish. Antennæ whitish-ochreous, eyecaps ochreous-whitish. Thorax dark bronzy-fuscous. Abdomen bronzy-grey. Forewings lanceolate; shining light bronze, irrorated with dark fuscous: cilia whitish-fuscous, sprinkled with dark fuscous. Hindwings pale grey; cilia whitish-fuscous.

Albany, West Australia, in December; one specimen.

Nepticula phyllanthina, n. sp.

Female, 4 mm. Head ochreous-yellowish. Antennæ whitish-grey, eyecap whitish. Thorax and abdomen purplish-fuscous. Forewings lanceolate; grey, mixed with grey-whitish and blackish-grey, anteriorly suffused with dark purplish-grey: cilia whitish-grey sprinkled with blackish-grey. Hindwings dark grey, on basal half more thinly scaled and blackish; cilia grey.

Sydney, New South Wales; three specimens bred in February. Larva mines a long broad sinuate gallery in leaves of *Phyllanthus Ferdinandi (Euphorbiaceæ)*; cocoon white. I believe the food-plant is not native near Sydney, but occurs naturally further north in New South Wales and Queensland; the tree from which I bred these specimens grew in the Botanic Gardens.

Nepticula libera, n. sp.

Male, 4 mm. Head yellow-ochreous. Antennæ whitish-fuscous, eyecap ochreous-whitish. Thorax fuscous sprinkled with dark fuscous. Abdomen rather dark fuscous. Forewings lanceolate; fuscous-grey, irrorated with dark fuscous: cilia grey, sprinkled with dark fuscous. Hindwings grey; cilia grey, mixed with dark grey towards base on both margins throughout.

Sydney, New South Wales; one specimen taken at light in March.

Nepticula trepida, n. sp.

Male, 4-5 mm. Head ferruginous-ochreous. Antennæ grey, eyecap ochreous-whitish. Thorax dark fuscous mixed with whitish. Abdomen dark grey. Forewings lanceolate; fuscous irrorated with whitish and blackish: cilia whitish-grey sprinkled with blackish. Hindwings and cilia light fuscous.

Gisborne, Victoria, in March: three specimens received from Mr. G. Lyell.

LEUCOPTERA, Hb.

This name supersedes *Cemiostoma*, Z. I have described one species, *L. chalcocycla*, and now add two more.

Leucoptera deltidias, n. sp.

Female, 8 mm. Head, antennæ, thorax, and abdomen snow-white. Forewings lanceolate, apex produced; 10 absent; shining snow-white; a small triangular fuscous spot in middle of disc; a pale golden-metallic post-tornal spot, edged with a few fuscous scales; apex tinged with brassy-yellowish, with a minute orange apical dot terminated by a black speck; two oblique fuscous lines in costal cilia, and a third inwardly oblique faint line converging to second, cilia otherwise white. Hindwings and cilia white.

Hobart, Tasmania, in December; one specimen.

Leucoptera hemizona, n. sp.

Female, 6 mm. Head, antennæ, thorax, and abdomen snow-white. Forewing lanceolate, apex produced; 10 absent; shining snow-white; an oblique pale brassy-yellowish bar from costa beyond middle, edged laterally with dark fuscous lines, not quite reaching half across wing; a pale brassy-yellowish blotch extending along termen, indistinctly edged with fuscous on termen; a black apical dot: cilia white, on costa with two rather oblique fuscous lines separated by a pale yellowish space beneath which is a minute fuscous dot, and a third inwardly oblique fuscous line before apex. Hindwings whitish-grey; cilia white.

Carnarvon, West Australia, in October; two specimens.

Phyllocnistis, Z.

I believe that under the name *diaugella* I confused two species; I now, therefore, re-describe this species, together with six new ones. The following tabulation includes all the eight described Australian species:—

1	Hindwings dark grey	*atranota.*
	Hindwings whitish	2.
2.	Forewings with dark fuscous costal blotch near base	*iodocella.*
	Forewings without such blotch	3.
3.	Forewings with black longitudinal apical dash	*acmias.*
	Forewings without apical dash	4.
4.	Forewings with post-median fascia angulated	*hapalodes.*
	Forewings with post-median fascia not angulated	5.
5.	Forewings with two strong dark fuscous streaks from base	*atractias.*
	Forewings with not more than one streak from base	6.
6.	Median costal streak reaching tornus	*psychina.*
	Median costal streak only reaching half across wing	7.
7.	Forewings with fuscous subcostal streak from base	*diaugella.*
	Forewings with yellowish discal streak from base	*triortha.*

Phyllocnistis acmias, n. sp.

Female, 5-6 mm. Head, palpi, antennæ, thorax, and abdomen shining white. Forewings lanceolate, apex long-caudate; shining brassy-white; an oblique dark fuscous wedge-shaped streak from dorsum beyond middle, reaching half across wing, and a short fine dark fuscous strigula from middle of costa, both followed by silvery-white spaces; a blackish longitudinal streak from $\frac{2}{3}$ of disc to apex, terminating in a black apical dot preceded by a silvery-white dot; apical portion of wing shows traces of alternate brassy-tinged and silvery-white bars; cilia white faintly barred with pale yellowish on costa, with fine black apical bar continuing the longitudinal streak. Hindwings and cilia whitish.

Blackheath, New South Wales, in February; two specimens. This is a very distinct species.

Phyllocnistis psychina, n. sp.

Female, 5 mm. Head, palpi, antennæ, thorax, and abdomen shining white. Forewings lanceolate, apex long-caudate; shining white; a fine pale yellowish streak along submedian fold from base to tornus; a slender oblique pale yellowish posteriorly fuscous-edged streak from middle of costa, and a nearly direct one from costa at $\frac{3}{4}$, meeting at tornus: two similar direct bars between this and apex; a round black apical dot: cilia white with slightly oblique extensions of bars from costa. Hindwings and cilia whitish.

Albany, West Australia, in December; one specimen. Distinguished from all by the first costal streak running straight to tornus.

Phyllocnistis hapalodes, n. sp.

Female, 6 mm. Head, palpi, antennæ, thorax, and abdomen shining white. Forewings lanceolate, apex long-caudate; shining snow-white; an ochreous-yellowish streak from base of costa above submedian fold to about middle: a narrow oblique light ochreous-yellowish fascia from $\frac{3}{5}$ of costa to tornus, posteriorly fuscous-edged, acutely angulated near dorsum: a light ochreous-yellowish posteriorly dark-edged fascia between this and apex; a black apical dot: cilia whitish, apparently with two or three diverging dark fuscous bars from costa (imperfect). Hindwings and cilia whitish.

Albany, West Australia, in December; one specimen.

Phyllocnistis triortha, n. sp.

Female, 6-7 mm. Head, palpi, antennæ, thorax, and abdomen shining white. Forewings elongate-lanceolate, apex shortly-caudate; shining white; a broad pale ochreous-yellowish discal streak from base to beyond middle; an evenly outwards curved fuscous line from $\frac{2}{3}$ of costa to dorsum before tornus, edged anteriorly with pale ochreous-yellowish suffusion, preceded on costa by an oblique fuscous line reaching half across wing, and followed on costa by two similar direct lines, edged anteriorly with pale ochreous-yellowish suffusion; a black apical dot: cilia whitish, on termen with basal half tinged with pale ochreous-yellowish, at apex with two indistinct diverging fuscous lines. Hindwings and cilia whitish.

Carnarvon, West Australia, in October; two specimens.

Phyllocnistis diaugella, Meyr.

Male, female, 3-4 mm. Head, palpi, antennæ, thorax, and abdomen shining white. Forewings lanceolate, apex long-caudate; shining white; a fine fuscous longitudinal streak beneath costa from base to middle; a fine oblique dark fuscous streak from middle of costa, reaching half across wing; a slightly outwards-curved dark fuscous line from $\frac{2}{3}$ of costa to tornus; two short direct fuscous lines from costa between this and apex; a round black apical dot: cilia white, with faint fuscous bars on costal lines and three or four diverging fuscous bars at and beneath apex. Hindwings and cilia whitish.

Sydney, New South Wales: bred from blotch-mines in leaves of *Euphorbia sparmanni*, in February and March. It is the smallest species of the genus, and is so slender as to be very difficult to pin. My original description included also the following species, which I now regard as distinct.

Phyllocnistis atractias, n. sp.

Male, 5 mm. Head, palpi, antennæ, thorax, and abdomen shining white. Forewings lanceolate, long-caudate; shining white: two strong dark fuscous longitudinal streaks (subcostal and plical) from base to beyond middle: a curved oblique dark fuscous streak from middle of costa, reaching more than half across wing: a triangular dark fuscous dorsal spot before tornus, its apex receiving a direct dark fuscous streak from costa at $\frac{2}{3}$: an ochreous-yellow terminal patch towards apex, edged with fuscous and anteriorly by a dark fuscous spot; two converging bars before apex, terminated by this patch; a round black apical dot preceded by a silvery-white dot: cilia white with three fuscous costal bars continuing costal markings. Hindwings and cilia whitish.

Sydney, New South Wales, in May; one specimen.

Phyllocnistis atranota, n. sp.

Male, 6 mm. Head, palpi, and thorax white. Antennæ white, ringed with grey. Abdomen grey. Forewings lanceolate, shortly caudate; shining white: a fuscous streak beneath costa from base to middle; an oblique fuscous line from middle of costa, reaching half across wing, and two others less oblique between this and apex, all preceded by pale yellowish shades; a similar oblique streak from tornus, not reaching half across wing; an ochreous-yellow patch towards apex; a dark fuscous direct bar just before apex: a round black apical dot: cilia white, with three dark fuscous bars on costa continuing costal markings, and two diverging dark fuscous bars beneath apex. Hindwings dark grey; cilia grey.

Sydney, New South Wales, in December; one specimen. Separated from all by the dark grey hindwings.

Epicnistis, n. g.

Head somewhat rough on crown, face smooth; tongue short. Antennæ almost 1, basal joint elongate, slightly flattened, not forming an eyecap. Labial palpi moderately long, smooth-scaled, drooping, terminal joint longer than second, pointed. Maxillary palpi obsolete. Posterior tibiæ thinly clothed with bristly hairs. Forewings with 1b simple, 3 absent, 4 absent, 6 and 7 stalked, 7 to costa. Hindwings $\frac{1}{2}$, linear-lanceolate, cilia 6; 3 absent, 4 absent, 5 and 6 stalked.

Closely related to *Phyllocnistis*, but distinguished by the head being rather rough on crown, and presence of vein 8 in forewings; there is no eyecap, but the dilation in some species of *Phyllocnistis* is extremely slight. The following species is very like a *Phyllocnistis* superficially.

Epicnistis euryscia, n. sp.

Female, 8 mm. Head, palpi, antennæ, thorax, and abdomen shining white. Forewings lanceolate, apex produced; shining snow-white; markings dark bronze; a longitudinal streak from base of costa beneath costa to meet posterior fascia; a slender mark along dorsum towards middle; a rather oblique fascia at $\frac{2}{3}$, narrow dorsally, furcate on costal half; two transverse fasciæ between this and apex; a black apical dot: cilia white, with bronzy basal patches on costal and terminal marks, edged externally with some dark fuscous points. Hindwings whitish; cilia white.

Mount Wellington, Tasmania, in December; one specimen.

Exorectis, n. g.

Head thinly rough-haired, hairs of face loosely appressed; tongue developed. Antennæ 2 or nearly, in male filiform, simple, basal joint rather dilated, with pecten. Labial palpi moderate, porrected, very slender, acute. Maxillary palpi moderately long, folded. Posterior tibiæ loosely scaled. Forewings with 1b furcate, 2 from angle, 7 and 8 stalked, 7 to costa, 11 from before middle. Hindwings 1, ovate-lanceolate, cilia 1; 2-7 tolerably parallel, 4 from angle.

An interesting form, probably allied to *Thereutis*; the antennæ, which are twice the length of the forewings, exceed anything outside the *Adela* group.

Exorectis autoscia, n. sp.

Male, 10-12 mm. Head, palpi, antennæ, thorax, and abdomen whitish-grey, body thinly scaled. Forewings elongate, rather narrow, costa moderately arched, apex pointed, termen extremely obliquely rounded; whitish-grey, irregularly strewn with small fuscous dots and strigulæ: cilia whitish-grey. Hindwings thinly scaled, whitish-grey; cilia grey-whitish.

Gisborne, Victoria, in March and April; two specimens received from Mr. G. Lyell.

Setomorpha, Z.

Head with loosely appressed hairs; tongue absent. Antennæ $\frac{5}{6}$ to almost 1, in male filiform, simple, basal joint moderate, without pecten. Labial palpi moderately long, curved, ascending, second joint much thickened with dense scales, slightly projecting beneath at apex, externally with several long projecting bristles, terminal joint as long as second or shorter, rather stout, obtuse or hardly pointed. Maxillary palpi absent. Posterior tibiæ clothed with long fine hairs. Forewings with 1b shortly furcate, 2 from angle, 7 and 8 stalked, 7 to costa, 11 from middle. Hindwings 1, elongate-ovate, cilia 1; 2 remote, 3 and 4 parallel, 5 and 6 stalked, 7 parallel, cell open between 4 and 5.

This curious genus is nearly related to *Tinea*, though differing widely in the nearly smooth head, ascending labial, and absence of maxillary palpi. It agrees with *Tinea* in neuration, in the characteristic and peculiar bristles of the labial palpi, in superficial appearance, and larval habits. The species are few in number, but are found throughout the Indo-Malayan and African regions, and in America; they are very similar in general appearance, and require careful attention to structural details. The larvæ feed on various dried substances, such as tobacco.

Setomorpha calcularis, n. sp.

Male, female, 17-27 mm. Head, palpi, and thorax pale brownish-ochreous: terminal joint of palpi as long as second. Antennæ and abdomen light greyish-ochreous. Forewings elongate, rather narrow, costa moderately arched, apex round-pointed, termen very obliquely rounded; pale brownish-ochreous, more or less sprinkled with fuscous; costa, termen, and dorsum irregularly spotted with fuscous; stigmata large, cloudy, fuscous, near together, plical obliquely beyond first discal; a similar spot on fold at $\frac{1}{4}$, and another towards apex of wing: cilia whitish-ochreous, mixed and indistinctly barred with fuscous. Hindwings and cilia pale fuscous.

Sydney, New South Wales; Melbourne, Victoria; Adelaide, South Australia; Geraldton, Perth, and York, West Australia; in June and July, and from October to February; ten specimens. This species may be specially recognised by the long terminal joint of palpi.

Mineralogical Notes.

By D. Mawson, B.E., B.Sc.

[Read May 1, 1906.]

Fetid Felspar (Necronite) and Quartz, from Umberatana.

The material described was discovered by Mr. W. Howchin, F.G.S., who, noting its fetid character when crushed, perceived it to be of special interest mineralogically.

Mr. Howchin describes it as occurring about two miles east of Umberatana* on the track to Illinawortina Station. The rocks in the vicinity are probably quite as old as Lower Cambrian. In the immediate neighbourhood bold outcrops of binary granite are conspicuous, forming hills as much as two hundred feet in height; veins of felspar, quartz, and graphic granite, with tourmaline and other minerals, were also noted.

The specimen examined is aplitic in appearance and slightly porous. It is composed of quartz, present to the extent of about 25 per cent., and an adularian felspar in typical rectangular sections. Grainsize averages one millimetre. On fracturing the rock a distinct fetid odour is produced, to be likened somewhat to that proceeding from carbon bisulphide.

Examined microscopically in thin sections, the felspars are seen to be idiomorphic; whilst the quartzes are, as a rule, subordinate. The felspar crystals also show the effects of crushing. Albite twinning is very common; whilst twins after the baveno law and the cross-hatching of microcline are also to be frequently noted. The refractive index is lower than that of the balsam.

Both minerals contain very numerous inclusions; these are most abundant in an outer zone around the felspars, and are also crowded thickly in a felspathic cement, occupying interstices between the grains. The inclusions are chiefly liquid and gaseous, in addition to which much opaque dust is sometimes present. This opaque matter is very likely largely carbonaceous, as several of the more translucent patches were identified as bitumen. The objectionable odour of the fractured rock is evidently derived from the contents of the liquid and gaseous inclusions; these are quite

* Umberatana is located about 50 miles in a direct line west of the northern extremity of Lake Frome.

irregular in shape, and have an average diameter of 0·005 millimetre.

On examining a freshly prepared slice, the contents of many of these cells are seen to be in rapid motion, evidently due to ebullition of the liquid contents caused by rapid diffusion of its gas through cracks developed in preparation of the section, or perhaps by diffusion through the wall of the cell where sufficiently thin. In one case the commotion was seen to be due to the dissolving up of a tiny black particle (probably a hydrocarbon) in the liquid contents of the cell. This particle was noticed to diminish to half its bulk in ten minutes. In the case of two under examination all commotion had ceased by the next day.

The rock is apparently a variety of fine-grained pegmatite, having the composition of a granite aplite, probably crystallized in the presence of abundant liquid gases. The later stages of crystallization have been those favouring the inclusion of the liquid gases, perhaps owing to rise of pressure due to gas escape being cut off.

The odour suggests that this gas may contain hydrogen sulphide, carbon bisulphide, acetylene, or like compounds. As available material was limited, little could be done towards definitely settling its nature. Chemical methods rendered possible through the courtesy of Professor Rennie, D.Sc., were undertaken.

The rock was powdered in a large mortar, under ammoniacal water, containing a few drops of lead acetate. Only the slightest browning was noted, indicating that hydrogen sulphide could not be present in more than the minutest quantities. The powder was then digested in hydrofluoric and nitric acids, and sulphuric acid tested for, with no better result.

Further investigation has been suspended pending arrival of additional supplies of the rock.

Atacamite from Bimbowrie.

Atacamite is extensively developed in the zone of weathering at the Mt. Howden Copper Mine.* Though practically identical in chemical composition, three forms are to be distinguished, differing greatly in physical appearance.

The most striking is an arrangement of radiating lamellæ in bunched masses, often 5 centimetres in diameter, forming magnificent specimens for exhibition purposes. When well developed the lamellæ measure 3·7 cms. by 2 cms., and

* Mount Howden is situated on Bimbowrie Run, within sight of the Barrier Ranges, and just 30 miles in a direct line north of Olary.

only 0·02 cm. thick. As atacamite is brittle, these specimens are, therefore, very delicate, the least rough handling causing them to crumble into fine sand, the *arsenillo* of the Chilians.

The lateral development of the lamellæ was expected to be in the direction of the *b* face, though such has not been borne out by observation on cleavage directions evidenced on fractured edges. This cleavage angle approximates to 66° 30′, and would appear to be referable to the angle *mm*′′′, indicating a laminar development parallel to the *c* face. As original crystal edges are not available for measurement, the point remains unsettled.

Viewed under the microscope, the delicate plates are noticeably ridged in a direction normal to the obtuse angle of the dominant cleavage; perpendicular are fine striations of a subordinate nature. Its orthorhombic character is evidenced by straight extinction along the two latter directions and biaxial character of the interference figure. The colour of the mineral is dark emerald green.

A complete qualitative analysis was supplemented by quantitative determinations of the chlorine and copper:—

Chlorine	16·78%
Copper	59·34%
Insoluble	trace
Iron	trace
Nickel and Cobalt	nil

Corresponding to the following composition:—

$CuCl_2$	31·83
CuO	55·43
H_2O (by diff.)	12·74
	100

The other two varieties of atacamite from this locality are closely associated in a reddish clayey matrix. One of these is in the form of small tablets, black by reflected light, but sufficiently translucent to show the characteristic green by fairly strong transmitted light. The tables, which have the following average dimensions, 4·7 mms. by 3 mms. by 1 mm., are developed parallel to the *b* face, bounded by $\{110\}$, $\{010\}$, $\{011\}$, and exhibit the usual cleavage. The chlorine was determined as 17·03 per cent.

The third modification consists in grass green granular aggregates, apparently deposited subsequent to the tabular variety, often enclosing the latter and always subordinate to it. An estimate of the chlorine returned 16·09 per cent., probably slightly low on account of difficulty in obtaining the mineral quite free from impurity.

The latter two were noted to carry more iron than the beautiful laminated variety first described. Nickel and cobalt were found absent in all three, though, on account of abundance of their ores in the vicinity, it was suspected that perhaps replacement by them of part of the basic constituent in the atacamite might be answerable for the variety of habit.

Descriptions of Australian Curculionidæ, with Notes on Previously Described Species.

By Arthur M. Lea.

Part IV.

[Read August 7, 1906.]

SUB-FAMILY OTIORHYNCHIDES.

Otiorhynchus sulcatus, Fab.

O. scabrosus, Marsh.

O. cribricollis, Gyll.

These species all occur as garden pests in Tasmania. With the exception of *sulcatus* they have not previously been recorded as Australian.

SUB-FAMILY CYLINDRORHINIDES.

Ocynoma antennata, Pasc.

This species is very common about the Swan River, and is very destructive in spring and early summer to buds and leaves of the grape-vine. The scales are singularly easily abraded and discoloured. *Cordipennis*, Pasc., appears to be synonymous.

Perperus malevolens, n. sp.

Black, appendages more or less obscurely diluted with red. Densely clothed with scales, varying from dingy-white to slaty-brown. With numerous setæ, dense, stout, and scarcely (or not at all) rising above the general level on head and prothorax, finer, sub-erect and more or less lineate in arrangement on elytra, dense and fine on under-surface, and long on tibiæ and muzzle.

Head with a feeble impression between eyes, these ovate. *Rostrum* the length of prothorax, moderately curved; tricarinate, the median carina acute and straight, the others more or less feebly waved. Scrobes deep in front, shallower behind. Antennæ not stout, scape extending to eye, first joint of funicle longer than second, and second longer than third, club slightly shorter than four preceding joints combined. *Prothorax* convex, slightly transverse, sides strongly rounded, base and apex almost truncate, ocular lobes fairly large and distinctly ciliated. *Scutellum* small but distinct. *Elytra* sub-ovate, base feebly incurved to middle, shoulders moderately rounded. *Legs* moderately long; front tibiæ with small but distinct teeth, the others edentate or almost so. Length (rost. incl.), 6-9 mm.

Hab.—Tasmania: Hobart, Huon River, Stonor, Parattah, etc.

The majority of the scales are of a dull-brown colour, but the sides of the prothorax and of the elytra are often supplied with more or less large patches of dingy-whitish scales, occasionally tinged with pale blue (but never shining), the white scales may also form small spots on the disc of the elytra and clothe the shoulders and a space between each shoulder and the scutellum; on the prothorax they are often condensed into feeble lines (two or three) on each side; white scales also occasionally surround the eyes and form feeble rings on the femora. On the upper surface the scales are more numerous than the setæ, on the lower the reverse is the case. The scrobes on abraded specimens can be quite distinctly followed to the eyes, but on perfect specimens do not appear to extend so far; on perfect specimens also the front parts appear to be much deeper than they really are; the front halves are arcuate and the scapes are so inserted that the portion in front of each would extend halfway to its fellow. On perfect specimens the only punctures which are visible are some forming series on the elytra, and these are distinct only at the base. But on abrasion the head, rostrum, prothorax, and tibiæ are seen to be densely covered with small punctures, on the prothorax these are often more or less confluent, and leave some subgranular spaces* and a feeble median elevated line (scarcely a carina)†; elytra with regular series of large punctures becoming smaller posteriorly, the interstices separately gently convex and much wider than punctures, especially in the female; sterna and two basal segments of abdomen transversely strigose as well as punctate.

On only one specimen before me are the deciduous mandibular appendages present, they are unusually small (scarcely longer than the basal joint of funicle), curved outwardly, dilated to the middle internally and of a reddish colour.

The female differs from the male in being larger, the elytra wider and the basal segment of abdomen convex (instead of concave) in the middle. In several females before me portion of the ovipositor is protruding, and to all appearance is a horny reddish sheath to a penis: the resemblance

* These subgranular spaces are not themselves punctate, and are much less distinct than the punctures, characters it is as well to mention, as there is a common (and apparently undescribed) species which closely resembles this, but differs in the characters mentioned.

† This is sometimes visible before abrasion.

is so striking that it was not till I had dissected such a specimen and found eggs that I was satisfied it really was a female.

I have referred this species to *Perperus*, although the antennæ are rather short for that genus, but as there are no other aberrant characters it was not considered advisable to propose a new genus for its reception.*

From the description of *languidus* it differs in being without an impressed line on the prothorax and the suture not carinated posteriorly.

SUBFAMILY HYLOBIIDES.

Aclees porosus, Pasc.†

Although not previously recorded as Australian this species appears to be as common in many parts of Queensland as in New Guinea. It extends also to the Clarence River in New South Wales. When living, specimens are covered with a pinkish meal, but this appears to be of an oily nature and cannot be preserved.

SUBFAMILY ERIRHINIDES.

Misophrice.

The genus *Misophrice* is a very interesting one on account of its clawless tarsi.‡ It is practically confined to the *Casuarinæ*, and although on occasions I have taken specimens on other plants, there was always the suspicion that they were there only by chance. On the *Casuarinæ*, however, they very often swarm, and I have seen eight species and thousands of specimens in an umbrella (used for beating into) at the same time. The species are all slow moving, and being of very small size they are apt to be overlooked. The *Casuarinæ* also being, as a rule, unproductive of beetles, are often neglected by collectors. It is probably owing to these facts that no species have been recorded from the northern half of Australia, as wherever I have searched for them in Australia and Tasmania they were in abundance. In all the

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* In the majority of instances it is hardly advisable to describe single species the position of which is at all doubtful, but as this is a very destructive species in Tasmania it is as well that it should be named at as early a date as possible. It has been seen destroying many buds of the apple, apricot, gooseberry, and currant; but in its natural state may be taken in abundance on several species of *Leptospermum*.

† Journ. Linn. Soc., xi., 1873, p. 172.

‡ The third joint is broad and appears to be slightly cleft in the middle; there really may be a claw-joint, but I have failed to discover any such under the microscope.

species here described the first joint of the funicle is stout, about as long as the second and third combined, and the second slightly longer than the third. The rostrum also in all is glabrous, either entirely or only excepting a small part of its base.

There are two other genera of *Erirhinides* in Australia with clawless tarsi, and differing from *Misophrice* practically only in the number of joints of the funicle.

Funicle with five joints	*Anarciarthrum.*
Funicle with six joints	*Misophrice.*
Funicle with seven joints	*Thechia.*

There is a genus of *Cryptorhynchides* (undescribed at present, but abundantly represented in Australia), the species of which bear a very strong general resemblance to the species of *Misophrice*, are clawless, and live on various species of *Casuarina*.

Misophrice squamiventris, n. sp.

Black, rostrum (base and tip excepted), funicle, club, femora, and tibiæ reddish. Densely clothed with rounded scales of a more or less golden colour, but feebly variegated with obscure darker and silvery patches; under surface with paler scales than upper.

Rostrum thin, strongly curved, slightly longer than prothorax; with four punctate-striæ on the basal half and scattered punctures on the apical half. *Prothorax* moderately transverse, sides rounded and diminishing slightly to apex, base distinctly bisinuate; punctures dense but concealed. *Elytra* not much wider than prothorax, widest near base; striate-punctate, the punctures in striæ rather large but almost concealed, interstices with dense concealed punctures. *Abdomen* gently convex in one sex, slightly flattened in middle in the other. Length, 2-3 mm.

Hab.—Tasmania: Hobart, Ulverstone, Launceston, Swansea (A. M. Lea); Victoria (National Museum).

On the prothorax three indistinct dark stripes can sometimes be traced; on the elytra across the middle pale scales form feeble markings, usually confined to alternate interstices. On the sterna and abdomen (except at the sides) the scales are often almost silvery-white, or with a slight bluish gloss, and they are just as dense on the abdomen as elsewhere, this being a very unusual feature in *Misophrice*, although equally dense in the following species.

Apparently nearer to *squamosa* than any other described species, but considerably smaller, rostrum not nearly straight, femora as well as tibiæ reddish, the funicle different, etc.

MISOPHRICE GLORIOSA, n. sp.

Black, parts of antennæ obscurely diluted with red. Densely clothed with rounded scales, varying from a dingy sooty-brown to a glittering green, or golden green, or blue, or silver, or gold.

Rostrum stouter than in the preceding species, but of similar shape and with similar punctures and striæ. *Prothorax* feebly transverse, sides rather strongly rounded and decidedly diminishing in width to apex, base almost truncate; punctures concealed. *Elytra* slightly wider than prothorax, basal two-thirds parallel-sided; striate-punctate, the punctures in striæ large and fairly distinct, those of the interstices concealed. *Abdomen* gently convex in one sex, flattened in middle in the other. Length, $1\frac{2}{3}$-2 mm.

Hab.—Tasmania: Hobart, Launceston, Frankford, Huon River (A. M. Lea).

The majority of the scales are usually of a more or less silvery green colour, but with fairly numerous glittering golden scales scattered about, especially on the elytra; on the elytra also the sooty scales are condensed into a large subapical ill-defined spot on each side; the basal half of the suture is almost or quite glabrous, and the apical half is always clothed with glittering scales, which are in strong contrast to the scales near them. The lower surface is densely and uniformly clothed, but the scales also vary in colour. Along the middle of the prothorax the clothing is subsetose.

Variety A. Scales of upper surface mostly sooty; two longitudinal stripes on prothorax and sides with feebly glistening whitish scales, similar scales forming short lines on the elytra and clothing the suture almost to base, and a subtriangular space on the sides.

Hab.—Tasmania: Hobart (one specimen only).

Variety B. Scales of an almost uniform silvery colour, with a very slight coppery or bluish gloss, denser on suture, almost to base, than elsewhere. Abdomen sparsely clothed along middle.

Hab.—New South Wales: Sydney.

I have seen but one specimen, and have not described it as distinct, as possibly the abdomen has been partially abraded.

MISOPHRICE APIONOIDES, n. sp.

Of a dingy testaceous-brown; head, base of rostrum, scutellum, suture, a postmedian and an apical spot on elytra, and the sterna black or piceous. Moderately clothed with whitish subsetose scales, becoming denser and more rounded on flanks of sterna than elsewhere.

Rostrum curved, distinctly longer than prothorax; basal three-fourths with punctate-striae, apical fourth with scattered punctures. *Prothorax* moderately transverse, apex considerably narrower than base; with dense, fairly large, and only partially concealed punctures. *Elytra* at base slightly wider than prothorax, feebly dilating to beyond the middle; striate-punctate, the punctures rather large, and rounded, punctures in striæ small and only slightly concealed. *Abdomen* with distinct punctures; the two basal segments slightly concave in middle. Length, $1\frac{3}{4}$ mm.

Hab.—New South Wales: Wollongong, Sydney (A. M. Lea).

The apical half of the antennæ is infuscate, and in one specimen the sides of the 1st and 2nd and the whole of the 3rd and 4th abdominal segments are infuscate. The post-median spot seems to be an abbreviated fascia extending across the 2nd-5th interstices, the subapical spot being equidistant between it and the apex. In *spilota* there are three distinct spots, of which two are on the 5th and on the 3rd interstices; of those on the 5th the front one is almost in the exact middle of each elytron and considerably in advance of the inner one; the hind spot is not quite confined to the 5th and is more distant from the apex than the similar spot on *apionoides*. On one of the specimens the lateral prothoracic scales have a distinct rosy gloss. In general appearance the two specimens before me (apparently of one sex) strongly resemble many species of *Apion*.

Misophrice inflata, n. sp.

Almost flavous; head, tip of rostrum, scutellum and a subtriangular space about it, suture and a subapical elongated spot on each elytron, and tip of tibiae more or less dark; club and tarsi somewhat paler. Rather sparsely clothed with pale green, subsetose scales, becoming denser rounded and shining on flanks of elytra and of sterna; middle of abdomen and of sterna glabrous.

Rostrum rather feebly curved, no longer than prothorax: basal half punctate-striate, apical half seriate punctate. *Prothorax* rather strongly transverse, apex not much narrower than base; with rather coarse only partially concealed punctures. *Elytra* at base scarcely wider than prothorax, rather strongly dilated posteriorly; striate-punctate, punctures large and distinct, interstices convex, with finely rugulose punctures. Two basal segments of *abdomen* and the metasternum with fine transverse corrugations, and seriate punctures; the former gently concave in middle. Length, $1\frac{1}{2}$ mm.

Hab.—New South Wales: Nepean River (A. J. Coates).

The two beautiful specimens before me are apparently of one sex.

Misophrice nigripes, n. sp.

Black; scape and elytra (sides, suture, and a rather large basal space excepted) of a dingy reddish-brown. Rather sparsely clothed with whitish or whitish-blue subsetose scales, absent along middle of under-surface.

Rostrum moderately curved, no longer than prothorax; basal two-fifths punctate-striate, elsewhere seriate-punctate. *Prothorax* moderately transverse, apex narrower than base; with large partially concealed punctures. *Elytra* not much wider than prothorax, slightly dilated posteriorly; striate-punctate, punctures large and not concealed. *Abdomen* with rather large distinct punctures; apical segment foveate in one sex, two basal segments feebly concave in the other. Length, 1 mm.

Hab.—Tasmania: Hobart, Huon River, Nubeena, Latrobe, Swansea (A. M. Lea).

Close to *clathrata*, but abdomen and legs black. The scales, especially at the sides, occasionally become of a rather bright green or coppery colour, but in nearly all the specimens before me are of a pale whitish blue and entirely without gloss. The first joint of the funicle is unusually stout and distinctly longer than the second and third combined. The size varies from slightly less to slightly more than one millimetre.

Variety A. Elytra almost or entirely black.* Size slightly smaller.

Hab.—Tasmania: Hobart.

A minute black species is suggestive of *parallela*, but this variety is even smaller than that species and is not parallel-sided.

Variety B. Size, $1\frac{1}{2}$ mm.

Hab.—Tasmania: Swansea, Nubeena, Hobart.

The three specimens of this variety seem to differ only from the typical form in their size. They appear to be very close to *nigriventris*, but differ in their entirely dark legs and antennæ.

Misophrice amplicollis, n. sp.

Of a dingy reddish-brown, elytra and legs paler; head, scutellum, suture, and fifth interstice of elytra, sterna, abdomen, funicle (basal joint excepted), and club, black or piceous. Moderately densely clothed with whitish subsetose

* I have several intermediate forms in colour.

scales, denser on prothorax and head and sparser along middle of under-surface than elsewhere.

Rostrum moderately stout and curved, no longer than prothorax; basal half punctate-striate, the lateral striæ continuous to apex. *Prothorax* large, moderately transverse, sides strongly rounded, apex much narrower than base; with large partially concealed punctures. *Elytra* slightly narrower than prothorax, parallel-sided to near apex; punctate-striate, punctures large and partially concealed. *Abdomen* and metasternum with coarse, partially concealed punctures; two basal segments of former feebly concave in middle. Length, 2¼ mm.

Hab.—Tasmania: Swansea, Hobart (A. M. Lea).

In shape much like the males of many species of *Mandalotus*, the dark portion of the 5th interstice terminates slightly before the apex; towards the apex it extends to the 4th and towards the base to the 6th interstices. On the prothorax the scales are condensed to form a distinct median line.

Variety A. Prothorax with sides rather less strongly inflated and no wider than elytra. Head, suture, sterna, and abdomen not dark; 5th interstice infuscate for a short distance only. Length, 2-2¼ mm.

Hab.—Tasmania: Launceston and Hobart.

This should perhaps have been described as the typical form.

Variety B. Prothorax as in A, but colour as in the type. Length, 2 mm.

Hab.—Tasmania: Launceston.

Variety C. Prothorax as in A, but abdomen paler than sterna. Length, 2 mm.

Hab.—Tasmania: Swansea.

Misophrice vicina, n. sp.

Testaceous-brown; head, tip of rostrum, funicle, club, scutellum, suture, and an elongated postmedian spot on 5th interstice, piceous or black; tarsi pro- and flanks of metasternum more or less infuscate. Rather sparsely clothed with whitish subsetose scales, absent from most of abdomen.

Rostrum thin, moderately curved, longer than prothorax, basal third striate, elsewhere smooth and almost impunctate. *Prothorax* and *elytra* much as in the preceding species, except that the prothorax is no wider than the elytra and its sides are less rounded, the elytra also are not quite so parallel-sided. Two basal segments of *abdomen* and metasternum with fine transverse corrugations and large sparse punctures; apical segment foveate in one sex, the two basal feebly concave in the other. Length, 1¼-1½ mm.

Hab.—Tasmania: Hobart, Swansea (A. M. Lea).

Allied to the preceding species, but the first joint of the funicle is considerably stouter, and the abdomen (except at sides of base) is glabrous; in *amplicollis* and all its varieties the abdomen is fairly densely clothed, the scales being present (although rather sparse) even along the middle. The largest specimen of this species also is smaller than the smallest of that one. The marking on the 5th interstice is of variable length and intensity, but never extends to the base.

Misophrice hispida, Pasc.

The pale scales of this species are easily discoloured, but it can be readily identified by the setæ, which are much longer, sparser, and stouter than in *argentata*, *setulosa*, or *alternata*. It was described originally from South Australia, but occurs also in New South Wales, Victoria, and Tasmania.

Misophrice variabilis, Blackb.

In a South Australian and several Tasmanian specimens before me the scales on the upper surface are of a beautiful golden colour, instead of white.

Hab.—South Australia; Tasmania: Hobart, Launceston, Swansea.

Misophrice submetallica, Blackb.

It is only in one sex (female?) that there is a "deep impression occupying the whole of the middle part of the basal two ventral segments"; in the other sex this space is flat, and the apical segment has a large shallow impression.

Hab.—S. Australia; Tasmania: Hobart, Mount Wellington (including the summit), Launceston, Swansea.

Misophrice setulosa, Blackb.

There are before me numerous specimens of a species (I have only taken it in Tasmania, but it is there the commonest of all) which either belong to *setulosa*, or to an undescribed species of the colour of *setulosa*. Blackburn says, "*Elytrorum disco . . . testaceis vel rufescentibus.*" In some of the Tasmanian specimens the elytra have a subtriangular basal patch, and the suture and sides narrowly infuscate; but the basal patch varies in area and the lateral dark markings are frequently absent. The green scales usually form a distinct line on each side of the suture, and are often rather dense across the base; but it is not uncommon for more than half of the scales on the upper surface to become abraded, and there are specimens before me in which practically all the scales and setæ have been abraded. The scales are usually of a beautiful metallic green, occasionally with a golden gloss, but they are sometimes of a rather pale blue. The sexual impressions of the abdomen are much as in *submetallica*, and one sex has more parallel-sided elytra than the other.

M. OBLONGA, Blackb.; *Hab.*—South Australia; New South Wales; Victoria; Tasmania.

M. VIRIDISQUAMA, Lea; *Hab.*—Victoria; Tasmania.

THECHIA PYGMÆA, Pasc.

There are before me numerous specimens (from New South Wales, Victoria, and Tasmania) of a species which either belong to *T. pygmæa* or to an undescribed species. Had they been from Western Australia, I should have referred them to *pygmæa* without hesitation. The description of that species, however, is not very satisfactory; of its clothing Pascoe says, "*squamis pallidis griseis vestita*"; and again, "Judging from my specimen, it is probable that the insect in a fresh state is tolerably closely covered with scales." The specimens before me have the head, base of rostrum, front and sides of prothorax, under-surface and legs more or less densely clothed with white, almost circular scales, having, under the microscope, a peculiarly granulated appearance, much like softened snowflakes. The elytra (except at the sides) and disc of prothorax are almost glabrous. Except that the funicle is seven-jointed there is nothing to distinguish it from *Misophrice*. Of *Thechia*, Pascoe says, "*prothorax transversus*"; but of *pygmæa* he says, "*prothorace latitudine longitudini aequali*. In my specimens the prothorax is very distinctly but not strongly transverse. The size varies from 1½ to 2 mm.

CYTTALIA APICALIS, n. sp.

Black; tip of rostrum, of elytra, and of abdomen diluted with red; appendages flavous; two apical joints of club and of tarsi piceous. Under-surface rather densely clothed with white subsetose scales, upper-surface less densely clothed, prothorax with transversely decumbent setæ, elytra with fine sparse pubescence and regular rows of stout yellowish decumbent setæ.

Rostrum the length of prothorax. Scape slightly longer than funicle. *Elytra* with punctures in striæ rather large and subapproximate, interstices with sparse punctures. Anterior *femora* feebly dentate. Length,* 2½ mm.

Hab.—New South Wales: Mount Victoria (A. M. Lea).

In general appearance close to *rufipes* (from Western Australia), but the rostrum decidedly longer, thinner, and reddish at its tip, the club not entirely dark, etc.

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* The lengths given are exclusive of the rostrum.

Cyttalia longirostris, n. sp.

Reddish-testaceous; under-surface (apex of abdomen diluted with red), head, rostrum, scutellum, and club black. Clothing as in the preceding species, except that on the under-surface it is not quite so dense, and that the elytral setæ are paler and more erect.

Rostrum thin, feebly curved, considerably longer than prothorax. Scape as long as funicle and club combined. *Elytra* with distinct punctures, but which are considerably narrower than the interstices; these almost impunctate. Anterior *femora* acutely dentate. Length 3-3¼ mm.

Hab.—New South Wales: Mount Kosciusko, 5-6,000 feet (R. Helms), vicinity of Jenolan Caves (J. C. Wiburd).

The rostrum is unusually long and thin, and this with the black colour of the same will readily distinguish the species from all those previously described.

Cyttalia piceosetosa, n. sp.

Reddish-testaceous, in places stained with piceous or black. Under-surface, sides of prothorax, and about eyes with soft white scales irregularly distributed; upper-surface with sparse pubescence; the prothorax and elytra with rather long, thin, dark, sparse setæ.

Rostrum feebly curved, distinctly longer than prothorax. Scape almost as long as funicle and club combined. *Elytra* with fairly large punctures in striæ, interstices almost impunctate. Anterior *femora* acutely dentate. Length, 3 mm.

Hab.—Tasmania: Huon River (A. M. Lea).

The elytral setæ are sparser, darker, and much less distinct than in any other species known to me. The head and prothorax are moderately dark, the dark parts of the elytra are nowhere sharply defined, but form a large irregular triangle about the scutellum, thence an irregular patch extends to beyond the middle, dilating to the sides; the shoulders are not dark; the metasternum is almost black, and the two basal segments of abdomen are piceous; the club is moderately dark. I have seen but one specimen.

Cyttalia oleariæ, n. sp.

Reddish-testaceous, elytra, abdomen, and appendages almost flavous, club black. Sterna with subsetose whitish scales, elsewhere with moderately dense whitish pubescence, prothorax with transverse decumbent setæ, elytra with regular rows of semi-decumbent setæ.

Rostrum in one sex the length of prothorax, in the other distinctly longer, feebly curved. Scape almost as long as funicle and club combined. *Elytra* with fairly large but almost concealed punctures in striæ. Front *femora* very feebly dentate. Length, 2⅓-3 mm.

Hab.—Tasmania: widely distributed and abundant on flowers of the native musk (*Olearia argophylla*).

The colours as described are those of the most abundant form, but there are many varieties. The metasternum is often black; when it is black the prothorax is often black also, also the head, rostrum (except at tip), and scutellum; the black colour often extends from the metasternum on to the abdomen, often to its apex, also to the sides of the elytra. I have seen no specimens in which the elytra are entirely dark, but two have the sides widely dark, with a distinct spot on each side just beyond the middle. Faint indications of these spots are to be seen on many other specimens. The elytral pubescence is much denser, whilst their setæ are less distinct and finer than in *Erichsoni*, *Sydneyensis*, and *tarsalis*. Looked at from the side the clothing seems much as in *Sydneyensis*, but when viewed directly from above it is seen to be very different.

On the elytra there are frequently to be seen four large yellowish spots, and the sides of the prothorax are often widely yellowish; but these spots are due to pollen, with which the specimens are usually densely covered when obtained, and they can readily be removed with a soft brush.

Cyttalia Erichsoni, Pasc.

In the type, and in the majority of specimens of this common and widely distributed* species, the two terminal joints of the club are dark, but I have single specimens from New South Wales, Victoria, and South Australia in which only one joint is dark.

Cyttalia tarsalis, Blackb.

Hab.—New South Wales: Queanbeyan, Mount Victoria, Ben Lomond, Mount Kosciusko; Tasmania: Hobart, Frankford, summit of Mount Wellington, Huon River.

Cyttalia Sydneyensis, Blackb.

Hab.—New South Wales; Sydney, National Park, Shoalhaven, Forest Reefs; Western Australia: Karridale.

Cyttalia maculata, Lea.

Hab.—Western Australia: Karridale.

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* I have specimens from New South Wales, Victoria, Tasmania, and South Australia.

Subfamily BARIDIIDES.

I have examined a considerable number of genera and species referred to this subfamily from various parts of the world. They all have the side pieces of the mesosternum almost or quite soldered together, large, and thrust like a stout wedge between the flanks of the prothorax and elytra. The main features relied upon for distinguishing the genera and sections are the degrees of obliquity of the pygidium, the apical segment of abdomen rounded or emarginate at its tip, the prosternum channelled or not, the shape of the rostrum and dentition of femora. Only three genera and seven species have previously been recorded from Australia; of these *Baris** is world-wide in its distribution, *Myctides* occurs in New Guinea and the Malay Archipelago, and *Platyphæus*,† so far as is known, only from Queensland. In Masters' Catalogue, *Aphela* is placed in the subfamily, but wrongly so.‡ The Australian genera known to me, including some now first recorded or proposed, may be tabulated as follows:—

Prosternum deeply grooved	*Solenobaris.*
Prosternum feebly grooved.	
Pygidium concealed	*Gymnobaris.*
Pygidum exposed	*Baris.*
Prosternum not grooved.	
Prothorax truncate at the apex¶ ...	*Acythopeus.*
Prothorax not truncate at apex.	
Pygidium covered or nearly so ...	*Ipsichora.*
Pygidium not covered	*Myctides.*

Baris.

To this genus I refer a number of species which might be regarded as belonging to several closely allied genera, but I do not think it desirable to propose new generic names for any of them, as the differences seem to be too slight to warrant generic rank. They all have the pygidium vertical, or almost so, and that organ causes the fifth ventral segment to

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* *Baridius* of various authors.

† The coarsely-faceted eyes and approximate front coxæ of this genus must appear strangely at variance with the other genera of the subfamily.

‡ Pascoe did not refer it to any subfamily at the time he described it, but subsequently (T.E.S., Lond., 1870, p. 23), he referred it to the *Amalactides.* It certainly does not belong to the *Baridiides*, the side pieces of the mesosternum being utterly at variance with the genera of that subfamily; nor does it seem very much at home with the Australian genera of *Amalactides.* It certainly belongs to the same subfamily as *Psaldus*, referred by Pascoe to the *Molytides.*

¶ Simply quoted from Pascoe.

appear emarginated at its apex; and they may be divided into the following sections:—

1. Prosternum from apex halfway or almost halfway to coxæ, with a shallow groove, bordered by distinct and usually carinated ridges.* This section is the most numerously represented in Australia, and is allied to European species, such as *scolopacea*.

2. Like Section 1, but with the frontal ridges of the prosternum continued to between the coxæ; the eyes also are more coarsely faceted than is usual in the family.

3. Prosternal groove as in Section 1, but rostrum subgibbous at base.

4. Prosternum with a shallow and wide groove to between coxæ, not bounded by carinated ridges, and with two distinct punctures in front.

5. Prosternum without grooves and ridges in front, but with two distinct punctures marking the position of the ridges.†

6. Prosternum as in Section 1, but rostrum suddenly gibbous at base.

7. Pectoral canal narrow and continuous to between anterior coxæ, and bounded by ridges (but which are not carinated). Tip of abdomen just perceptibly emarginated. The pectoral canal is more distinct than in the other sections, being much as in the European *abrotani*, with which, however, *ebenina* has little else in common.

8. As Section 6, but rostrum much shorter.

The following table of species known to me is arranged for convenience of identification only:—

Elytral interstices with coarse punctures	*porosa.*
Elytral interstices not coarsely punctate.	
Upper surface with clothing in isolated patches.	
Prothorax and elytra both with scales.	
Elytral markings transverse ...	*niveonotata.*
Elytral markings longitudinal.	
Prothorax with four isolated spots	*leucospila.*
Prothorax with two stripes ...	*devia.*

* These ridges, however, can usually be seen with difficulty, until the head is removed.

† These punctures are to be seen in several other sections, but are usually concealed by the clothing.

Prothorax without scales.
Elytra with six spots ... ... *albopicta.*
Elytra with two spots.
Spots basal ... ... *tenuistriata.*
Spots subapical ... ... *albigutta.*
Upper surface glabrous.*
Size very minute ... ... *microscopica.*
Size larger.
Prothorax with very coarse punctures at sides ... ... *sublaminata.*
Prothorax with much less coarse punctures at sides.
Prosternum grooved to between front coxæ ... ... *ebenina.*
Prosternal groove much shorter and less distinct.
Scutellar lobe with a few scales ... ... *sororia.*
Scutellar lobe without scales *glabra.*
Upper surface with clothing not condensed into spots only.
Eyes not very finely faceted ... ... *elliptica.*
Eyes finely faceted.
A deep notch between head and base of rostrum ... ... *basirostris.*
Without such a notch.
Elytra no wider than prothorax *oblonga.*
Elytra wider than prothorax.
Elytra with isolated scales ... *angophoræ.*
Elytra with scales in linear arrangement.
Less than $1\frac{1}{2}$ mm. in length *Australiæ.*
More than $1\frac{1}{2}$ mm. in length { *subopaca.* / *vagans.*

Baris leucospila, Pasc. †

(? *Baris amœnula*, Boh.)

Described by Pascoe from Katau, but fairly common in Queensland.‡ The markings of the upper surface are very peculiar, and are exactly as in the description of *amœnula*, but the prothorax could scarcely be called carinated. Some specimens, it is true, have a feeble median line, but Boheman, in his short diagnosis of *amœnula*, calls it "*carinato*," whilst in the full description he says, "*linea dorsali longitudinali subelevata, lævi.*" He also says the scutellum is clothed with white scales, whilst in the ten specimens before me it is glabrous. Of the rostrum he says, "*piceum, subnitidum, subtiliter punctulatum.*" In the specimens before

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* *Microscopica* is included here, as its clothing is so sparse and indistinct that it might fairly be regarded as glabrous; in *sororia* the only scales are a few on the scutellar lobe.

† Ann. Mus. Civ Gen., 1885, p. 291.

‡ Cairns, Port Denison, etc.

me the basal half of the rostrum is opaque, and with coarse punctures, but the apical half is shining and with sparse and minute punctures. If the species is *amœnula*, as seems quite possible, then *leucospila*, as the later name, will have to be dropped. The size ranges from $3\frac{1}{2}$ to $4\frac{1}{2}$ mm.

BARIS AUSTRALIS, Boi.

The description* of this species is too short to enable any insect to be positively identified from it, but such as it is it fits the preceding species and no other known to me from Australia.

Section 1.†

BARIS ANGOPHORÆ, n. sp.

Black, shining. Upper surface head and rostrum sparsely, elsewhere moderately densely clothed with white scales.

Head with dense punctures larger at apex than at base. *Rostrum* distinctly longer than prothorax; a slight depression marking its junction with head, densely and coarsely punctate on sides, punctures sublinear in arrangement along middle. Scape inserted slightly beyond the middle in male, slightly before it in female; basal joint of funicle stout, not twice as long as second. *Prothorax* with dense, rather large, clearly defined punctures becoming small at middle of apex. *Elytra* cordate, striate, the two sutural striæ with distinct punctures towards base, interstices each with a single row of somewhat irregular and not clearly defined punctures. *Femora* edentate. Length, $2\frac{2}{3}$ mm.

Hab.—New South Wales: Ash Island (Macleay Museum), Narrabeen (W. W. Froggatt), Sydney, National Park (A. M. Lea).

The whole insect is somewhat briefly elliptic in outline; the prothorax is fully twice as wide at base as at apex, its base is strongly bisinuate, sides strongly rounded, disc moderately convex and the scutellar lobe slightly flattened, all these being characters common to most of the species here described. The punctures in the elytral interstices are not very clearly defined, but when seen obliquely appear to be in single rows; some of them are transverse; the lateral interstices from certain directions appear to be overlapping. The white scales are absent from the disc of the prothorax, but are

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* "Ater, albo-lineatus, thorace ruguloso; elytris punctato-striatis."

† I have not usually considered it necessary to describe in each of the species the characters for which they are placed in the various sections.

condensed into feeble spots at the sides and middle of base*: on the elytra the scales are isolated and very sparse. The species may be taken in abundance on *Angophora cordifolia.*

Baris sororia, n. sp.

Black, shining; antennæ and tarsi almost black. Upper surface (except for a few scales on the scutellar lobe of the prothorax), head, and rostrum glabrous; elsewhere moderately clothed with white scales.

Rostrum slightly longer than the prothorax, its punctures and those of head, and the antennæ, much as in the preceding species. *Prothorax* and *elytra* of the same shape as in the preceding species, but the punctures of the former rather larger: the punctures of the elytral striæ are larger, more numerous, and not confined to the two near the suture, and the interstices have larger punctures, many of which are distinctly transverse, and extend almost from stria to stria. *Femora* feebly dentate. Length, 3 mm.

Hab.—Queensland: Capes Grenville and York, Endeavour River, Port Denison (Macleay Museum), Cairns (E. Allen).

Very close to the preceding species, but larger, rostrum shorter, and sides of prothorax without scales; in *angophoræ* the scales are very distinct at the sides, but in the present species they are entirely absent. I have examined numerous specimens of both species.

Baris subopaca, n. sp.

Black, subopaque. Upper surface with scattered whitish scales, condensed into lines on the elytra; under surface and legs with denser and whiter scales.

Head with very feeble punctures except between the eyes. *Rostrum* the length of prothorax, a feeble depression marking its junction with head, with dense and rather coarse punctures at base and sides, feeble and sublinear in arrangement elsewhere. Antennæ as in preceding species. *Prothorax* densely and rather coarsely punctate, with traces of a feeble median elevation. *Elytra* striate, the interstices punctate. *Femora* edentate. Length, $2\frac{1}{4}$ mm.

Hab.—New South Wales: Galston, Sydney (D. Dumbrell and A. M. Lea).

Of a decidedly more elongate form than the two preceding species, the prothoracic punctures not so clearly defined

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* On numerous specimens the scales on the prothorax just above the scutellum form a very distinct spot, but they are easily abraded.

owing to their density; the elytral striæ with punctures which do not encroach on the interstices, and are only visible from certain directions, and the interstices each with a single row of punctures, but these, although perhaps larger than in those species, are not so clearly defined. The scales of the upper surface are easily abraded, but in perfect specimens form single and regular lines on the elytral interstices, except the sutural (where there are none), on the prothorax they are not condensed into a spot on the scutellar lobe.

Baris vagans, n. sp.

Black, moderately shining. Upper surface clothed with very fine scales or setæ, forming regular lines on the elytral interstices; lower surface and legs with larger (but still small) scales.

Head, *rostrum*, and antennæ as in the preceding species. *Prothorax* with more clearly defined punctures; *elytra* with narrower striæ, the interstices each with a single row of small but round and clearly defined punctures. *Femora* edentate. Length, 2 mm.

Hab.—New South Wales: Gosford, Galston; Tasmania, Hobart, Mount Wellington (including the summit), Huon River, Frankford (A. M. Lea).

In general appearance close to the preceding species, but smaller, and with the punctures more clearly defined. The clothing of the upper surface is very fine, and it is only on a close examination that its slightly speckled appearance is seen to be caused by very thin whitish scales or setæ, although in certain lights the elytra appear to have very fine whitish lines. It is as yet the only species of its subfamily known to occur in Tasmania, where it is fairly common on *Pultenea juniperina.*

Baris australiæ, n. sp.

Black. Clothed with distinct whitish scales, and forming regular lines on the elytra.

Head with fairly distinct punctures, becoming rather coarse between the eyes. *Rostrum* stout, scarcely, if at all, longer than prothorax, with distinct punctures on top of the apical half and coarse ones elsewhere. Antennæ stout; scape inserted nearer apex than base of rostrum; basal joint of funicle very stout. *Prothorax* with numerous and fairly large but partially concealed punctures; apex more than half the width of base. *Elytra* elongate-cordate, shoulders distinctly wider than prothorax, their outline not almost continuous with it; punctures in striæ and in interstices more or less concealed. *Femora* edentate. Length, $1\frac{1}{4}$ mm.

Hab.—New South Wales: Galston, Sydney: Western Australia: Swan River, Vasse, Bunbury, Donnybrook (A. M. Lea).

Apparently the most abundant and widely distributed of all the Australian *Baridiides*; although considerably smaller than the preceding species, the clothing is much the same, except that on the elytra it is more distinct, on most of the specimens before me the lines are sufficiently clear, although the scales are small, but in a few the lines and scales are both very distinct.

Baris oblonga, n. sp.

Black: legs of a dull red, apex of rostrum and antennæ darker. Densely clothed with whitish scales and forming regular lines on the elytra.

Head with indistinct punctures, except between eyes. *Rostrum* just perceptibly longer than prothorax, rather feebly curved and thinner than usual; with coarse, partially concealed punctures on sides and base, and moderately distinct towards apex on upper surface. Scape inserted about two-fifths from apex of rostrum. *Prothorax* parallel-sided to near apex, punctures concealed. *Elytra* parallel-sided, no wider than prothorax; striæ distinct but punctures concealed. *Femora* feebly dentate. Length, $1\frac{3}{4}$ mm.

Hab.—Western Australia: Geraldton (A. M. Lea).

On the lower surface and legs the scales are almost of a snowy whiteness, but on the upper surface and on the flanks of the prothorax they are tinged with yellow: the scales on the elytra, although condensed into distinct lines, are not placed singly, as in some of the preceding species. The base of the head is sparsely clothed and the apex of the rostrum is nude.

Baris microscopica, n. sp.

Black, moderately shining. Upper surface almost glabrous, lower sparsely clothed with white scales.

Head with distinct punctures between eyes, but feeble elsewhere. *Rostrum* stout, scarcely the length of prothorax; shining and feebly punctate on upper surface, and moderately coarsely on sides. Scape inserted almost in exact middle of rostrum. *Prothorax* with rather large, clearly defined punctures, except in middle of apex. *Elytra* very little wider than prothorax, parallel-sided to near apex: with narrow not visibly punctured striæ, interstices each with a row of minute punctures. *Femora* edentate. Length, 1 mm.

Hab.—Western Australia: Geraldton (A. M. Lea).

The non-squamose body distinguishes this from the other Western Australian species; it is the smallest known Australian species of its subfamily.

BARIS SUBLAMINATA, n. sp.

Black, shining, antennæ and tarsi of a dull reddish brown, scape somewhat paler. Under surface and legs with fine setose scales, elsewhere glabrous.

Head with small and sparse punctures between eyes, very indistinct elsewhere. *Rostrum* thin, longer than prothorax, flattened but not depressed at its junction with head; with coarse punctures at sides, upper surface with moderately strong punctures on basal half, but becoming much smaller and sparser towards apex. Scape inserted about two-fifths from apex of rostrum; basal joint of funicle almost twice as long as second. *Prothorax* with large, dense, clearly-defined punctures, becoming much smaller and sparser (but still clearly defined) at apex and along middle. *Elytra* cordate; narrowly striate, the two sutural striæ with a few rounded basal punctures, encroaching on the interstices, the lateral striæ with distinct but deeply set punctures; interstices each with a row of exceedingly minute punctures. *Femora* feebly dentate. Length, $3\frac{3}{4}$ mm.

Hab.—Queensland: Cairns (Macleay Museum).

At first sight very suggestive of *Myctides*, but the short pectoral groove, apart from other characters, prevents it from being placed in that genus. In shape it is much like *angophoræ* and *sororia*, but much larger, and punctures very different. The large punctures at the sides of the prothorax are each almost the size of the scutellum. The lateral interstices seem to be slightly overlapping, and the seriate punctures of all of them are so small as to be practically absent.

Section 2.

BARIS ELLIPTICA, n. sp.

Black or almost black, rostrum and appendages of a dull red. Moderately densely clothed with whitish setiform scales and forming lines on the elytra.

Head almost impunctuate except between eyes, with traces of a feeble median line. Eyes more coarsely faceted than usual. *Rostrum* distinctly longer than prothorax, rather thin, rather suddenly arched at base, with a distinct but not deep depression marking its junction with head; with coarse punctures at base and sides and sparser and smaller (but not very small) ones elsewhere. Scape inserted about two-fifths from apex of rostrum. *Prothorax* with fairly large punctures, but which are more or less concealed by clothing. *Elytra* slightly wider than prothorax, parallel sided to near apex; deeply striate, punctures of striæ and interstices more or less concealed. *Femora* edentate. Length, $3\frac{1}{4}$ mm.

Hab.—North-west Australia: Derby (R. Helms).

The outline is almost perfectly elliptic. The eyes are less finely faceted than usual, but they are certainly not coarse. The colour is somewhat variable; in two specimens the legs are very slightly paler than the body, in two others they are more noticeably paler, and in a fourth very decidedly pale. The under surface is sometimes diluted with red. The upper surface is never of the deep jetty black so characteristic of *Baris*. On the upper surface the scales are not quite so white as on the lower; the lines of white scales on the elytra are very distinct, but in addition to these there are some slate-coloured ones, which at first sight are apt to be overlooked, but they may really be discoloured white ones, as they are much more numerous on some specimens than on others.

Section 3.

BARIS GLABRA, n. sp.

Black, shining; basal half of scape of a dull red. Glabrous.

Head with moderately distinct punctures between eyes, small and indistinct elsewhere. *Rostrum* rather stout, slightly longer than prothorax; with coarse punctures becoming very coarse at base and sides, a distinct depression marking its junction with head. Scape inserted about one-third from apex of rostrum. *Prothorax* with fairly numerous and clearly defined but not very large punctures on disc, becoming denser and larger on sides. *Elytra* elongate-cordate, distinctly wider than prothorax; narrowly striate towards base, with punctures in striæ, but these distinct and encroaching on interstices only towards the suture; interstices with scarcely visible punctures. *Femora* finely but acutely dentate. Length, $2\frac{2}{3}$ mm.

Hab.—Queensland: Cairns (Macleay Museum).

In general appearance close to *sororia* (which also occurs at Cairns), but the elytral interstices practically impunctuate, and the prothoracic punctures sparser.

BARIS ALBOPICTA, n. sp.

Black, highly polished, basal half of funicle and the scape of a dull red. Clothed with snowy white scales, irregularly distributed and forming elongated spots in places.

Head with small and rather sparse but clearly defined punctures. *Rostrum* rather thin, slightly longer than prothorax, its junction with head marked by a depressed line, with rather small but clearly-defined punctures, except at sides of base, where they are concealed by scales. Scape inserted about two-fifths from apex of rostrum, basal joint of funicle stouter, but not longer than second. *Prothorax* with clearly-defined but small and not dense punctures, becoming larger at base and sides. *Elytra* elongate-cordate, outline almost continuous with that of prothorax; punctate-striate, punctures deeply set and encroaching on interstices only towards the base; interstices with sparse and exceedingly minute punctures, the lateral ones with an appearance as of feebly overlapping. *Femora* acutely and rather strongly dentate. Length, 6 mm.

Hab.—Queensland: Cape York (type in Macleay Museum).

The upper surface is glabrous, except for three distinct spots on each elytron; of these two are on the fourth interstice (one basal, one—the longest of all—post-median), and one on the second (apical and slightly smaller than the basal one). The legs are moderately densely clothed, but the apex of the upper surface of each of the femora has a similar patch to those on the elytra; apex of prosternum, sides of metasternum, and sides of rostrum behind the antennæ with large scales, elsewhere almost or quite glabrous.

Baris tenuistriata, n. sp.

Black, highly polished. Upper surface glabrous, except for a patch of white scales on the third interstice of the elytra at the base; lower surface sparsely clothed with indistinct whitish scales, but a distinct patch on the flanks of the metasternum; legs with moderately distinct scales.

Head with moderately large but clearly-defined punctures. *Rostrum* no longer than prothorax, its junction with head marked by a transverse impression, base wider than apex; with coarse punctures at sides and base, smaller (but distinct) along middle, and fine at apex. Scape inserted slightly nearer apex than base, basal joint of funicle distinctly longer than second. *Prothorax* almost parallel-sided to near apex; with rather sparse and small but clearly-defined punctures. *Elytra* elongate-cordate, scarcely wider than prothorax; very narrowly striate, the four sutural striæ at base with more or less rounded and distinct punctures, elsewhere and the interstices impunctate. *Femora* edentate. Length, 3 mm.

Hab. — Queensland: Cape York, Cairns (Macleay Museum), Barron Falls (A. Koebele).

The highly-polished upper surface, glabrous except for a patch of white scales on each side of the base of the elytra, renders this a very distinct species.

Section 4.

BARIS ALBIGUTTA, n. sp.

Black, highly polished; base of scape of a dull red. Upper surface glabrous, except for a stripe of snowy scales on the fifth interstice, extending from just beyond the middle to near the apex; sides of base of rostrum and sterna with a few large scales, rest of under surface with subsetose clothing, or glabrous, legs (except parts of femora where the scales are dense) with rather sparse clothing.

Head as in the preceding species. *Rostrum* scarcely the length of prothorax; with coarse concealed punctures at base and basal half of sides, small but distinct punctures on apical half of sides, and fine elsewhere. Scape inserted almost in exact middle of rostrum; basal joint of funicle twice as long as second. *Prothorax* and *elytra* as in the preceding species, except that the punctures are more distinct, and in the elytral striæ a few small ones are to be seen towards the sides. *Femora* edentate. Length, 4 mm.

Hab.—Queensland: Cairns (type in Macleay Museum).

In general appearance close to the preceding species, but the white elytral scales subapical instead of basal.

Section 5.

BARIS NIVEONOTATA, n. sp.

Black, highly polished; head, rostrum, legs, and sides of elytra more or less obscurely diluted with red, antennæ (club excepted) of a more distinct red. Prothorax and elytra with irregular spots of large, soft, pearly-white scales; sterna, legs, and rostrum with subsetose scales; flanks of metasternum with somewhat similar scales to those of upper surface; elsewhere glabrous or almost so.

Head with indistinct punctures, even between eyes. *Rostrum* slightly longer than prothorax, rather strongly but not suddenly arched at base, with coarse but partially concealed punctures on sides, base with large, clearly-defined punctures, becoming much smaller (but still clearly defined) to apex. Scape inserted about two-thirds from apex of rostrum; basal joint of funicle as long as the three following combined. *Prothorax* with strongly rounded sides: disc with fairly large and clearly-defined but not dense punctures, but becoming dense on sides. *Elytra* elongate-cordate, distinctly wider than prothorax; punctate striate, punctures in striæ deeply set; interstices each with a row of minute punctures. *Femora* edentate. Length, 4½ mm.

Hab.—North-west Australia (Macleay Museum).

On the prothorax the scales are formed into irregular spots at the sides, on the elytra they form four distinct spots (appearing much like interrupted fasciæ), two basal and two postmedian; in addition a few are scattered about singly or are clustered together to form small spots.

*Section 6.**

BARIS BASIROSTRIS, n. sp.

Of a dingy reddish-brown and subopaque. Moderately densely clothed with yellowish subsetose scales.

Head with moderately distinct punctures. *Rostrum* slightly longer than prothorax, base much wider than apex, suddenly and strongly arched; apical half of upper surface with moderately distinct punctures, elsewhere with coarse but more or less concealed punctures. Scape inserted in exact middle of rostrum; basal joint of funicle as long as the two following combined. *Prothorax* parallel-sided to near apex; with dense and fairly large but partially concealed punctures. *Elytra* elongate-cordate, not much wider than prothorax; deeply striate, punctures in striæ and interstices more or less concealed. *Femora* edentate. Length, 3½ mm.

Hab.—Queensland: Cairns (Macleay Museum).

The apical half of the rostrum is glabrous, and the scales are condensed into a feeble median line and a distinct spot on each side of base of prothorax, and into feeble spots on the elytra; but with these exceptions the clothing is fairly evenly distributed.

Seen from the side, there appears to be a deep notch between the head and base of rostrum in this and the following species, much as in Pascoe's figure of *Acythopeus bigeminatus*.†

BARIS DEVIA, n. sp.

Reddish-brown and shining, scape somewhat paler. With soft yellowish scales, sparsely and irregularly distributed on the under surface, clothing the sides of base of rostrum, and formed into elongated spots on the upper surface.

Head with rather dense but not clearly defined punctures. *Rostrum* slightly longer than prothorax; with coarse punctures except at tip; its junction with head as in preceding species. Scape inserted one-third from apex of rostrum; first joint of funicle as long as the two following combined. *Prothorax* with clearly-defined but not very large or dense punctures on disc, becoming larger and denser at sides. *Elytra* striate, with fairly distinct punctures in striæ towards base and sides; interstices each with a single row

* *Leucospila* belongs to this section.

† Journ. Linn. Soc. Zool., xiii., pl. iii., fig. 17.

of indistinct but not very minute punctures. *Femora* edentate. Length, 3¼ mm.

Hab. — Queensland: Cape York, Cairns (Macleay Museum).

There are a few irregular scales at apex of elytra, but except for these the clothing on the upper surface is condensed into elongated spots, of which there are three on each elytron, one on the ninth interstice before the middle, and two on the third (one basal and one postmedian); on the prothorax the scales are formed into slightly-arched lines extending from base to apex, and appearing as continuations of the basal markings on elytra. The scales appear to be easily abraded, as on only one of the three specimens before me are they present on the rostrum. On two of them the scales of the upper surface are of a pale yellow, but on the third they are almost of a snowy whiteness. The outline is almost exactly as in the preceding species, but the punctures are much more distinct owing to the very different clothing.

Section 7.

Baris ebenina, n. sp.

Black, shining; scape piceous-red. Glabrous.

Head with very indistinct punctures. *Rostrum* moderately thin, distinctly longer than prothorax; with coarse punctures at sides and rather fine ones elsewhere; a feeble transverse impression marking its junction with head, but the impression narrowly foveate in middle. Scape inserted about two-fifths from apex of rostrum. *Prothorax* with small and rather sparse but clearly-defined punctures. *Elytra* cordate, outline continuous with that of prothorax; striæ very narrow, but towards base with fairly numerous, round, clearly-defined punctures encroaching on the interstices; these each with a row of almost microscopic punctures. *Femora* edentate. Length, 2½ mm.

Hab.—Queensland: Barron Falls (A. Koebele).

In general appearance somewhat like *glabra*, but rostrum longer, prothoracic punctures sparser, and elytral punctures and interstices and the prosternum different.

Section 8.

Baris porosa, n. sp.

Black, opaque. Lower surface, legs, and rostrum with minute indistinct scales or setæ, elsewhere glabrous or almost so.

Head with dense but indistinct punctures. *Rostrum* stout, slightly shorter than prothorax, very coarsely punctate except for a rather narrow shining line from between antennæ to apex. Scape inserted almost in exact middle of rostrum. *Prothorax* with very dense and moderately large punctures. *Elytra* elongate, cordate, not much wider than prothorax, punctate-striate, punctures in striæ deeply set; interstices coarsely punctate, each puncture almost extending from stria to stria. *Under surface* (abdomen to a less extent) and *legs* coarsely punctate; *femora* almost edentate. Length, 3½ mm.

Hab.—Queensland: Cairns (Macleay Museum), Mackay (C. French).

Much more densely punctate than any other species of the subfamily known to me.

Gymnobaris, n. g.

Head small, eyes rather distant. *Rostrum* rather long and thin, moderately curved. Antennæ thin, scape inserted nearer apex than base of rostrum, first joint of funicle large. *Prothorax* transverse. *Elytra* subcordate. Prosternum with a wide and feeble groove, bounded on each side by a feeble carina to near the coxæ, these very widely separated. Pygidium concealed. *Femora* feebly grooved and dentate.

The entirely concealed pygidium readily distinguishes this genus from *Baris*, to several Australian species. of which it would otherwise appear to be allied; from *Ipsichora* it is distinguished by its slightly grooved prosternum and much more widely separated front coxæ.

Gymnobaris politus, n. sp.

Black, highly polished; scape reddish. Glabrous except for a few indistinct scales or setæ on under surface and legs, front tibiæ with long cilia at apex in male.

Head with sparse and minute but fairly distinct punctures. *Rostrum* thin, distinctly longer than prothorax, with moderately large and dense punctures at sides, but small and sparse elsewhere. Scape inserted two-fifths from apex of rostrum, basal joint of funicle as long as three following combined. *Prothorax* with sparse and minute punctures, sides oblique to near apex and then suddenly diminishing to apex. *Elytra* subcordate, shoulders closely clasping prothorax with which their outline is continuous; finely striate, two sutural striæ with a few round punctures towards base; interstices each with a row of minute, distant punctures. *Femora* rather feebly dentate. Length, 4 mm.

Hab.—Queensland: Cairns (Macleay Museum).

The punctures in the elytral interstices are so minute as to be practically invisible.

Ipsichora.*

There are five species before me which I refer to this genus, previously unknown from Australia, but numerously represented in the Malay Archipelago. Its main features appear to be the rostrum long and not gibbous at base, scape extending close to but not reaching the eye, front coxæ widely separated and the femora grooved and dentate. The species are all of a more or less metallic blue or violet. Three of those noted here (*mesosternalis*, *desiderabilis*, and *Macleayi*) have the pygidium small but visible, and causing the fifth abdominal segment to appear feebly emarginate at tip: in the others the pygidium is quite concealed and the fifth segment is continuously rounded; these differences, if the stated characters of the subfamily were strictly adhered to, would divide the species between two sections, but they are all evidently congeneric.

The Australian species may be tabulated as follows:—

Side pieces of mesosternum practically impunctate	*mesosternalis*, n. sp.
These parts with large punctures.	
Femora edentate	*desiderabilis*, n. sp.
Femora dentate.	
Femora partly red	*femorata*, Pasc.
Femora entirely dark.	
Prothorax with minute punctures	*Macleayi*, n. sp.
Prothorax with small but not minute punctures	*duplicata*, n. sp.

Ipsichora femorata, Pasc.†

Two specimens from Kuranda probably belong to this species; they differ from the original description, however, in having only the four hind femora reddish in the middle, instead of apparently the whole six.

Ipsichora mesosternalis, n. sp.

Of a brilliant metallic blue, antennæ almost black. Glabrous except for a few indistinct setæ on legs and apex of abdomen.

Head impunctate. *Rostrum* thin, strongly curved and (including the head) fully twice the length of prothorax; with distinct (but not dense or coarse) punctures at sides and very sparse ones or absent elsewhere. Scape inserted two-fifths from apex of rostrum; two basal joints of funicle equal in length. *Prothorax* with sparse and minute punctures. *Elytra* elongate-cordate, outline almost continuous with that

* Pascoe: Journ. Linn. Soc. Zool., xii., p. 58.

† *l.c.* p. 59.

of prothorax; rather finely striate, punctures in striæ small, but usually slightly encroaching on interstices; each of these with a row of minute punctures. *Under surface* with sparse and minute punctures, side pieces of mesosternum practically impunctate. *Pygidium* small, but distinct. *Femora* feebly dentate. Length, 5 mm.

Hab.—Queensland: Somerset (C. French), Cairns (Macleay Museum).

Of the two specimens before me one has a distinct, whilst the other has a slight, purplish gloss. It is the only species of the subfamily known to me in which the side pieces of the mesosternum are not impressed with large punctures.

Ipsichora desiderabilis, n. sp.

Of a brilliant metallic blue; under surface, legs, and rostrum of a more or less metallic green; antennæ almost black. Glabrous.

Head with small and indistinct punctures. *Rostrum* (for the genus) fairly stout, slightly longer than prothorax; with fairly large and distinct punctures on sides, sparse and minute elsewhere. Scape inserted about one-third from apex of rostrum; basal joint of funicle as long as the two following combined. *Prothorax* with minute and rather sparse but clearly defined punctures. *Elytra* elongate-subcordate, outline quite continuous with that of prothorax; punctures much as in preceding species, except that in the three sutural striæ near the base they are distinctly rounded. *Under surface* with irregularly distributed punctures of variable size, but larger on side pieces of mesosternum than elsewhere. *Pygidium* small but distinct. *Femora* edentate. Length, 3½-5 mm.

Hab.—Queensland: Cairns (Macleay Museum and H. Hacker).

The edentate femora and comparatively short rostrum will readily distinguish from the other Australian species. There are six specimens before me, of which four, probably the males, have the pygidium fairly distinct, and a large round fovea on the apical segment of the abdomen; the others have the pygidium smaller and the fovea absent.

Ipsichora Macleayi, n. sp.

Black, highly polished, with a more or less distinct purplish gloss; antennæ (base of scape reddish) almost black. Glabrous, except for some very indistinct setæ on legs and sides of under surface.

Head with sparse and minute punctures. *Rostrum* thin, twice the length of prothorax: punctures fairly dense and large on sides behind antennæ, sparse and small elsewhere.

Scape inserted in middle of rostrum; basal joint of funicle as long as the two following combined, second as long as the two following combined. *Prothorax* with sparse and minute punctures, but with larger ones margining the base. *Elytra* shaped as in *mesosternalis*, but with punctures as in the preceding species. *Under surface* with small and irregularly distributed punctures, becoming larger on mesosternum, and especially on its flanks. *Pygidium* concealed. *Femora* acutely dentate. Length, $4\frac{3}{4}$ mm.

Hab.—N.S. Wales: Morpeth (Macleay Museum), Macleay River (R. Helms).

Although a beautiful insect, the colour is much less bright and metallic than in the other species of *Ipsichora*. Of the two specimens before me one has a decided purplish gloss on both upper and lower surfaces, but in the other this gloss is almost absent.

IPSICHORA DUPLICATA, n. sp.

Of a briliant metallic purplish-blue; rostrum black, but in places glossed with green or purple; antennæ (base of scape obscure red) black. Under surface and legs with thin setose scales in punctures, elsewhere glabrous.

Head with rather small but clearly-defined punctures. *Rostrum* about once and one-half the length of prothorax; punctures clearly defined and not very sparse, and on the sides behind antennæ becoming rather dense and coarse. Antennæ as in the preceding species. *Prothorax* and *elytra* of the same shape as in *mesosternalis*, but prothorax with considerably larger and clearly defined (but still small) punctures, and a distinct row margining the base; elytral striæ with fairly numerous punctures encroaching on the interstices, and each of these on basal half with a feeble double row, and beyond middle a single row of minute punctures. *Under surface* with small punctures, but becoming large on mesosternum, especially on its flanks. *Pygidium* concealed. *Femora* acutely dentate. Length, $5\frac{1}{2}$ mm.

Hab.—Queensland: Darling Downs (C. French).

Close to the preceding species, but larger and with considerably larger and somewhat different punctures.

A specimen, from the Endeavour River in the Macleay Museum, has the under surface quite glabrous, and the prothoracic punctures somewhat larger.

MYCTIDES.

This genus is widely distributed in the Malay Archipelago, and two species of it have already been recorded from Queensland. Its members have the rostrum very long, scape terminated some distance from the eye, femora feebly dentate, prosternum wide, not grooved, front coxæ distant, and the pygidium exposed. According also to Pascoe, "the males of all the species have the rostrum somewhat straighter, with the apical half within closely bearded."*

Of the species hitherto recorded from Australia, *barbatus*† seems to be close to *imberbis*,‡ but is described as black with the rostrum fuscous, the basal joint of the funicle twice as long as the second, the prothorax with small and sparse punctures, and the elytral interstices "*subtiliter sparse punctulatis*." All of which are at variance with *imberbis*, apart from its beardless rostrum. There is a bearded male in the Macleay Museum from the Endeavour River which may be *barbatus*; it is deep black without metallic gloss, the prothoracic punctures finer than in *imberbis* (but certainly not sparse), and the punctures in the elytral interstices minute and not transverse; its rostrum, however, is just as dark as the rest of its body. *Familiaris* is described as a large (5 mm.) black species, with the prothorax sparsely punctured, its rostrum is apparently bearded in the male; I do not think that I have seen it.

MYCTIDES IMBERBIS, n. sp.

Black, shining; with (except on head and rostrum) a metallic purplish gloss; antennæ obscurely (or not at all) diluted with red. Lower surface and legs moderately densely clothed with white or whitish scales, denser at apex of prosternum than elsewhere; upper surface, head, and rostrum glabrous.

Head with dense, clearly defined but not large punctures. *Rostrum* thin, much longer than prothorax; with coarse punctures at extreme base and on sides behind antennæ, small and sparse elsewhere. Scape inserted in middle of rostrum; basal joint of funicle once and one-half the length of second. *Prothorax* with fairly dense and rather large clearly-defined punctures, becoming denser and larger on sides. *Elytra* wide and subcordate, outline almost continuous with that of prothorax; with distinct striæ, towards base with punctures encroaching (especially in the two sutural rows) on interstices, towards sides punctures deeply impressed, but not interfering with interstices; these with short transverse scratches instead of punctures. *Femora* finely, but acutely dentate. Length, 4½-5½ mm.

Hab.—Queensland: Cooktown (C. French), Kuranda (H. H. D. Griffith).

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* Ann. Mus. Civ. Gen., 1885, p. 293.

† Described originally as from Batchian.

‡ One of my specimens of this species bears a label, in the Rev. T. Blackburn's writing, *Myctides barbatus*, Pasc.

Judging by the antennæ both sexes of this species are before me, and in neither is the rostrum barbed; in one specimen (presumably the male) the rostrum is at least once and one-third the length of the prothorax, in two others (presumably the females) it is much longer. In one specimen of each sex the scape is at rest in its scrobe, with the rest of the antenna directed forward; in the male the funicle and club extend distinctly more than halfway to the apex of the rostrum from the tip of the scape, in the female they extend considerably less than halfway to the apex.

MYCTIDES BALANINIROSTRIS, n. sp.

Black, highly polished; scape obscurely diluted with red. Clothing as in the preceding species, except that it is sparser.

Head with fairly numerous and small but clearly-defined punctures. *Rostrum* thin, except at the base, considerably longer than prothorax; punctures as in the preceding species. Scape inserted slightly nearer base than apex; basal joint of funicle as long as the two following combined. *Prothorax* less transverse than in the preceding species; with comparatively small and rather sparse but sharply-defined punctures. *Elytra* subcordate, closely clasping prothorax, deeply striate, the punctures in the striæ deeply impressed and scarcely, even towards the base, encroaching on the interstices, each of these (except towards the base where they are more or less irregularly doubled) with single rows of minute punctures. *Femora* almost edentate. Length, 3½-5 mm.

Hab.—Queensland: Endeavour River, Cairns (Macleay Museum).

There are five specimens before me, varying considerably in size, but apparently of one sex.

ACYTHOPEUS ATERRIMUS, Waterh.*

Baris orchivora, Blackb.

Described by Waterhouse from Singapore as attacking orchids, subsequently described as a *Baris* by Blackburn, also as attacking orchids, and figured in the *Agricultural Gazette* of New South Wales† under the latter's name. The species is readily distinguished by its opaque surface and peculiarly granulated elytral interstices. Mr. Waterhouse sent a specimen of his *aterrimus* to Mr. Froggatt, who kindly allowed me to examine it and compare it with a specimen of *orchivora*, reared by himself from orchids, and there is no doubt

* Ent. Mo. Mag., vol. x., p. 226.

† 1904, fig. 2, in a plate facing p. 514.

about the identity of the same. Waterhouse's is the earlier name.

Waterhouse referred the species to *Baridius*, but stated that it would probably enter into Pascoe's genus *Acythopeus*.* It seems to me, however, that the species cannot be referred to *Acythopeus*,† of which Pascoe says that the scape is remote from the eye; in *aterrimus* it extends quite close to the eye; he also says:—"Near *Myctides*, only the rostrum is very much curved and thickened at the base." Certainly in *aterrimus* the outlines are very different from the two figures of the rostrum and head as figured for *tristis* and *bigeminatus*.‡ The sculpture of the elytra also is very different to that described by Pascoe in the five species known to him. But as the species is an introduced one I have not felt justified in proposing a new generic name for it.

Solenobaris, n. g.

Head comparatively large. Eyes large, round, and close together. *Rostrum* moderately stout, the length of prothorax, moderately curved. Antennæ stout; scape inserted about middle of rostrum, resting in a shallow scrobe, and extending back to the eye;¶ basal joint of funicle stout. *Prothorax* slightly transverse. *Elytra* cordate. Prosternum with a moderately wide and deep pectoral canal, sharply limited on the sides and terminated behind front coxæ. *Abdomen* large, first segment slightly longer than the two following combined. *Pygidium* rounded and distinct. Legs moderately long. *Femora* not very stout, feebly or not at all dentate.

At first sight apparently belonging to the *Cryptorhynchides*, and close to *Idotasia* of that subfamily, but the side pieces of the mesosternum are unusually large and are typical of the *Baridiides;* the pygidium is also distinct. The pectoral canal, however, is quite as in many of the *Cryptorhynchides*, as is also the intercoxal process of the mesosternum. I think the genus should be referred to the very end of the *Baridiides*.

Solenobaris decipiens, n. sp.

Deep black, shining, antennæ almost black. Glabrous. *Head* rather densely and strongly punctate. *Rostrum*

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* At that time (January, 1874) unpublished.

† It is certainly not a *Baris*, however, as the prosternum is without the slightest trace of a longitudinal impression.

‡ Journ. Linn. Soc. Zool., xii., pl. iii., figs. 11*a* and 17.

¶ It really does extend back to the eye, although when set out it apparently does not do so.

stout, compressed, dilated to apex: coarsely punctate at sides and distinctly but not coarsely elsewhere. *Prothorax* with moderately small and not dense punctures, larger on flanks than on disc. *Elytra* cordate; at sides and near suture feebly striate, elsewhere scarcely visibly so; near base, especially about suture, with rows of rather large, round, distant punctures, disappearing before the middle, a few punctures about shoulders, elsewhere impunctate. *Mesosternum* with intercoxal process depressed between coxæ, raised transverse and narrow in front, and its sides angularly produced to front coxæ: side pieces with larger punctures than elsewhere. *Pygidium* densely and strongly punctate. *Femora* feebly grooved and feebly bidentate, the teeth level, subequal in size, and marking the termination of the ridges bordering the grooves. Length, $2\frac{3}{4}$ mm.

Hab.—Queensland: Endeavour River (Macleay Museum).

Remarkably close in general appearance to *Baris ebenina*, but the prosternum with a deep pectoral canal. The intercoxal process of the mesosternum on a first glance appears to form part of the prosternum.

Solenobaris edentata, n. sp.

Black, shining, upper surface with a bluish gloss. Glabrous.

Head rather sparsely and finely punctate. Eyes rather larger and closer together than in the preceding species. *Rostrum* almost parallel-sided, punctate at sides. *Prothorax* longer than in preceding species: moderately strongly punctate, punctures not much larger on sides than on disc. *Elytra* rather longer than in the preceding species, all the striæ traceable: punctures much as in the preceding species, but larger. Intercoxal process of *mesosternum* transverse and feebly concave, side pieces with larger punctures than elsewhere. *Femora* very feebly grooved and edentate. Length, $1\frac{4}{5}$ mm.

Hab.—Queensland: Barron Falls (A. Koebele).

In many respects different to the preceding species, but with the same deep and sharply limited pectoral canal. A second specimen differs from the type in being slightly smaller, with larger punctures and with a bronzy gloss.

Notes on South Australian Decapod Crustacea. Part IV.

By W. H. Baker.

[Read June 5, 1906.]

Plates I. to III.

The following notes refer to seven species. The first three are members of the Oxyrhyncha or Maioid crabs. Two of these were dredged by Dr. Verco in 104 fathoms off the Neptune Islands. One of these two I have referred to the genus *Eurynome;* the other is a species of *Stenorhynchus;* the third I take to be a strong variety of *Paratymolus latipes*, Haswell, and comes from much shallower water.

Two allied species belong to genera quite remote from the foregoing: *Elamena truncata*, Stimpson?, and *Hymenosoma rostratum*, Haswell, do not seem to have been figured heretofore.

Litocheira glabra, n. sp., seems to be as rare as its near relation, *L. bispinosa*, Kinahan, is common on our coast. These two are the only representatives of the genus known to me in the Australian fauna.

The rare genus, *Trichia*, is represented by a unique species, which I must be content solely to describe, as its affinities are unknown to me Miss Rathbun (see Proc. Biolog. Soc., Washington, No. xi., p. 166) has proposed the name *Zalasius* for *Trichia*, but for certain reasons I have retained the old one.

The types have been placed in the Adelaide Museum.

I must mention my indebtedness to Mr. F. E. Grant, of Sydney, who has been good enough to read the paper and offer some criticisms, and supply some information.

OXYRHYNCHA.

Family Inachidæ.

Sub-family Leptopodiinæ.

Genus *Stenorhynchus*, Lamarck.

Stenorhynchus ramusculus, n. sp.

Pl. i., figs. 1, 1a.

The body is thick.

The carapace is sub-triangular, moderately smooth, longer than broad, strongly convex, especially on the gastric region; the branchial regions also are full. There is a median gastric and a cardiac spine, which project upwards, and a small curved spine on each metabranchial region.

The rostral horns are rather long, slender, tapering, not divergent, projecting horizontally, slightly distant; each is bifid at the apex, with a lateral spine lower down on the distal third, and a faint spinule near the base on the outer side.

The upper orbital border is slightly raised, and bears a large supra-orbital spine, which is curved forwards and outwards, and immediately anterior to this there are two or three minute teeth on the margin. There is a post-ocular spine on the hepatic region, and below and behind it the sub-hepatic region is visible from above as a conical prominence tipped with two small teeth. The branchial regions have each a lateral spine.

The posterior margin is medianly slightly insinuate, and towards the sides bears a row of minute spinules.

A faint median groove extends from the rostral horns a short distance behind on the narrow inter-ocular space.

The ocular peduncles are thick, and the eyes well developed and retractile towards the sides of the carapace. There is a small spinule on the anterior side of the peduncle.

The antennular fossettes are elongate, and the median ridge between each is produced to a large downward projecting spine.

The basal antennal joint is narrow on the part forming the external boundary of the fossette. It appears slightly grooved longitudinally, and is curved to form the lower border of the eye socket, it distally bears a strong spine, which projects forwards and downwards and very slightly outwards. The portion which limits the fossette bears three or four spinules along its length, with a few very small ones on the external border; the basal portion of the joint is continuous with the epistome. The second peduncular joint is short, the third long, the flagellum sparingly furnished with long setæ.

The epistome is long and narrow.

The antero-external angles of the buccal frame are prominent and acute, the upper margin dips medianly into the cavity.

The pterygostomial region has a prominent oblique ridge, which bears a strong spine about the middle.

The sternal plastron has a strong, transverse, lunate ridge between the bases of the chelipeds, this ridge has its outer ends spined; a rather large excavated area exists between the ridge and the base of the buccal frame; on the posterior side the ridge is reached by the terminal segment of the pleon.

The pleon is composed of six segments in the male. The first two are narrow from side to side; the third is broadest, and has three prominences, each bearing a few small denticles; the lateral prominences are larger than the median. The two following segments are medianly prominent, and the distal end of each prominence bears one or two spinules, the terminal segment is rounded at the end, and bears a strong median spine on the basal median elevated portion, and two smaller ones close to the distal end.

The external maxillipeds do not completely close the buccal cavity. The ischium is well produced at its internal distal angle, the merus is narrower and shorter than the ischium, longer than broad, rounded distally with a strong spine on the inner margin, and a few spinules on its external surface, the succeding joint is articulated at its summit. The exopod reaches farther than the external angle of the merus.

The chelipeds are long, robust, considerably over-reaching the rostral horns. The ischium is spinulate. The merus is trigonous, reaching as far as the eyes, curved, bearing a row of strong spines on the lower margin, and more or less is spinulate on the internal surface; there is a large forward curved spine on the upper side near the distal end. The carpus is sub-cylindrical, slightly curved, and spinulate, with a large curved spine above near the proximal end. The palm is tumid and bears some strong spines on the upper and lower margins, otherwise it is smooth. The fingers are long, nearly as long as the palm, curved, laterally compressed, slightly ridged externally, their opposable edges more or less dentate and without an hiatus.

The ambulatory legs are very long and slender, the joints expanding a little distally, the meri bear distal spines projecting anteriorly, the dactyli are long and nearly straight till near the distal ends, bearing a few minute recurved teeth—especially one close to the terminal claw—and some hairs. The joints bear some scattered groups of curved bristles, as is usual among these Maioid crabs.

This species bears strong resemblances to *Lispognathus thomsoni*, Norman, as figured in the "Challenger" report. The basal antennal joint, however, is adherent, or fused, for the whole of its length, and does not narrow distally.

Length, excluding rostral horns, 6 mm.
Breadth, 4½ mm.
Length of cheliped, 8 mm.
Length of second leg, 19 mm.
Dredged by Dr. Verco, S.A. coast, 104 fms.
Type (1).

Family Paratymolidæ.

Genus *Paratymolus*, Miers.

Paratymolus latipes, Haswell; var. *quadridentata*; n. var.
Pl. i. fig. 2.

The body and limbs are covered with a short pubescence of flattish hairs, amongst which longer, reddish, club-shaped ones are scattered. The anterior third of the carapace is much depressed, as is also to a somewhat less degree the posterior third; it is only slightly convex in the transverse direction.

The front consists of two short, obtuse projections, each tipped with two small acute teeth, from the narrow hiatus between these projections a shallow median sulcus extends back for a short distance; there is also a shallow sulcus between each rostral projection and supra-orbital spine.

The surface of the carapace is uneven, but the regions are indistinctly defined. The gastric region is rather timid.

The antero-lateral borders are irregularly toothed, four larger ones on each side are spiniform and directed forwards, and have the following positions:—One on the inner orbital angle, one on the exterior orbital angle, one on the lateral angle of the carapace, with the largest midway between this and the one on the external orbital angle. Besides these there are smaller more or less spiniform tubercles between the larger ones, the most posterior of these terminates an oblique rounded ridge, which extends some distance on the carapace.

The undersides of the rostral projections are completely occupied by the fossettes, which are longitudinal or slightly oblique in position. The antennules are large, the basal joints separated by only a very thin septum.

The orbits are shallow, there is a spiniform tooth at the internal sub-ocular angle, the remainder of the lower margin being a thin ridge bearing a few spinules. The eyes are of moderate size, the peduncles being constricted.

The basal joint of the antenna is large and mobile, filling the orbital hiatus; the next two joints are also large, the second longer than the first, and the third longer than the second. The flagellum is long and carries club-shaped hairs.

The epistome is rather broad, its anterior border is straight and granulate, posteriorly and medianly it is divided by an incision into two lobes, which project into the buccal cavity.

There are no endostomial ridges.

The external maxillipeds are sub-opercular; the ischium is twice as long as broad, is prominent at its internal distal angle, and has a longitudinal sulcus; the merus is small, about half as long as the ischium, sub-pentagonal in shape, with granulate or spinulate margins and two longitudinal sulci, with a few spinules between them; the next three joints are large, united to the merus behind its apex. The exopod reaches to the external angle of the merus.

The sub-orbital, sub-hepatic, and pterygostomial regions are granulate to spinulate, the latter somewhat tumid.

The pleon in the male is five-jointed, triangular from the second segment; in the female it is six-jointed, and scarcely larger, not nearly covering the dense mass of small ova.

The chelipeds in the male are long and strongly developed; the merus is trigonous and granulate, to spinulate on the margins, especially below, on the upper border there is a small tubercle near the middle; the carpus is rounded above, and indistinctly ridged with a very large internal spine; the palm is much compressed, the outer surface rounded and faintly ridged, with a strong longitudinal sulcus near the upper border, proximally narrowed in the vertical direction, it is distally expanded, and the upper border is denticulated, the internal surface is granulate and slightly excavate. The fingers are shorter than the palm, irregularly toothed, slightly ridged, and sulcated towards their tips, which are brown in colour, externally granulate, and only meeting at their tips.

The ambulatory legs are slender, compressed, and not as long as the chelipeds in the male. The dactyli are longer than the propodi, are nearly straight, and longitudinally sulcate; the propodi also have external sulci and two granulate ridges on each of their inner surfaces.

Length of carapace in male, 13 mm.
Breadth of carapace in male, 11 mm.
Length of cheliped in male, 26 mm.
Specimens dredged by Dr. Verco, S.A. coast.

Family MAIIDÆ.

Sub-family MAIINÆ.

Genus *Eurynome*, Leach.

Eurynome granulosa, n. sp.

Pl. i., figs. 3, 3a.

The animal is covered with a very short furry tomentum, which entangles much mud.

The carapace is elongate-ovate, to sub-pyriform, moderately convex, with the regions well defined. The surface is mostly covered with large granules, which, however, are not crowded, and which become tuberculiform, or sub-spiniform, on the sides of the branchial regions, and are more marked as follows:—Two mid-gastric, one on each side latero-gastric, one on each epibranchial region, one each median on the cardiac and intestinal regions, and two latero-intestinal. The inter-orbital space is slightly raised above the orbital borders, and bears some small red granules, a shallow transverse sulcus divides this from the gastric region, and also sulci separate it from the orbital borders.

The rostral horns are small, well separated, divergent, acute, horizontally projecting, sub-cylindrical, tapering, and slightly curved inwards; externally they bear a few very minute teeth, and internally some long corneous bristles.

The eyes are small, the peduncles short, in almost complete orbits, and are slightly visible when retracted. The upper orbital border has the anterior portion arcuated in the vertical direction; the posterior end, however, is not spined. A small hiatus separates this end from what I have called elsewhere the intermediate spine of the upper orbital border; external to this is another process, which corresponds to the post-ocular spine separated only from the former by a closed fissure. The lower orbital border is marked by two closed fissures.

The hepatic regions are depressed, projecting, and more or less lobate, separated from the branchial regions by narrow V-shaped clefts of the margin. The postero-lateral and posterior margins are rounded and thickened.

The anterior margins of the fossettes reach close to the margin of the front; the lower halves of their external margins are formed by the basal antennal joints.

The basal antennal joint is moderately large, with a strong outer lobe, or branch, which forms part of the lower orbital border; it narrows slightly towards the distal end, and is without distal spines. The second and third peduncular joints are small, and the flagellum minute. The second peduncular joint springs from the anterior angle of the orbit, there being no closed fissure, caused by an upper pressure of the end of the basal joint against the upper orbital border, as in *Paramithrax* and other genera.

The epistome is rather narrow, and a little excavate. The external angles of the upper margin of the buccal frame are very prominent, but the upper margin is depressed medianly.

The sub-hepatic region is separated from the sub-orbital by a slight excavation, and from the pterygostomial by an oblique sulcus; both regions are strongly granulate, and not spined.

The external maxillipeds have the ischium produced at the internal distal angle; its surface is marked by a deep longitudinal furrow. The merus is triangular, the external distal angle is slightly produced, the internal distal angle slightly truncated and very slightly insinuate; the lower border is thickened and prominent, and there is a pit about the middle of the outer surface. The carpus is partially hidden by the internal angle of the merus.

The pleon of the female is seven-segmented; all the segments are free, the terminal one is broadly triangular, with the external margins slightly insinuate. The other segments are medianly umbonate.

The chelipeds in the female are weak, reaching a little beyond the rostral horns; the merus is sub-cylindrical; the carpus is noncarinate, the palm is scarcely compressed laterally; the fingers are moderately long, shorter than the palm, thin, and sharp, the immobile one with distinct brownish teeth, the mobile scarcely toothed; this appears to be slightly excavate.

The ambulatory legs are short, becoming successively shorter behind, but not markedly so; they are moderately robust and smooth, the meri appear distally rounded, the carpi and propodi are together about as long as the meri and ischii together, the dactyli are long—nearly as long as the propodi—cylindrical, with long, thin, sharp, corneous claws.

Length, excluding rostral horns, 8 mm.

Breadth, 5 mm.

Length of cheliped, 8 mm. (drawn rather large in figure).

Dredged by Dr. Verco, 104 fms., S.A. coast.

Type (1).

CATAMETOPA.

Family Ocypodidæ.

Sub-family Carcinoplacinæ.

Genus *Litocheira,* Kinahan.

Litocheira glabra, n. sp.

Pl. ii., figs. 1, 1*a*; and Pl. iii., fig. 3.

The carapace is broader than long, about as 9 is to 7½, glabrous, smooth, with the regions not defined, with some faint transverse markings on the gastric region, slightly convex, more so in the longitudinal direction than in the transverse, marked all round with a distinct border, anteriorly depressed.

The front is well arched, thin, not depressed more than the anterior part of the carapace, without a groove along the margin as in *L. bispinosa*, rather less than half the width of the carapace, not greatly accentuated from the upper orbital border; upper orbital border entire ending rather obtusely at the external angle, the oblique extent being equal to about half the front.

Antero-lateral margins slightly arcuate, with a faint insinuation near the lateral angle, but no spine; postero-lateral margins slightly converging; posterior margin very slightly insinuate.

The antennules when folded are well covered by the front.

The sub-orbital margin is entire, the inner sub-ocular angle prominent. The ophthalmopods have a small tubercle above.

The basal antennal joint does not attain to the process of the sub-ocular angle, but on the other side reaches a sub-frontal process, the third joint reaches the margin of the front, the flagellum is slightly longer than the three peduncular joints together.

The epistome is short and somewhat sunken.

The endostomial ridges are distinct.

The upper margin of the buccal frame is arcuate, with the external ends prominent.

The oblique pterygostomial ridges are well marked.

The external maxillipeds are broad and well cover the buccal orifice; the ischium presents a nearly flat surface, and its lower internal angle is not much cut away, the margin bordering the merus is slightly oblique; the merus is sub-quadrate, very slightly projecting at the external distal angle, slightly insinuated on the distal margin, the inner distal angle truncated with the upper end of this somewhat accentuated, the surface is scarcely excavate. The exopod barely attains to the external angle of the merus.

The chelipeds in the female are sub-equal, the merus reaches the lateral angle of the carapace, and bears a small spiniform tubercle about the middle of its upper edge; the carpus is sub-quadrate on the upper surface, which is convex, with a strong inner projection or tooth; the hand is short, laterally compressed, smooth, and rounded on the outside, on the inner side it is vertically abrupt; the fingers are nearly as long as the palm and much compressed laterally; the immobile finger has an oblique ridge below, extending for a short distance on to the palm, otherwise the fingers are not markedly ridged, they are crossed at the tips, and in that position are without an hiatus, and are evenly but sparingly denticulate.

The ambulatory legs are smooth, short, and quite glabrous, the dactyli are stiliform and ridged, they are longer than the propodi except on the last pair, the carpi are without external sulci.

The pleon in the female is 7-jointed, the terminal joint strongly arcuate on its distal margin.

A small species, equal in size to *L. bispinosa*.

Dredged by Dr. Verco, St. Vincent's Gulf.

Type (one female).

Family Pinnoteridæ.

Sub-family Hymenosominæ.

Genus *Elamena*, M.-Edw.

Elamena truncata, Stimpson.

Pl. ii., figs. 2. 2*a*, 2*b*, 2*c*, 2*d*.

Trigonoplax truncatus, Stimpson, Proc. Acad. Nat. Sci. Philad., 1858, p. 109.

Elamena truncata, Alcock, Jnl. Asiatic Soc. Bengal, lxix., ii., p. 386, 1900.

Elamena truncata, A. M.-Edw., Nouv. Archiv. du Mus., ix., 1873, p. 323.

Elamena truncata, J. R. Henderson, Trans. Lin. Soc. Zool. (2), v., 1893, p. 395.

Body almost totally glabrous and smooth.

Carapace sub-orbicular in outline, as broad as long, from slightly convex to depressed, with the margins raised or accentuated; the regions ill-defined. The lateral angles are slightly prominent, but not spined, the antero-lateral margins with slight prominences about the middle. Postero-lateral margins with a slight insinuation above the last pair of legs. Front prominent, about one-fourth the width of the carapace, the margin straight with rounded ends, sometimes showing from above a median slight prominence; below it a laterally-compressed triangular keel reaches its apex just anteriorly to the antennules, and forms a strong septum between them.

The orbits are shallow, totally concealed beneath the carapace, they are near each other and not separated from the fossettes. The ocular peduncles are short, thickened proximally, and do not reach the margin of the carapace.

The antennules are small.

The antennæ are slender and short, not reaching the margin of the carapace, they have the first joint very short, the second long, the third shorter than the second; the flagellum is very small.

The epistome is well developed and not depressed.

The anterior angles of the buccal frame are prominent, and between them the margin is well defined and sinuate.

The external maxillipeds are broad, completely closing the buccal cavity. The ischium is considerably longer than the merus, its articulation with it oblique, the merus is subtriangular, with its inner distal angle strongly truncated, the margin being insinuate, the carpal joint is articulated near the prominent outer angle; the exopod does not quite reach this angle.

The pterygostomial region is rather tumid, with a conical, obliquely-compressed tubercle.

The pleon of the female is very broad, covering the whole of the sternum behind the maxillipeds, truncated distally with a faint median-rounded ridge between two furrows, composed of six segments, the three more proximal ones much shorter than the others.

The male pleon is small and narrow, the sides contracting halfway to the apex, of five segments, the basal joint occupying not quite the whole width of the sternum between the last pair of legs.

The chelipeds in the female are slender, the merus cylindrical, expanding distally with a sub-acute prominence at the distal end on the outer side; the hand is tumid in the middle, giving a rather spindle-shape, viewed from above. The fingers are as long as the palm, curved inwards, and slightly twisted distally, with their outer margins minutely toothed, meeting only at their tips; from this margin the inner surface of each is much excavated. In the male the chelipeds are more robust, the hand is scarcely spindle-shaped, the fingers are more robust, and a good deal shorter than the palm.

The ambulatory legs are moderately long, the meri cylindrical, with distal, strong, sub-acute prominences above; the propodi are compressed, about one and a half as long as the carpi, which also have distal prominences, the dactyli are about three-fourths the length of the propodi, much compressed, a little constricted at their proximal ends, curved, with the margins defined by a thickened line, with a terminal, short, acute claw and two teeth near it, the innermost triangular and directed backwards; the inner margin bears a fringe of soft hairs.

A littoral species, S.A., south coast.
Breadth of carapace (male), 6 mm.
Length of cheliped (male), 9 mm.
Length first ambulatory leg, 12 mm.

Genus *Hymenosoma*, Leach.

Hymenosoma rostratum, Haswell, Cat. Aust. Crust. p. 116.

Pl. iii., figs. 2, 2*a*, 2*b*.

The following notes are to be taken in addition to the description in the above catalogue.

The surface of the carapace is sometimes convex, sometimes quite flat, or even sunken. The spines or teeth at the lateral angles are sometimes very strongly developed. The margin is raised and thickened, and the antero-lateral margin behind the post-ocular spine, which curves towards the eye, has a slight prominence. In the male the posterior margin is very short and arcuate.

The rostrum is about one-fourth the greatest breadth of the carapace, elongate, triangular, and flat above, it is strongly keeled below, the keel produced to a septum between the antennules, with its greatest depth just anterior to them.

The ocular peduncles project about half the length of the rostrum; there is a conical tooth beneath on the orbital border at the base of the peduncle, and a small tubercle on the peduncle close to the ophthalamus on the anterior side.

The epistome is rather long and full.

The anterior angles of the buccal frame are very prominent.

Of the three pterygostomial tubercles the middle one is slenderer and more spiniform.

The orbito-fossettes are very poorly developed.

The antennules are robust, and when extended reach beyond the rostrum.

The antennæ are slender and only reach a little beyond the eyes.

The merus of the external maxillipeds has the following joint articulated near the prominent and rounded external angle, and there is a slight notch at its base.

On the acute upper margin of the merus of the cheliped there is a short keel-like prominence near the proximal end, and the palm is well keeled on both its upper and lower margins.

The dactyli of the ambulatory legs are about three-fourths the length of the propodi; they are slightly curved and carry a series of small teeth of about equal size with hairs between.

A small species, not exceeding in size the *Elamena truncata*.

Genus *Trichia*, Nob. de Haan.

Fauna, Japon. Crust., p. 109.

Trichia australis, n. sp.

Pl. iii., figs. 1, 1*a*, 1*b*.

Body strongly granulate on all parts, with a few groups of long hairs here and there on the less exposed parts. Carapace sub-octagonal, as broad as long, strongly embossed, covered with small short hairs interspersed amongst the granules, but not obscuring them. Two deep, sinuous, longitudinal furrows, commencing behind the orbits, separate the median regions from the lateral.

The front is prominent, advancing beyond the orbits, rather less than one-fourth the width of the carapace, anteriorly depressed, divided by a median furrow into two lobes. On a frontal view each lobe is seen to be cut into rather deeply by the anterior margins of the fossettes, these terminating rather acutely at both their inner and outer angles. The rather wide median furrow extends backwards, widening and bifurcating behind the protogastric regions, joining the longitudinal furrows before mentioned.

The cardiac region is separated from the gastric by a shallow transverse depression; it is somewhat diamond-shaped, the lateral angles being emphasized.

The intestinal region is less elevated, contracted in front it widens out behind to form a thickened posterior margin.

The mid-branchial regions are prominent and rounded, each having a prominence on the inner side projecting into the longitudinal furrow, and one on each outer side on the lateral margin. The meta-branchial regions are depressed with strong marginal tubercles at the external postero-lateral angles of the carapace.

The hepatic regions are also depressed, very much so anteriorly, the depressions extending to the sub-ocular regions. Above, each has two strong tubercles, the inner ones placed a little in advance of the outer.

The orbits are nearly circular, three-lobed above, the one at the exterior angle being abruptly declivous to the hepatic region; the inner lobe is separated from the middle one by a rather wide space, and from the front by a smooth narrow groove. The lower margin has two small lobes, including the internal sub-ocular angle.

The fossettes are large and oblique nearer the longitudinal position.

The basal antennal joint is large and somewhat obliquely wedged in between the inner sub-ocular angle and the inferior process of the front; its outer distal angle reaches the summit of the inner sub-ocular lobe, its inner distal angle and margin is strongly prominent and granulate, the remaining joints are small.

The epistome is narrow in the longitudinal direction, and sunken.

The pterygostomial regions are full, marked by oblique, granular ridges; above the ridges on each sub-hepatic region are two large spiniform granules.

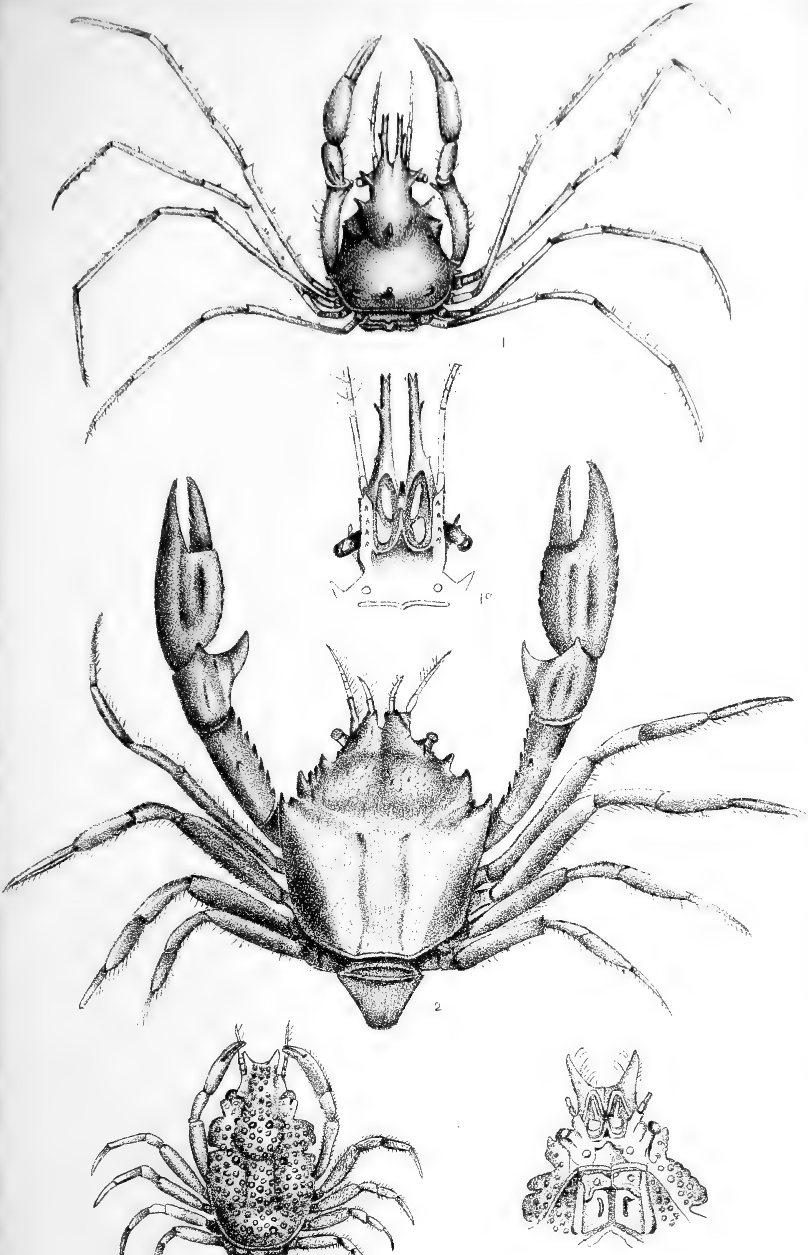
The buccal frame narrows somewhat anteriorly, its upper margin is strongly arched, and two median lobes of this margin are united in front, leaving a small opening or foramen behind, opening on to the epistome. The sides, also, of the buccal frame are slightly arcuate.

The external maxillipeds are narrow. The ischium joints are very narrow at their bases, but expand distally, the internal distal angles being prominent and almost touching, thus a large triangular space is made between them. The merus joints are oblong, shorter than the ischium, with the distal fourths quickly accuminating to obtuse median apices, beneath which the carpal joints are articulated, only a portion of them being exposed. The exopod gradually narrows distally, and although rather long does not attain to the apex of the merus.

The pleon of the male has the first segment evenly granulate from side to side, occupying the whole of the space between the last pair of legs, the second segment is short, the third, fourth, and fifth are coalesced; the second to the sixth inclusive has each a medium prominence, on which a larger granule is situated; the seventh segment is small and rounded at the extremity. The pleon narrows from the third segment.

The chelipeds are short and stout, cancriform, the fingers of each just meeting when folded in front, only a small portion of the distal end of the arm is visible from above; this has a thickened distal ridge on the outer side. The carpus is broad, externally convex, bearing four or five granulate tubercles. The hand is short, externally convex, bearing finer granules, with two granular tubercles near the upper margin; the larger one near the base of the mobile finger; also a mass of long hair spreads over the base of the mobile finger. The fingers are rather narrow, short, the mobile one strongly curved, hairy above, with a few small granules, and a few small teeth on its cutting edge. The immobile finger is shorter, and bears a strong tooth near the end and a short sulcation on the outer side. There is a small proximal hiatus between the two fingers.

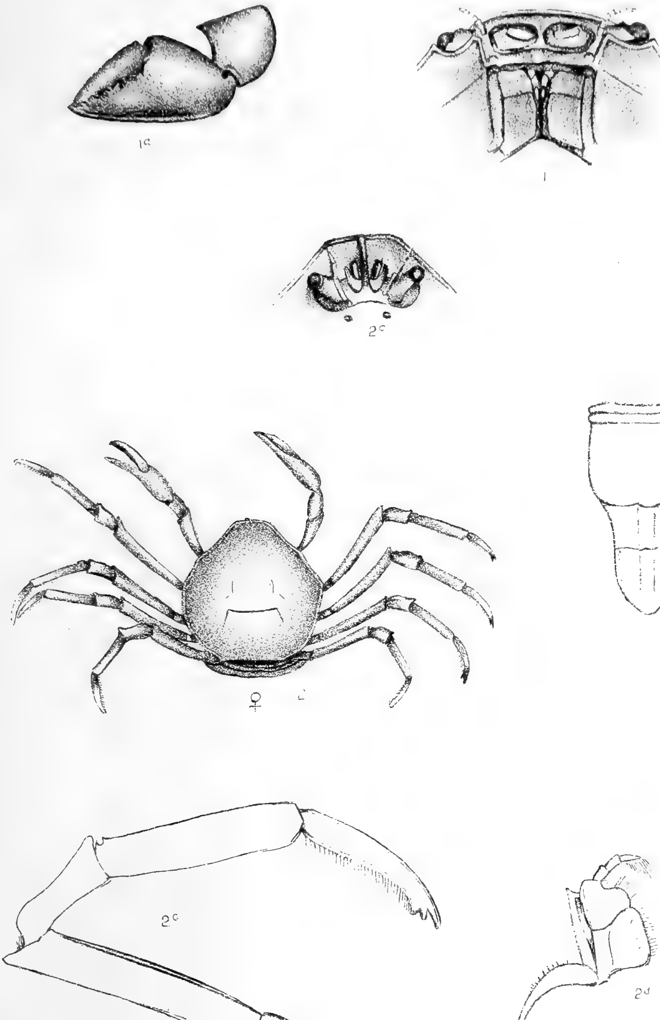
The ambulatory legs are short, moderately stout, finely granulate, and moderately hairy. The carpal and propodal



W.H.B. DEL,

HUSSEY & GILLINGHAM, LITH

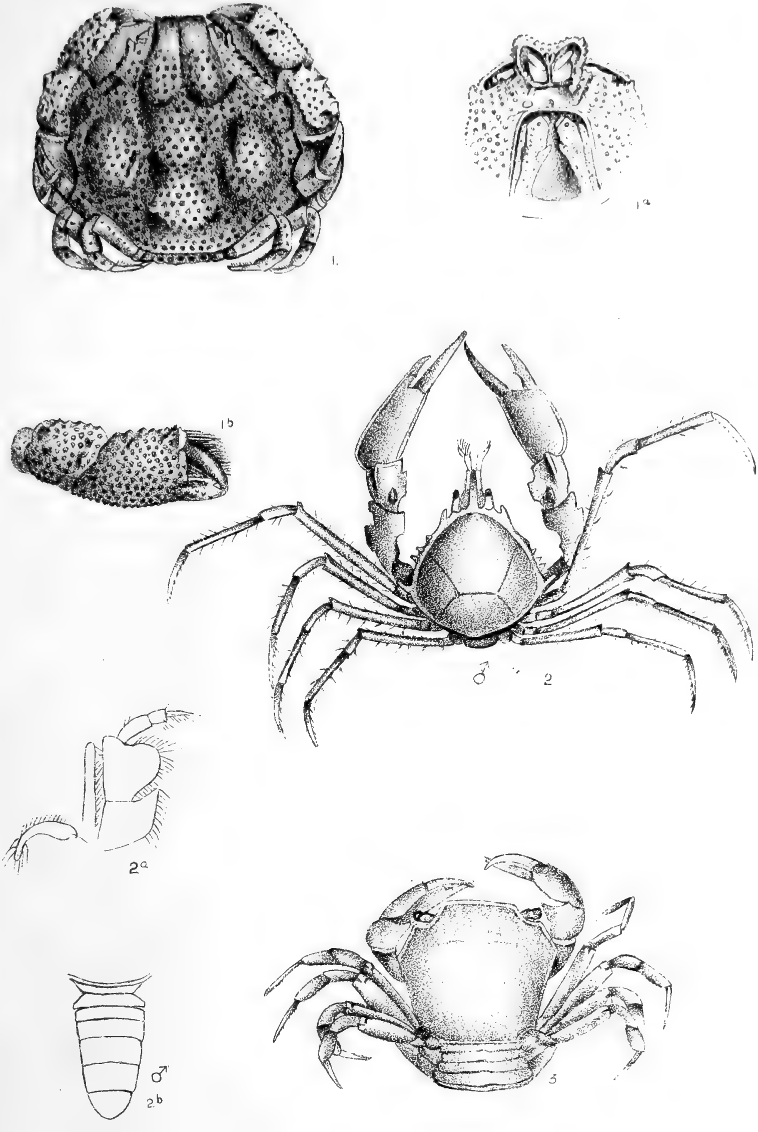
1. STENORHYNCHUS RAMUSCULUS. 2. PARATYMOLUS LATIPES.
3. EURYNOME GRANULOSA.



W.H.B. DEL.

HUSSEY & GILLINGHAM, LITH.

1.- LITOCHEIRA GLABRA. 2.- ELAMENA TRUNCATA.



W.H.B. DEL.

HUSSEY & GILLINGHAM. LITH

1. TRICHIA AUSTRALIS. 2. HYMENOSOMA ROSTRATUM. 3. LITOCHEIRA GLABRA.

joints are subequal in length. The carpal joints have external sulci. The dactyli are cylindrical, slightly longer than the propodi, and very slightly sigmoid.

Length, 18 mm.

One male specimen from Port Willunga presented to the Museum by Mr. W. J. Kimber.

Type (1 male).

Description of Plates.

Plate I.

Fig. 1. *Stenorhynchus ramusculus*, n. sp. Enlarged.
Fig. 1a. ,, ,, n. sp.—Frontal regions enlarged.
Fig. 2. *Paratymolus latipes*, Haswell. Enlarged.
Fig. 3. *Eurynome granulosa*, n. sp.—Enlarged.
Fig. 3a. ,, ,, n. sp.—Frontal regions enlarged.

Plate II.

Fig. 1. *Litocheira glabra*, n. sp.—Frontal regions enlarged.
Fig. 1a. ,, ,, n. sp.—Cheliped enlarged.
Fig. 2. *Elamena truncata*, Stimpson.—Enlarged.
Fig. 2a. ,, ,, Frontal regions enlarged.
Fig. 2b. ,, ,, Pleon enlarged.
Fig. 2c. ,, ,, Leg enlarged.
Fig. 2d. ,, ,, External maxilliped enlarged.

Plate III.

Fig. 1. *Trichia australis*, n. sp.—Enlarged.
Fig. 1a. ,, ,, Frontal regions enlarged.
Fig. 1b. ,, ,, Cheliped enlarged.
Fig. 2. *Hymenosoma rostratum*, Haswell.—Enlarged.
Fig. 2a. ,, ,, External maxilliped enlarged.
Fig. 2b. ,, ,, Pleon enlarged.
Fig. 3. *Litocheira glabra*, n. sp.—Enlarged.

New Australian Lepidoptera, with Synonymic and other Notes.

By A. Jefferis Turner, M.D., F.E.S.

[Read July 10, 1906.]

Family ARCTIADÆ

Genus Maenas.

Maenas, Hb., Verz. p. 167, Hmps., Cat. Lep. Phal. iii., p. 247.

This small genus only differs from *Diacrisia*, Hb. (*Spilosoma*, Steph.), in the posterior tibiæ having one pair of spurs. It has not been previously recorded from Australia, but allied species occur in the Malay Archipelago.

Maenas arescopa, n. sp.

(*Arescopos*, of pleasing appearance.)

Male, 33 mm. Female, 47 mm. Head whitish. Palpi fuscous. Antennæ fuscous; pectinations unequal, in male outer row 8 inner 5, in female outer $1\frac{1}{2}$ inner 1; each pectination with a terminal bristle. Thorax whitish; tegulæ edged with rosy, and with a pair of fuscous spots; patagia with fuscous spot at base. Abdomen rosy above, with a few median fuscous dots on posterior segments; beneath whitish; a row of lateral fuscous dots. Legs fuscous; anterior coxæ fuscous anteriorly, rosy posteriorly; anterior femora rosy anteriorly, whitish posteriorly; middle and posterior femora whitish. Forewings triangular, costa in male straight to near apex, in female evenly arched, apex rounded, termen obliquely rounded; whitish; markings fuscous; two incomplete fasciæ from costa near base; a fascia from costa before middle to mid-dorsum, broad on costa, sometimes interrupted; two oblique postmedian fasciæ from costa at $\frac{2}{3}$ and near apex to dorsum, more or less interrupted to form partially confluent spots; a short sub-terminal series of dots opposite mid-termen, and another on mid-termen; cilia whitish, on spots fuscous. Hindwings with termen rounded; whitish; with small fuscous spots; one on end of cell, another on tornus, two in a line from tornus to apex, first before vein 2, second beyond vein 5; cilia whitish.

Type in Coll., *Turner*.

N.Q., Kuranda, in May and June; three specimens received from Mr. F. P. Dodd.

Family NOCTUIDÆ.

Section AGROTINÆ.

CANTHYLIDIA MELIBAPHES.

Melicleptria melibaphes, Hmps., Cat. Lep. Phal. iv., p. 666a, pl. 78, f. 17.

The type, which is in my collection, is rather small (20 mm.), with pale-ochreous wings without markings, the ochreous tinge being more pronounced in the hindwings. The underside is similar, except for a discal fuscous suffusion of forewings. I have also received a female, which differs only in having a suffused fuscous terminal band on upper surface of hindwings, incomplete towards tornus, and in size (28 mm.).

N.Q., Thursday Island (male type), Geraldton (female).

Section HADENINÆ.

The following locality notes are supplementary to Sir Geo. Hampson's Cat. Lep. Phal., vol. v.

BRITHYS CRINI.

N.Q., Thursday Island, Kuranda. Q., Duaringa, Brisbane.

CIRPHIS LEUCOSTA.

N.Q., Kuranda. Mackay *(Lower)*.

This is a northern species. I think the South Australian locality is due to a confusion with the rather similar *eboriosa*, Gn., and I am strengthened in this opinion by the fact that Mr. Lower affixed the name *leucosta* to an example of *eboriosa* in the Queensland Museum.

CIRPHIS SUBSIGNATA.

N.Q., Cairns.

CIRPHIS YU.

N.Q., Cairns, Kuranda.

DASYGASTER EUGRAPHA.

Dasygaster eugrapha, Hmps., Cat. Lep. Phal. v., p. 473.

(*Eugraphos*, well-marked.)

Male, 40 mm. Head and palpi fuscous-brown mixed with brown-whitish; lower half of face brown-whitish. Antennæ fuscous; in male shortly pectinate (1), with a short terminal bristle on each pectination, apical $\frac{1}{3}$ simple. Thorax fuscous mixed with brown and brown-whitish. Abdomen brownish-grey. Legs reddish-brown mixed with fuscous. Forewings elongate-triangular, costa straight, apex rounded, termen rounded, wavy, slightly oblique; fuscous, with dark-fuscous and whitish markings; a whitish line edged with dark-fuscous scales from costa near base to mid-disc; an ante-median similar line from $\frac{1}{5}$ costa to $\frac{1}{3}$ dorsum, doubly edged with dark-fuscous; a whitish dot on costa slightly beyond middle, preceded and followed by a dark-fuscous dot; claviform whitish, elongate-oval, with fuscous centre, and preceded by a dark-fuscous spot; orbicular roundish, reniform kidney-shaped, both similar to claviform; a post-median whitish line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, preceded by a series of dark-fuscous lunules between veins, and edged posteriorly by a fine dark-fuscous line; a whitish sub-terminal line preceded by elongate dark-fuscous spots between veins; terminal area irrorated with whitish; a series of triangular dark-fuscous terminal dots between veins; cilia fuscous mixed with brownish. Hindwings with termen rounded; fuscous; cilia pale fuscous, apices whitish.

Type in National Museum, Melbourne.

V., Melbourne, one specimen.

Section ACRONYCTINÆ (Caradrininæ).

Euplexia adamantina, n. sp.

(*Adamantinos*, firm, unyielding.)

Female, 37 mm. Head and palpi fuscous-brown. Antennæ fuscous. Thorax reddish-brown. Abdomen fuscous. Legs fuscous; tarsi annulated with whitish. Forewings elongate-triangular, costa gently arched, apex round-pointed, termen bowed, slightly wavy, oblique; reddish-brown partly suffused with fuscous, especially towards costa and termen; a fuscous ante-median line edged posteriorly by a pale line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum, slightly dentate; claviform obsolete; orbicular a circular pale ring with darker centre, not conspicuous; reniform represented by two straight conspicuous white lines converging beneath with a pale area between them; post-median line fine, fuscous, from mid-costa above reniform, strongly outwardly curved and then slightly sinuate to $\frac{4}{5}$ dorsum; an interrupted dark-fuscous sub-terminal line; two or three minute white dots on costa beyond $\frac{2}{3}$; cilia brown mixed with fuscous. Hindwings with termen rounded, slightly wavy; dark fuscous; cilia fuscous, apices whitish.

Type in National Museum, Melbourne.

V., Melbourne; one specimen.

Eccleta.

Eccleta, Turn., P.L.S.N.S.W, 1902, p. 6. The definition should be amended as follows:—Face with a short median acute projection concealed by scales.

Section SARROTHRIPINÆ.

Sarrothripa baeopis, n. sp.

(*Baiopis*, of insignificant appearance.)

Male, 13 mm. Head, palpi, and thorax grey. [Antennæ broken.] Abdomen pale ochreous, partly suffused with grey on dorsum. Legs grey-whitish. Forewings oblong, costa straight except at base and apex, apex rounded, termen obliquely rounded; grey; with three fine transverse fuscous lines; first from $\frac{1}{4}$ dorsum, obsolete towards costa; second from $\frac{2}{3}$ costa, describing a strong sigmoid curve and ending on mid-dorsum; third from $\frac{3}{4}$ dorsum first inwardly then outwardly curved, obsolete towards costa; a terminal row of fuscous dots; cilia grey. Hindwings with termen rounded; ochreous-whitish; towards termen broadly fuscous; cilia fuscous.

Type in Coll., *Turner*.

N.Q., Thursday Island; one specimen.

Section NOCTUINÆ.

Crioa lophosoma, n. sp.

(*Lophosomos*, with crested body.)

Male, 24 mm. Head, thorax, and palpi grey-whitish, irrorated with dark fuscous. Antennæ ochreous-fuscous; in male with rather long pectinations ($2\frac{1}{2}$), apical $\frac{1}{5}$ simple, each pectination with a terminal bristle of equal length. Abdomen whitish, densely irrorated with fuscous; fuscous crests on first, third, fourth, and fifth segments, that on fourth specially large. Legs whitish, with some fuscous irroration, more on forelegs; fore-tibiæ annulated with fuscous. Forewings triangular, costa rather strongly arched, apex rounded, termen bowed, oblique, crenulate; grey-whitish mixed with fuscous; markings darker fuscous; a short line from costa near base, bent in disc at a right angle and continued to base; a slightly dentate line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum; a line from beneath $\frac{3}{5}$ costa towards tornus, forming a large loop extending $\frac{2}{3}$ across disc and ending beneath $\frac{4}{5}$ costa; from anterior aspect of loop is a line to $\frac{2}{3}$ dorsum; a small sub-apical fuscous shade; a terminal fuscous line; cilia pale fuscous. Hindwings with termen rounded, slightly crenulate; whitish; terminal third suffused with fuscous; cilia whitish, obscurely interrupted with fuscous.

Type in Coll., *Turner*.

Q., Brisbane, in September; one specimen.

Acantholipes coniochroa, n. sp.

(*Coniochroos*, dust-coloured.)

Female, 26-30 mm. Head, brown-whitish; face and palpi dark-fuscous. Antennæ brown-whitish, apical half dark-fuscous. Thorax and abdomen brown-whitish. Legs dark-fuscous: middle femora, posterior femora, and tibiæ brown-whitish irrorated with fuscous. Forewings triangular, costa straight, somewhat arched towards base and apex, apex rounded, termen rounded, slightly oblique; brown-whitish with some fuscous irroration towards termen; markings dark-fuscous; an incomplete transverse line near base; a partly dentate line from $\frac{1}{6}$ costa to $\frac{1}{5}$ dorsum, with an outward projection below middle: a fuscous dot with whitish centre in disc at $\frac{1}{4}$, and a similar rather larger dot before middle; a finely dentate slender line from $\frac{2}{3}$ costa to $\frac{3}{5}$ dorsum; an irregularly dentate brown-whitish sub-terminal line; a series of triangular dark-fuscous terminal dots between veins; cilia brownish-fuscous. Hindwings with termen rounded; colour and markings as forewings, but without basal lines, and with a single discal dot not pale-centred.

Somewhat variable: my second specimen is darker, with markings less developed.

Type in Coll., *Turner*.

N.Q., Kuranda, in April (*Dodd*). Q., Sandgate, near Brisbane. Two specimens.

Section ERASTRIANÆ.

RAPARNA TRIGRAMMA, n. sp.

(*Trigrammos*, thrice marked.)

Male, 24 mm. Head, white; face and palpi grey-whitish. Antennæ fuscous, towards base whitish. Thorax, grey-whitish. Abdomen, grey; terminal segments clothed beneath with dense fuscous hairs, which form lateral tufts. Legs whitish-grey; posterior pair whitish. Forewings triangular, costa nearly straight, apex tolerably pointed, termen slightly bowed, slightly oblique; grey-whitish, with three whitish lines edged anteriorly with grey; first, from $\frac{1}{4}$ costa to mid-dorsum, nearly straight; second, from before mid-costa to beyond mid-dorsum, slightly outwardly curved; third, from $\frac{2}{3}$ costa to $\frac{4}{5}$ dorsum, rather more curved; a faint dentate sub-terminal line from $\frac{5}{6}$ costa, otherwise resembling preceding, but much fainter, and becoming obsolete towards tornus; a faint grey terminal line, cilia grey. Hindwings with termen rounded; grey towards base, and dorsum whitish: cilia grey, towards tornus whitish.

Type in Coll., *Lyell*.

N.S.W., Sydney, in March; one specimen.

LIODES NEUROGRAMMA, n. sp.

(*Neurogrammos*, with well-marked nerves.)

Male, 32-33 mm. Head brown, mixed with whitish. Palpi porrect, rather long (1⅗), second joint with loose spreading hairs above and beneath; fuscous, upper edge whitish. Antennæ grey; in male with a double row of long pectinations (6), inner row somewhat shorter, not quite reaching apex. Thorax brown, mixed with whitish. Abdomen ochreous-whitish. Legs ochreous-whitish, anterior pair suffused with fuscous-brown internally, and with a posterior tibial tuft. Forewings elongate-triangular, costa nearly straight, apex rounded-rectangular, termen at first straight and scarcely oblique, then obliquely rounded; brownish-fuscous; costa and all veins marked by strong whitish lines; costal edge fuscous to $\frac{3}{4}$; cilia fuscous, barred with whitish. Hindwings broad, termen rounded, somewhat sinuate beneath apex; in male with a pencil of long whitish-ochreous hairs from base of dorsum on under-surface; ochreous-whitish; termen suffused with fuscous at apex; cilia whitish.

Type in Coll., *Lyell*.

V., Geelong, in November; one specimen. T., Georgetown; one specimen.

Section HYPENINÆ.

CATADA ACROSPILA, n. sp.

(*Acrospilos*, with apical spot.)

Male, 20 mm. Head brown-whitish. Palpi brown-whitish, irrorated with dark-fuscous; terminal joint with a broad median, dark-fuscous ring; base of second joint dark-fuscous externally. Antennæ whitish, towards base dark-fuscous; in male with rather long ciliations (2). Thorax dark-fuscous; collar brown-whitish. Abdomen brown, irrorated with dark-fuscous; first two segments dark-fuscous. Legs ochreous-whitish; anterior pair fuscous. Forewings triangular, costa nearly straight, apex rounded, termen bowed, oblique, crenulate; brown, suffused with dark-fuscous; costa with brown-whitish strigulæ at $\frac{1}{4}$, beyond middle, and near apex; the last ends in a large whitish reniform sub-apical blotch, from which an indistinct pale line proceeds to tornus; a series of blackish dots on veins close to termen; a slender dark-fuscous terminal line; cilia dark-fuscous with obscure paler bars. Hindwings with termen rounded, dentate; pale brown with some dark-fuscous scales towards base; a fine dentate transverse fuscous line at $\frac{3}{5}$, a fine fuscous terminal line; cilia brown, on dentations fuscous.

Type in Coll., *Turner*.

N.Q., Geraldton, in May; one specimen.

Bracharthron melanostrotum, n. sp.

(*Melanostrotos*, overlaid with blackish.)

Male, 30 mm. Head and thorax ochreous-whitish irrorated with fuscous. Palpi extremely long, reaching far behind thorax; ochreous-whitish, on external surface irrorated with fuscous, bearing a tuft of long ochreous-whitish hairs on inner side towards apex. Antennæ fuscous; in male shortly pectinate (1), nearly to apex, each pectination bearing a longer ($1\frac{1}{2}$) terminal bristle. Abdomen pale fuscous, apices of segments and tuft whitish. Legs fuscous; apices of tibiæ and tarsal joints ringed with ochreous-whitish. Forewings triangular, costa nearly straight, apex rounded, termen bowed, oblique, crenulate; whitish, densely suffused with dark-fuscous; indications of paler transverse lines from costa near base, at $\frac{1}{4}$, and more broadly at middle; a dentate whitish sub-apical line, its anterior edge sharply defined, posterior edge indistinct; beyond this disc is largely whitish, especially opposite mid-termen and tornus; cilia fuscous, mixed with whitish. Hindwings with termen rounded, scarcely crenulate; fuscous; terminal band mostly whitish; cilia whitish with some fuscous scales.

Type in Coll., *Turner*.

N.Q., Geraldton, in May; one specimen.

Family, LYMANTRIADÆ.

Sub-family, ASOTINÆ.

Nyctemera crescens.

I do not think *Deilemera dinawa*, Bak., can be distinct from this species; the only difference appears to be that the veins of forewings are whitish towards base, and this seems insufficient.

Sub-family, LYMANTRIANÆ.

Porthesia acatharta, n. sp.

(*Acathartos*, impure.)

Male, 25 mm. Female, 35 mm. Head pale ochreous; in female ochreous-whitish. Palpi ochreous-whitish. Antennæ whitish-ochreous, pectinations well developed in both sexes, longer in male. Thorax and abdomen pale ochreous; tuft ochreous. Legs ochreous-whitish. Forewings rather elongate-triangular, costa strongly arched, apex rounded, termen bowed, strongly oblique; whitish-ochreous, irrorated with ochreous; paler towards costa; a faintly-marked sinuate whitish line from $\frac{3}{4}$ costa to $\frac{3}{4}$ dorsum, better seen in female; cilia whitish. Hindwings with termen strongly rounded; whitish; cilia whitish.

Type in Coll., *Turner.*

N.Q., Kuranda, in August; two specimens received from Mr. F. P. Dodd.

EUPROCTIS EPIDELA, n. sp.

(*Epidelos*, conspicuous.)

Male, 25 mm. Female, 35-45 mm. Head, palpi, thorax, and abdomen ochreous. Antennæ pale ochreous. Legs whitish-ochreous. Forewings triangular, more elongate in female, costa strongly arched, apex rounded, termen obliquely rounded; bright ochreous, in female ochreous or pale ochreous; a pale transverse line near base; a broader outwardly curved transverse line at $\frac{1}{5}$; and a similar sinuate line at $\frac{3}{5}$; in female these lines are obsolete; cilia concolorous. Hindwings with termen rounded; pale ochreous; in female concolorous with forewings; cilia concolorous.

This may possibly be the same as *Euproctis varians*, Wlk., an Indian species (Hmps., Moths Ind. 1, p. 475).

Type in Coll., *Turner.*

N.Q., Kuranda, in August, September, October, April, and May; five specimens (one male), received from Mr. F. P. Dodd.

EUPROCTIS EPAXIA, n. sp.

(*Epaxios*, of worth.)

Male, 18 mm. Head, palpi, and thorax ochreous. Antennæ ochreous-whitish. Abdomen whitish-ochreous. Legs whitish; anterior tibiæ and tarsi densely fringed with long ochreous hairs. Forewings triangular, costa strongly arched, apex rounded, termen bowed, oblique; pale ochreous, irrorated with bright ochreous, except on two broad bands, on which the irroration is dark brown; first band at $\frac{1}{4}$, not quite reaching costa or dorsum; second band sub-terminal, ending on tornus, not quite reaching costa; cilia ochreous. Hindwings, with termen, rounded; pale ochreous; cilia pale ochreous.

My type of this small and delicate species is somewhat rubbed.

N.Q., Kuranda, in July; one specimen received from Mr. F. P. Dodd.

LYMANTRIA NOVAGUINEENSIS.

Lymantria novaguineensis, Bak., Nov. Zool., 1904., p. 407, Pl. vi., f. 35.

Mr. Bethune-Baker does not mention whether this species, of which he has a series, is variable. It comes very close to *L. turneri*, Swin., and may be the same species.

Dasychiroides.

Dasychiroides, Bak., Nov. Zool., 1904, p. 405.

Palpi, porrect, or slightly inclined upwards, moderate (1), second joint fringed with long hair beneath, terminal joint very short. Thorax and abdomen not crested. [Posterior tibiæ broken.*] Forewings, with 7, 8, 9, 10 stalked, 7 from before 10, 11 anastomosing shortly with 12. Hindwings with 5 approximated to 4 at base, discocellular angled, 6 and 7 connate, 7 anastomosing shortly with 8 before middle.

Distinguished from *Euproctis* by the anastomosis of 11 and 12 of forewings; from *Acyphas*, Turn., by the absence of the areole.

Dasychiroides pratti.

Dasychiroides pratti, Bak., Nov. Zool., 1904, p. 406, Pl. vi., f. 7.

N.Q., Kuranda, in October; one male received from Mr. F. P. Dodd. It is not so darkly marked as in the figure, but there is no doubt as to its identity.

Imaus.

Imaus, Moore, Lep. Atk., p. 54 (1879), Hmps., Moths Ind. 1, p. 466.

This genus has not been previously recorded as Australian. Mr. Bethune-Baker has recently described seven new species from New Guinea. It differs from *Euproctis* in the separation of veins 6 and 7 of the hindwings; points of less importance are the somewhat longer palpi, and the peculiar form of the hindwings.

Imaus ochrias, n. sp.

(*Ochrias*, pale.)

Male, 32 mm. Head and thorax ochreous-grey-whitish. Palpi ochreous-whitish, with some dark-fuscous scales on external surface. Antennæ whitish-ochreous. Abdomen white. Legs whitish. Forewings triangular, costa strongly arched, apex rounded, termen rounded, oblique; vein 11 free; ochreous-grey-whitish, with pale grey markings and a few scattered dark-fuscous scales; two dark-fuscous dots near base close to costa and dorsum respectively; a faint wavy transverse line at $\frac{1}{4}$; and a second from costa before middle to dorsum beyond middle, joined in disc by a dentate line from $\frac{5}{6}$ costa; a pale-grey circular orbicular spot in outline; a dentate subterminal line; a minute dark-fuscous dot on second line at end of cell (cilia denuded). Hindwings with termen forming

* Mr. Bethune-Baker does not state whether they have one or two pairs of spurs.

a rounded projection with its apex on vein 3; white; cilia white.

Though I cannot identify this with any of Mr. Baker's descriptions, it appears to come near *Imaus pratti*, Bak., Nov. Zool., 1904, p. 409.

Type in Coll., *Turner*.

N.Q., Kuranda, in November; one specimen received from Mr. F. P. Dodd.

Sub-family, ANTHELINÆ.

Anthela uniformis.

Darala uniformis, Swin., Cat. Oxf. Mus., i., p. 210.

Anthela niphomacula, Low., Tr.R.S.S.A., 1905, p. 175.

N.Q., Cooktown. Q., Rockhampton, Duaringa.

Family, GEOMETRIDÆ.

Sub-family, GEOMETRINÆ.

Euchloris citrolimbaria.

Chlorochroma citrolimbaria, Gn., Lep. ix., p. 366, *nec* Wlk., Brit. Mus. Cat. xxii., p. 562.

Chlorochroma inchoata, Wlk., Brit. Mus. Cat. xxii., p. 563, Meyr., P.L.S.N.S.W., 1887, p. 881.

Iodis illidgei, Luc., P.L.S.N.S.W., 1889, p. 603.

I have examined Walker's types, and have no doubt of this identification.

Q., Nambour, Brisbane, Mount Tambourine. The larva is attached to *Duboisia*.

Euchloris xuthocrania, nom. nov.

(*Xuthocranios*, tawny-headed.)

Iodis submissaria, Meyr., P.L.S.N.S.W., 1887, p. 882, *nec* Wlk., Brit. Mus. Cat. xxii., p. 529.

This species is sufficiently described by Mr. Meyrick (*loc. cit.*). Walker's type, which I have examined, is an example of *dichloraria*, Gn.

Q., Stanthorpe. V., Melbourne. T., Deloraine, Strahan. S.A., Mount Lofty.

Euchloris megaloptera.

Euchloris megaloptera, Low., Tr.R.S.S.A., 1894, p. 87.

Chrysochloroma subalbida, Warr., Nov. Zool., 1896, p. 364.

Euchloris hypoleucus, Low., P.L.S.N.S.W., 1897, p. 263.

Lower's type is in the Queensland Museum, and was described on a passing visit. Subsequently he forgot his own species and described it again. Warren's type I have examined.

N.A., Port Darwin. N.Q., Cooktown, Townsville; received from Mr. F. P. Dodd, who obtained the larvæ from the nests of the green ant, formed by spinning together the leaves of shrubs.

EUCHLORIS RHODOCROSSA, n. sp.

(*Rhodocrossos*, rosy fringed.)

Male, 21 mm. Head, face, and palpi crimson; fillet snow-white. Antennæ white; pectinations in male long (8), inner row crimson-tinged. Thorax and abdomen green (faded in type). Legs whitish; anterior pair crimson anteriorly. Forewings triangular, costa very slightly arched, apex fairly acute, termen straight, moderately oblique; 6 from upper angle of cell, 11 anastomosing with 12, and then with 10; bright green; transverse lines obsolete; a crimson streak on costal edge at base, then close beneath costa, leaving costal edge snow-white, gradually fading posteriorly, but returning to costa near apex; cilia with bases dark-crimson, apices whitish. Hindwings with termen rounded; 3 and 4 short-stalked, 6 and 7 short-stalked; colour and cilia as forewings, but without costal streak.

Type in Coll., *Lyell*.

W.A., Bridgetown, in February; one specimen.

EUCHLORIS PISOCHROA, n. sp.

(*Pisochroos*, pea-green.)

Female, 30 mm. Head and fillet green; face pale brownish, tinged with green. Palpi brownish. Antennæ greenish. Thorax and abdomen bright green, terminal segments paler. Legs whitish; anterior pair greenish-tinged. Forewings triangular, costa rather strongly arched, apex rounded, termen bowed, oblique; bright-green, posterior half of disc obscurely strigulated with darker green; a blackish median discal dot; cilia green. Hindwings with termen rather strongly bowed on vein 4; colour and markings as forewings. Underside pale green.

Type in Coll., *Turner*.

N.Q., Kuranda in September and November; three specimens received from Mr. F. P. Dodd.

EUCHLORIS AMPHIBOLA, n. sp.

(*Amphibolos*, enveloped.)

Female, 37 mm. Head green; face, fillet, and palpi brown. Antennæ pale ochreous. Thorax with a small posterior crest; pale brown irrorated with darker brown; tegulæ and bases of patagia green. Abdomen brown, paler posteriorly, with a triangular median white dot on third, fourth, and fifth segments. Legs pale ochreous; dorsum of first and second pairs purplish. Forewings rather elongate-triangular, costa scarcely arched, apex rounded, termen strongly bowed, strongly oblique, slightly wavy; green, with some scattered reddish-brown irroration; a fuscous-brown spot on base of dorsum; a blackish median discal dot; a broad terminal fuscous-brown band, partly ferruginous, from tornus to upper $\frac{1}{4}$ of termen, where it leaves termen and forms a rounded projection near, but not touching costa at $\frac{4}{5}$: a fine fuscous-brown terminal line; cilia pale fuscous, darker towards tornus. Hindwings with termen dentate on veins 6 and 4, thence wavy to tornus; colour and markings as forewings, but terminal band broader and running to apex, and with an additional diffused fuscous-brown spot on dorsum before middle. Underside whitish, terminal band on forewings fuscous, that on hindwings nearly obsolete.

Type in Coll., *Turner*.

N.Q., Kuranda, in June; one specimen received from Mr. F. P. Dodd.

NEMORIA IOSOMA.

Nemoria iosoma, Meyr., Tr.E.S., 1889, p. 495.

N.Q., Kuranda; Townsville; a series received from Mr. F. P. Dodd. The type came from New Guinea.

NEMORIA PELLUCIDULA, n. sp.

(*Pellucidulus*, somewhat transparent.)

Male, female, 24 mm. Head and face dull greenish; fillet narrowly white. Palpi ochreous-brown, anteriorly whitish. Antennæ ochreous-brown; ciliations in male $1\frac{3}{4}$. Thorax dull greenish. Abdomen dull greenish; third and fourth segments reddish-brown; with three small crests, those on third and fifth segments white, on fourth segment fuscous. Legs whitish-ochreous. Forewings triangular, costa slightly arched, more strongly at base and towards apex, apex round-pointed, termen bowed, oblique, slightly wavy; dull olive greenish, thinly scaled; costa narrowly bright-ochreous strigulated with blackish; lines darker green, rather obscure, wavy: first from beneath $\frac{1}{3}$ costa to $\frac{2}{5}$ dorsum, preceded by white dots on veins; second from $\frac{3}{4}$ costa to $\frac{3}{4}$ dorsum, followed by white dots on veins; a terminal series of white dots on veins; cilia greenish. Hindwings with termen produced to a sharp tooth on vein 4; colour and markings as forewings. Underside green-whitish, costa of forewings as on upper surface.

Similar to the preceding, with which it agrees structurally. It may be distinguished by the dull colouring, more transparent wings, absence of continuous white lines, much more strongly toothed hindwings, and markings on abdomen.

Type in Coll., *Turner*.

N.Q., Kuranda, in September and October; two specimens received from Mr. F. P. Dodd.

PSEUDOTERPNA PAROPTILA, n. sp.

(*Paroptilos*, brown-winged.)

Male, 46 mm. Head, palpi, thorax, and abdomen pale brownish. [Antennæ broken.] Legs ochreous-whitish [anterior pair broken]. Forewings triangular, costa gently arched, apex round-pointed, termen strongly bowed, oblique, crenulate; brown-whitish, with sparse blackish strigulæ on costa and veins; lines reddish-brown; first from $\frac{1}{5}$ costa to $\frac{1}{3}$ dorsum, nearly straight; second from $\frac{3}{4}$ costa, straight to mid-disc, thence inwardly curved, and dentate on veins, to $\frac{2}{3}$ dorsum; its lower portion closely followed by a parallel line; a fine linear discal mark beneath mid-costa; a faintly-marked, whitish, dentate, sub-terminal line, towards dorsum edged with reddish-brown posteriorly; cilia concolorous. Hindwings with termen rounded, obtusely dentate; colour and markings as forewings, but lines less defined. Underside whitish, washed with dull reddish, leaving a white post-median costal area on forewing, and a larger, less-defined area on hindwing; discal spot of forewing large, oval, blackish, of hindwing smaller, elongate; both wings with a broad, blackish sub-terminal band, not reaching margins.

Type in Coll., *Lyell*.

N.Q., Atherton, in June; one specimen.

Sub-family MONOCTENIANÆ.

ADEIXIS.

Adeixis, Warr., Nov. Zool., 1897, p. 27.

Paragyrtis, Meyr., Tr.E.S., 1905, p. 222.

Mr. Warren's name must be adopted for this genus. His type, *A. insignata*, is identical with *inostentata*, Wlk.

DICERATUCHA.

Diceratucha, Swin., A.M.N.H., 1904, p. 133.

Type, *Oenone xenopis*, Low., Tr.R.S.S.A., 1902, p. 227.

This is a good genus closely allied to *Oenone*, Meyr., the neuration in each being the same; but the frontal projections and the absence of the excessive hairiness of *Oenone* are sufficient for its separation.

ACIBDELA, *nov.*

(*Acibdelos*, pure.)

Tongue present. Palpi very small, slender, somewhat ascending. Antennæ in male with a double row of long pectinations, extending nearly to apex. Posterior tibiæ with two pairs of spurs, which are closely approximated. Forewings with 6, 7, 8, 9, 10 stalked; 11 anastomosing with 12 and then with 10; 10 anastomosing with 9. Hindwings with 3 and 4 separate; 5 from well above middle of cell; 6 and 7 stalked.

Type *Nearcha alba*, Swin. (A.M.N.H., 7, ix., p. 79).

I am indebted to Mr. G. Lyell for the loan of specimens of this species taken at Roeburne, N.W.A.

Dichromodes trychnoptila, n. sp.

(*Trychnoptilos*, rough-winged.)

Male, 31 mm. Head whitish. Palpi moderate (2); whitish-grey. Antennæ pale-ochreous; in male unipectinate, the pectinations short (1) and very stout, being as broad as long. Thorax and abdomen whitish, with a few pale grey scales. Legs ochreous-whitish; anterior femora fuscous; anterior and middle tibiæ and tarsi fuscous, annulated with whitish. Forewings triangular, costa rather strongly arched, apex round-pointed, termen bowed, oblique; whitish mixed with pale grey and sparsely scattered fuscous scales; a raised crest of fuscous scales on costa near base; another on costa at $\frac{1}{4}$, giving rise to a fuscous line strongly curved outwards in disc, ending in $\frac{1}{4}$ dorsum; a third on costa at $\frac{2}{5}$, giving rise to a similar but indented line to dorsum at $\frac{2}{3}$; beyond this is a largish fuscous discal spot touching line at lower extremity; an obscure subterminal line; cilia (worn). Hindwings with termen rounded; grey-whitish with an obscure darker median transverse line; cilia whitish.

The type is worn, but the species should be unmistakable by the crested wings and peculiar male antennæ.

Type in Coll., *Lyell*.

T., Zeehan, in February; one specimen.

Dichromodes haematopa, n. sp.

(*Haematopos*, blood-stained.)

Male, female, 24-26 mm. Head and face white, irrorated with fuscous and tinged with reddish on crown. Palpi $2\frac{1}{4}$; dark-fuscous; base sharply white; upper surface irrorated with white. Antennæ dark-grey; pectinations 5. Thorax pale-fuscous mixed with darker fuscous and ferruginous red. Abdomen whitish mixed with fuscous. Legs white irrorated with fuscous; anterior and middle tarsi fuscous with whitish annulations. Forewings triangular, costa nearly straight, apex round-pointed, termen bowed, moderately oblique; ferruginous red with some dark-fuscous and white scales; a costal streak white irrorated with dark-fuscous; a dark fuscous spot mixed with ferruginous red on costa near base; a dark-fuscous spot on dorsum near base, reaching to margin of cell; lines slender, wavy, dark-fuscous; first from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum, edged anteriorly with white; second from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, edged posteriorly with white; a fuscous discal spot beneath mid-costa; an irregularly dentate dark-fuscous sub-terminal shade, ill-defined anteriorly, sharply defined posteriorly, with a bidentate projection below middle; a terminal series of triangular dark-fuscous spots on veins; cilia fuscous-whitish, with a fuscous median line. Hindwings with termen rounded; fuscous; cilia fuscous, apices whitish.

Type in Coll., *Turner*.

V., Sea Lake: two specimens taken on March 31st by Mr. D. Goudie.

AMPHICLASTA, nov.

(*Amphiklastos*, broken all round.)

Face with dense protuberant scales. Tongue developed. Antennæ in male (unknown). Palpi moderate, porrect; second joint clothed with dense projecting scales; terminal joint very short, obtuse. Thorax and abdomen stout, the former densely hairy beneath, and with a slight posterior crest above. Tarsi spinulose; posterior tarsi with two pairs of spines. Forewings with 6 separate, 7, 8, 9, 10 stalked, 11 connected by a bar with 8 before 10. Hindwings with 6 and 7 separate, 8 closely approximated to cell to beyond middle. Both wings with hindmargins deeply and irregularly dentate.

AMPHICLASTA LYGAEA, n. sp.

(*Lugaios*, dark, gloomy.)

Female, 50 mm. Head, thorax, and abdomen grey; the latter dark-fuscous beneath. Face dark-fuscous. Palpi brown. Antennæ grey. Legs fuscous; tarsi annulated with ochreous-whitish. Forewings triangular, costa straight, except near base and apex, apex acute, somewhat produced, termen oblique, dentate, with more prominent teeth on veins 3 and 6; grey, towards termen brownish-tinged; cilia concolorous. Hindwings with termen irregularly dentate; with stronger teeth on veins 3, 6, and 7; purplish-grey; a short darker sub-terminal line from dorsum near tornus, edged posteriorly with obscure whitish; cilia brownish.

Type in Coll., *Turner*.

V., Birchip, in August. I am much indebted to Mr. D. Goudie for presenting me with the only example he has taken of this interesting species.

Homospora rhodoscopa.

Onychodes (?) rhodoscopa, Low., Tr.R.S.S.A., 1902, p. 228.

Homospora procrita, Turn., Tr.R.S.S.A., 1904, p. 230.

Homospora rhodoscopa, Low., Tr.R.S.S.A., 1905, p. 178.

While admitting the correctness of this identification, I think that in default of any description of structural generic characters I could hardly have been expected to recognise the original description. Recognition was not rendered easier by the locality assigned to the species by Mr. Lower, nor by his remark—"Doubtfully referable to *Onychodes*, more probably referable to the *Bombycina*." Before describing a lepidopteron, one should at least have a clear idea as to what family it should be referred to, even if the genus is uncertain.

Mr. Lower received this species from Mr. F. P. Dodd, of Townsville, North Queensland; and my example was received from the same source at a later date.* Why Mr. Lower should have referred so many species received from Mr. Dodd to the locality, "Derby, Western Australia." is difficult to understand.

Sub-family SELIDOSEMINÆ.

Selidosema viridis, n. sp.

(*Viridis*, green.)

Female, 34 mm. Head and face bright green. Palpi green, inner aspect and terminal joint whitish-ochreous. Antennæ grey, towards base green. Thorax bright green. Abdomen bright green with two pairs of dark fuscous dots. Legs ochreous-whitish; anterior pair greenish. Forewings triangular, costa moderately arched, apex rounded, termen bowed, oblique; 7, 8, 9, 10 stalked, 11 anastomosing with 12 and then connected with 8 before 10; green-whitish thickly beset with small spots and strigulæ of bright green more or less confluent; posterior $\frac{3}{4}$ of costal edge narrowly whitish, strigulated with fuscous and green; a blackish dot near mid-base; another on costa at $\frac{1}{5}$, below which are three in a transverse line on veins; a dot on costa before middle, with another beneath it in disc; an outwardly curved series of blackish dots from $\frac{2}{3}$ costa to $\frac{3}{5}$ dorsum, and another midway between this and termen, interrupted in middle; all these dots are more or less edged with ochreous scales; a terminal series of black dots between veins; cilia green, apices whitish. Hindwings with termen rounded, slightly crenulate; colour and markings as

* As I did not receive this until the year following Mr. Lower's visit to Brisbane, his statement that he had pointed out to me, when in Brisbane, that he had given it a MS. name, is purely imaginary.

forewings. Underside whitish suffused with dull green, with darker discal dots and sub-terminal suffusion.

Type in Coll., *Turner.*

N.Q., Kuranda, in November; one specimen received from Mr. F. P. Dodd.

Deilinia odontocrossa, n. sp.

(*Odontocrossos*, with toothed margins.)

Male, 28 mm. Head, palpi, thorax, and abdomen grey. Antennæ grey; pectinations in male very long (10), and extending almost to apex. Legs (broken). Forewings elongate-triangular, costa scarcely arched except near apex, apex round-pointed, termen slightly bowed, oblique, slightly wavy; 11 anastomosing with 12 and then with 8 before 10; grey; markings fuscous-grey; costa fuscous-grey dotted with pale grey; a faint line from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum; a discal dot beneath mid-costa, connected by a fine line with mid-dorsum; a very fine dentate line with darker dots on veins from costa at $\frac{3}{4}$, to dorsum beyond middle; traces of a sub-terminal line; cilia grey. Hindwings with termen nearly straight, dentate, teeth large and well marked; colour and markings as forewings. Underside grey, with a darker post-median line.

Type in Coll., *Lyell.*

T., Strahan, in October; one specimen. A much-wasted specimen from Hobart, sent to me by Mr. Lyell, may be the same species.

Deilinia glaucochroa, n. sp.

(*Glaucochroos*, grey-coloured.)

Male, 27 mm. Head and palpi deep ochreous. Antennæ [broken near base] with long pectinations in male. Thorax pale grey; collar deep ochreous. Abdomen pale grey. Legs grey-whitish. Forewings triangular, costa straight to near apex, apex round-pointed, termen bowed, oblique; pale grey; with a few fine darker transverse strigulæ; costal edge ochreous to near apex; fine obscure darker lines at $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$; the median line preceded by a grey, sub-costal dot; a terminal series of fuscous dots on veins; cilia pale grey. Hindwings with termen rounded; colour and markings as forewings, but strigulæ better marked and basal line obsolete. Underside as upper, but lines obsolete, and strigulæ nearly so; a fuscous dot at end of cell in each wing.

Type in Coll., *Lyell.*

N.Q., Townsville, in March; one specimen received from Mr. F. P. Dodd.

Idiodes homophaea, n. sp.

(*Homophaios*, uniformly dusky.)

Male, 32 mm. Head, palpi, thorax, and abdomen fuscous. Antennæ fuscous; ciliations in male extremely short ($\frac{1}{8}$). Legs fuscous; posterior tibiæ of male dilated, with a long tuft of hairs on inner aspect. Forewings triangular, costa nearly straight, apex tolerably acute, termen moderately and evenly bowed, oblique; 10 connected with 8 and 9, 11 anastomosing with 10; pale fuscous obscurely irrorated wth darker fuscous; costal edge and veins ochreous-tinged; a minute fuscous dot on origin of vein 2, and another rather anterior on vein 1; an oblique series of similar dots, succeeded by pale dots, on veins from beneath costa to $\frac{2}{3}$ dorsum; a terminal series of dark-fuscous dots between veins; cilia fuscous. Hindwings with termen rounded at apex, thence nearly straight; colour and markings as forewings.

Abundantly distinct from any of the varieties of *I. apicata*, Gn.

Type in Coll., *Turner*.

Q., Nambour; one specimen.

Idiodes loxosticha, n. sp.

(*Loxostichos*, with oblique line.)

Female, 42 mm. Head fuscous, with purplish reflections; face and palpi dark-fuscous. Antennæ pale ochreous, towards apex greyish. Thorax and abdomen fuscous, with purplish reflections; apex of abdomen pale ochreous. Legs fuscous. Forewings triangular, costa straight, slightly arched near base and apex, apex acute, termen straight, sinuate beneath apex, oblique; 10 arising from 7, anastomosing with 8 and 9, 11 anastomosing first with 12 then with 10; fuscous with dull purplish reflections; costal edge ochreous; a faintly darker transverse line at $\frac{1}{4}$, and a faint discal dot before middle. An oblique ochreous-fuscous line from apex to $\frac{2}{3}$ dorsum; cilia fuscous. Hindwings with termen evenly bowed; as forewings but with the line transverse and before middle.

Type in Coll., *Turner*.

N.Q., Kuranda, in May; one specimen received from Mr. F. P. Dodd.

Nycterephes, nov.

(*Nycterephes*, dark, gloomy.)

Face rounded, strongly prominent. Tongue well-developed. Palpi rather short, sub-ascending, shortly rough-scaled; terminal joint very short, obtuse. Antennæ in male bipectinated almost to apex. Thorax with a strong posterior crest;

hairy beneath. Abdomen smooth. Femora not hairy. Anterior tibiæ with a posterior tuft of hairs from base. Posterior tibiæ with two pairs of spurs. Forewings in male without fovea; vein 2 from $\frac{3}{4}$, 3 from before angle, 7, 8, 9, 10 stalked, 11 connected by a bar with 12 and with 8, 9, 10. Hindwings with 3 and 4 separate, 6 and 7 separate, 8 closely approximated to basal half of cell.

Nycterephes coracopa, n. sp.

(*Coracopos*, raven-black.)

Male, 35 mm. Head, palpi, and thorax black. Antennæ pale-fuscous, towards base black; pectinations in male 6. Abdomen grey-whitish. Legs dark-fuscous; tarsi with whitish annulations; femora and posterior tibiæ whitish with dark-fuscous annulations. Forewings triangular, costa slightly arched, apex rounded, termen bowed, slightly oblique: blackish, with obscure black markings: a dentate transverse line at $\frac{1}{5}$; a rather large suffused discal spot beneath mid-costa; a dentate line from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum, outwardly curved in disc; cilia blackish. Hindwings with termen rounded; whitish; towards termen and dorsum suffused with blackish; a blackish discal dot, and dentate line from tornus not reaching costa.

Type in Coll., *Lyell*.

W.A., Bridgetown, in April; one specimen.

Family CASTNIADÆ.

Synemon phaeoptila, n. sp.

(*Phaioptilos*, dusky-winged.)

Male, 32-36 mm. Head, thorax, and abdomen fuscous. Palpi whitish, apices ochreous. Antennæ dark-fuscous, narrowly annulated with whitish; clubs dark-fuscous. Legs ochreous; posterior pair whitish. Forewings triangular, costa moderately and evenly arched, apex rounded, termen rounded, slightly oblique; fuscous; costal edge narrowly whitish, becoming ochreous towards base; a median line of whitish-ochreous somewhat lustrous scales from along lower edge of cell, expanding into a broader suffusion beyond cell; a whitish discal spot on end of cell; cilia fuscous, bases mixed with whitish; apices paler. Hindwings with termen rounded; fuscous; cilia fuscous, apices paler. Underside of forewings bright brownish-ochreous becoming whitish-ochreous towards costa; a large fuscous basal blotch, not reaching costa, extending almost to tornus; a fuscous post-median spot; three small fuscous subapical spots preceded by three whitish spots. Of hindwings fuscous; costa narrowly and dorsum broadly shining grey-whitish, a median, two post-median, and a terminal series of spots of the same colour.

Female, 34-36 mm. As male, with following exceptions: Forewings beneath without basal blotch; post-median spot whitish. Hindwings above bright brownish-ochreous; towards base suffused with fuscous; a post-median series of dark-fuscous spots, three towards costa, and two larger median; bases of cilia dark-fuscous, apices paler and mixed with whitish. Underside of hindwings whitish-ochreous; a fuscous ante-median spot, confluent with an irregular median fuscous band; an interrupted sub-terminal fuscous fascia; fuscous markings edged with ochreous; base and dorsum suffused with grey-whitish; cilia bases dark-fuscous, middle whitish, apices pale fuscous.

Type in Coll., *Turner*.

N.Q., Kuranda, in January and February; seven specimens received from Mr. F. P. Dodd.

Family ZYGAENIDÆ.

ONCEROPYGA, *nov.*

(*Onceropugos*, with swollen rump.)

Face forming a smooth rounded projection. Palpi slender, minute, porrect. Antennæ in both sexes thickened and moderately pectinated to apex. Posterior tibiæ without middle spurs. Forewings with all veins present, 7 and 8 stalked. Hindwings with all veins present, 3 and 4 connate, 6 and 7 separate.

One of the *Procris* group. It agrees with *Homophylotis*, Turn., in neuration, but differs from it in the short palpi and antennæ pectinated to apex.

ONCEROPYGA ANELIA, n. sp.

(*Anelios*, sombre.)

Female, 15-16 mm. Head, antennæ, thorax, and legs dark-fuscous. Palpi whitish. Abdomen dark-fuscous; tuft similar with metallic green reflections. Forewings elongate-triangular, costa scarcely arched, apex rounded, termen obliquely rounded; dark-fuscous irrorated with grey-whitish scales, which form indistinct transverse bands at $\frac{1}{4}$, beyond middle, and before termen; cilia dark-fuscous. Hindwings with termen rounded; blackish, thinly scaled; cilia blackish.

Type in Coll., *Turner*.

Q., Toowoomba, in April; two specimens.

POLLANISUS.

Pollanisus, Wlk., Brit. Mus. Cat. i., p. 114.

Mr. Meyrick (P.L.S.N.S.W., 1886, p. 790) divides the genus *Procris* into two sections. These are, I think, better regarded as distinct genera. The first section in which vein 4 of the hindwings is present contains only one Australian species, *dolens*, Wlk., which appears to be a true *Procris*. The second section has vein 4 of the hindwings absent, and includes all the remaining Australian species, for which Walker's generic name should be adopted.

The Australian genera may be thus tabulated:—

A. Forewings with 8 and 9 stalked ...	*Monoschalis.*
AA. Forewings with 8 and 9 separate.	
B. Forewings with 7 and 8 stalked.	
C. Male antennæ with apical $\frac{1}{6}$ simple, female antennæ simple	*Homophylotis.*
CC. Antennæ of both sexes pectinated to apex	*Onceropyga.*
BB. Forewings with all veins separate.	
C. Hindwings with vein 6 absent ...	*Hestiochora.*
CC. Hindwings with vein 6 present.	
D. Hindwings with vein 4 absent	*Pollanisus.*
DD. Hindwings with all veins present	*Procris.*

Family LIMACODIDÆ.

Nervicompressa.

Nervicompressa, Baker, Nov. Zool., 1904, p. 389.

This genus, of which Mr. Bethune-Baker describes six species from New Guinea, is remarkable for the peculiarly distorted neuration of the forewings. Whether it is correctly referred to this family I cannot determine, as I have been unable in my solitary example to ascertain whether there are two internal veins in the forewing.

Nervicompressa dubia.

Nervicompressa dubia, Baker, Nov. Zool., 1904, p. 391, pl. iv., f. 19.

N.Q., Kuranda, in May; one bred male, in perfect condition, received from Mr. F. P. Dodd.

Momopola.

Momopola, Meyr., Tr.R.S.S.A., 1891, p. 190.

Tetraphleps, Hmps., Moths Ind. 1, p. 383.

In my tabulation (Tr.R.S.S.A., 1904, p. 240) these names were intended to be bracketed opposite the initial "D."

Momopola loxogramma.

Parasa loxogramma, Turn., Tr.R.S.S.A., 1902, p. 193.

Having had occasion to re-examine the type I find I have placed it wrongly. Vein 10 is shortly stalked with 7, 8, 9, and the antennæ are pectinated to apices, though the pectinations are very short in the terminal half.

Birthama haplopis, n. sp.

(*Haplopis*, of simple appearance.)

Male, 16-19 mm. Female, 26 mm. Head, palpi, antennæ, thorax, abdomen, and legs pale ochreous-brown. Forewings shortly triangular, costa rather strongly arched, apex rounded, termen obliquely rounded; pale ochreous-brown; a darker brown line from mid-costa, bent inwards beneath cell, to $\frac{2}{5}$ dorsum; obsolete in female; a second finer line from $\frac{2}{3}$ costa evenly curved outwards to tornus, in female followed in upper part by a pale line; cila concolorous. Hindwings with termen strongly rounded; rather paler than forewings; cilia as forewings.

Type in Coll., *Turner*.

N.Q., Kuranda, in October; five specimens: 4 male, 1 female, received from Mr. F. P. Dodd.

Birthama delocrossa, n. sp.

(*Delocrossos*, plainly edged.)

Male, 20 mm. Head, palpi, thorax, and abdomen fuscous; antennæ ochreous-fuscous. Legs fuscous; tarsi annulated with whitish-ochreous. Forewings shortly triangular; costa straight, gently rounded towards apex, apex rounded, termen obliquely rounded; deep fuscous-brown; a transverse whitish line at base; a fine whitish sub-terminal line, preceded by a whitish dot in disc; termen dark-grey; cilia grey, with faint basal median and apical whitish lines. Hindwings with termen rounded; dark-grey; cilia as forewings.

Type in Coll., *Turner*.

N.Q., Kuranda, in March; one specimen received from Mr. F. P. Dodd.

Family, ZEUZERIDÆ.

Xyleutis eremonoma, n. sp.

(*Eremonomos*, dwelling in the desert.)

Male, 34-44 mm. Head and palpi brownish-ochreous. Antennæ white, pectinations fuscous. Thorax and abdomen whitish, suffused with brownish-ochreous. Legs ochreous-whitish; tarsi dark-fuscous, with whitish annulations. Forewings clear white, with numerous dark-fuscous spots and strigulæ; costa with numerous spots from base to apex; nearly touching or partly confluent with these a sub-costal series of spots; some small spots in cell; many narrow transverse strigulæ, more or less elongate, in dorsal and postmedian areas; cilia white, obscurely barred, with pale fuscous. Hindwings whitish; post-median area with numerous closely-set and partly confluent fuscous strigulæ; cilia white barred with fuscous.

Type in Coll., *Turner.*

Q., Cunnamulla (300 miles from coast); five specimens.

Family, TINEIDÆ.

Sub-family, XYLORYCTINÆ.

Cryptophasa xylomima, n. sp.

(*Xylomimos,* imitating a stick.)

Male, female, 44-50 mm. Head pale ochreous. Palpi pale ochreous; some fuscous irroration on outer surface of second joint towards base. Antennæ pale-ochreous; pectinations in male 2. Thorax whitish, with a few dark-fuscous scales; tegulæ anteriorly pale-ochreous, posteriorly dark-fuscous, apices ochreous-brown. Abdomen pale ochreous; dorsum of third segment, bright ochreous. Legs pale-ochreous; middle and posterior tarsi fuscous. Forewings elongate-oblong, costa gently arched towards base, thence straight, apex rounded, termen nearly straight, not oblique; whitish, costal third suffused with ochreous-grey, with sparse general irroration of blackish scales; a transverse discal blackish mark before $\frac{2}{3}$; a terminal series of dark-fuscous dots; cilia whitish. Hindwings with termen gently rounded; pale-ochreous; cilia pale-ochreous.

Type in Coll., *Turner.*

N.Q., Mulgrave River, near Cairns; one specimen. Kuranda, in December; two specimens received from Mr. F. P. Dodd.

Cryptophasa porphyritis, n. sp.

(*Porphyrites,* purple.)

Male, 46 mm. Head and palpi white. Antennæ fuscous; pectinations in male rather short ($1\frac{1}{2}$). Thorax white, with a posterior and two lateral purple-fuscous spots. Abdomen dark-fuscous. Legs fuscous, mixed with white. Forewings elongate-oblong, costa very slightly arched, apex rectangular, termen slightly rounded, slightly opaque; pale purple irrorated with reddish-brown, whitish, and a few blackish scales; costa from base to middle fuscous; base from beneath costa and along dorsum to $\frac{1}{6}$ broadly white; a blackish discal dot beyond middle; a triangular white spot on costa at $\frac{3}{4}$, succeeded by two minute white dots before apex; a sub-terminal line of blackish dots outlined by reddish-brown; a terminal series of reddish-brown dots; cilia pale purplish, a basal line of reddish-brown interrupted by white. Hindwings dark-fuscous; cilia fuscous, with some whitish scales, which are absent towards apex and tornus.

Type in Coll., *Walsingham.*

N.Q., Kuranda, in January; one specimen received from Mr. F. P. Dodd.

Cryptophasa argyrias, n. sp.

(*Arguros*, silver.)

Female, 60 mm. Head ochreous; face ochreous, whitish in centre. Palpi dark-fuscous, with some pale ochreous scales; posteriorly pale ochreous. Antennæ pale-grey; pectinations in male moderate ($3\frac{1}{2}$). Thorax silvery-white; tegulæ pale-ochreous; patagia forming loose spreading hair-like tufts, pale ochreous, mixed with fuscous. Abdomen dark-fuscous; first and second segments pale ochreous; third segment suffused with reddish-ochreous; terminal segment ochreous. Legs dark-fuscous; coxæ, small posterior tufts on anterior tibiæ, and obscure tarsal annulations ochreous. Forewings elongate-oblong, costa gently arched, apex rounded, termen rounded, scarcely oblique; shining silvery white; a dark-fuscous line along costal and terminal edge, broader on latter; cilia whitish-ochreous. Hindwings ochreous-whitish-grey; terminal edge fuscous; cilia pale ochreous, with a basal fuscous line.

Type in Coll., *Walsingham.*

N.Q., Kuranda, in January; one female and a mutilated male received from Mr. F. P. Dodd.

Cryptophasa pellopis, n. sp.

(*Pellopis*, dusky.)

Male, 32 mm. Head whitish. Palpi whitish; external surface of second joint fuscous except at apex. Antennæ whitish-grey; pectinations in male 3. Thorax whitish, with some fuscous scales. Abdomen fuscous; dorsum of third segment ochreous. Legs fuscous; tarsi annulated with whitish. Forewings oblong, costa gently arched, apex rounded, termen obliquely rounded; whitish closely irrorated with brownish and dark-fuscous; a blackish suffusion on base of costa prolonged as a blotch, reaching fold at $\frac{1}{3}$, and connected beneath costa with a roundish, blackish, sub-apical spot; a discal spot before $\frac{2}{3}$ is also connected with this suffusion; a pale fuscous terminal line; cilia fuscous, bases whitish, containing an interrupted dark-fuscous line at $\frac{1}{3}$. Hindwings with termen rounded; dark-fuscous; cilia pale fuscous, with a darker line at $\frac{1}{3}$.

Type in Coll., *Turner.*

Q., Nanango, in January, one specimen.

SCIEROPEPLA MONOÏDES, n. sp.

(*Monoeides*, simple.)

Female, 20 mm. Head, palpi, antennæ, thorax, and abdomen dark-grey. Legs dark-grey; posterior pair whitish. Forewings narrow-elongate, costa moderately arched, apex tolerably acute, termen very obliquely rounded; uniformly dark-grey; cilia dark-grey. Hindwings with termen gently rounded; pale grey; cilia pale grey.

Type in Coll., *Lyell.*

W.A., Bridgetown, in April; two specimens.

PHYLOMICTIS ECLECTA, n. sp.

(*Eklektos*, picked out.)

Male, 18 mm. Head and thorax whitish-grey. Palpi whitish, mixed with fuscous. Antennæ whitish, towards apices grey; ciliations in male rather long ($2\frac{1}{2}$). Legs white; anterior and middle tibiæ mixed with fuscous; tarsi fuscous with white annulations. Forewings with a large fovea on under-side between veins 10 and 11, which are distorted; white finely irrorated with grey; a large oval grey spot on dorsum at $\frac{1}{4}$; cilia white, bases barred with grey. Hindwings with termen gently rounded, slightly sinuate; grey; cilia grey.

Type in Coll., *Turner.*

Q., Burpengary, near Brisbane, in August; one specimen.

Notes on South Australian Marine Mollusca, with Descriptions of New Species.—Part III.

By Jos. C. Verco, M.D. (Lond.), F.R.C.S. (Eng.), etc.

[Read May 1, 1906.]

Plate IV.

Cingulina spina, Crosse and Fischer.

Turritella spina, Crosse and Fischer, Journ. de Conch., 1864, p. 347; 1865, p. 44, t. 3, figs. 12-14, type locality, St. Vincent Gulf; *Aclis tristriata,* Ten. Woods, Proc. Roy. Soc. Tasm., 1877, p. 150; type locality, N.W. Coast, Tasmania; No. 220, Handlist of Aquatic Moll. of S. Aust., Adcock, 1893.

This species varies greatly. It may be very attenuate, or comparatively wide; uniformly subulate or posteriorly spindle-shaped; have valid or obsolete axial striæ; a smooth base, or with numerous sublenticular spiral grooves, or two slight spiral undulations. The last whorl may be very ventricose. A more or less valid lira may lie in the suture. The cinguli are usually nearly equal, but the central one may be more developed, and the suture be wide and deep and distinct.

Cingulina diaphana, *spec. nov.* Pl. iv., fig. 11.

Shell thin, diaphanous. Protoconch asymmetrical smooth. Whorls exclusive of this six, medially carinate, with seven valid spiral liræ, equally distant on the penultimate, scabrous from microscopic accremental striæ, obliquely receding from the suture. Suture well marked, slightly channelled. Body-whorl with a stouter lira at the periphery, and a deeper sulcus below it, and seven basal liræ less valid than those above, base sloping. Aperture fusiformly lozenge-shaped, slightly contracted behind, and narrowly effuse in front. Outer-lip simple. Columella slightly convex posteriorly uniformly concave throughout the anterior three-fourths; inner-lip complete.

Length, 2·1 mm.; breadth, ·7 mm.; aperture, ·6 mm.

Hab.—Henley Beach, one example in the late Prof. Tate's collection, labelled "*Mathilda pagodula.*" One other specimen dredged in deep water St. Vincent Gulf.

Scala aculeata, Sowerby, jun.

Scalaria aculeata, Sowerby, Proc. Zool. Soc. Lond., 1844, p. 12; Thes. Conch., vol. i., p. 86, sp. 13, pl. xxxii., figs. 35, 36, 37, 1847; Tryon, Man. Conch., vol. ix., p. 63, pl. xiii., figs. 90, 91, 1887; No. 192, Handlist of Aquatic Moll. of S. Aust., 1893; *S.*

aculeata, Lamarck, 1819; in Tate and May's Tasmanian Census, Proc. Lin. Soc. of N.S.W., 1901, pt. 3, p. 379.

It ranges alive from the shore (Henley Beach, "with a purple mucus," A. Zietz), to 12 fathoms Porpoise Head, and 22 fathoms Backstairs Passage; and dead in perfect condition in 104 fathoms 35 miles S.W. of Neptune Islands.

Scala jukesiana, Forbes.

Scalaria jukesiana, Forbes, appendix to Voy. of "Rattlesnake," vol. ii., p. 383, t. 3, f. 7, 1852; Tryon, Man. Conch., vol. ix., p. 66, pl. xiv., f. 20, 1887; No. 194, Handlist of Aq. Moll., Adcock, 1893. *Scalaria delicatula*, Crosse and Fischer, Journ. de Conch., 1864, p. 347; 1865, p. 42, t. 3, f. 9, 10; type locality, St. Vincent Gulf, S. Aust.; Tryon, Man. Conch ix., p. 69, pl. 14, f. 39, 1887; habitat, New Caledonia.

Tryon defines it as "'very minutely spirally striated," but Crosse says "the intervals between the ribs are smooth." No fine spiral lines could be detected by me on the two shells in the British Museum, labelled "*S. delicatula*, Cr. and F., S. Aust., G. F. Angas," on the back of the tablet being "S. Aust. and New Zealand. Type."

Pritchard and Gatliff, in Cat. of Marine Shells of Victoria, Proc. Roy. Soc. of Vict., 1900, vol. xiii. (N.S.) pt. i., p. 143, give *S. consors*, Crosse and Fischer, Journ. de Conch., 1864, p. 347; 1865, p. 43, pl. iii., f. 11, 12, as a synonym; but the type shell in the Brit. Mus. shows a well-marked peripheral keel, which none of our S. Australian *S. jukesiana* possesses.

Scala friabilis, Sowerby, jun.

Scalaria friabilis, Sow., Proc. Zool. Soc., Lond, 1844, p. 27; Thes. Conch., vol. i., p. 95, sp. 47, pl. xxxiii., f. 47, 1847; Tryon, Man. Conch., vol. 9, p. 61, f. 75, 1887; No. 193, Handlist Aq. Moll., Adcock, 1893.

On the tablet in the Brit. Mus. is "Swan River, Australia, on the sands, unique, Dr. Collie, type." Our shells are identical with this; but one measures 22 mm., *i.e.*, 6 mm. longer than the type. Porpoise Head, 12 fathoms, 2 recent, 2 dead: Backstairs Passage, 20 fathoms, 1 recent.

Scala rubrolineata, Sowerby, jun.

Scalaria rubrolineata, Sow., Thes. Conch., vol. i., p. 91, sp. 33, pl. xxxiv., f. 83, 84, 1847; Tryon, Man. Conch., vol. ix., p. 60, pl. xii., f. 82-83, 1887.

This species, misidentified, was listed in Handlist of Aq. Moll. of S. Aust., Adcock, 1893, as No. 195, *S. imperialis*, Sby. It is very rare. The Levens Beach, Spencer Gulf (W. T. Bednall); St. Vincent Gulf (D. J. Adcock).

Scala zelebori, Dunker.

Scalaria zelebori, Dunker, Verhandl. Zool. Bot., Gesell., Wien, 1866, vol. xvi., p. 912. *Scalaria zelebori*, Frauenfeld, Reise, Fregatte Novara, vol. ii., pt. 3, p. 7, t. i., f. 6, 1868; Tryon, Man. Conch., vol. ix., p. 78, pl. 15, f. 75, 1887; Hand-list of Aq. Moll. of S. Aust., Adcock, 1893, No. 199.

This is recorded for S. Aust. by Tate, from a single individual given to him by Mr. Pulleine, from Encounter Bay. No other collector has taken it, nor has it been found in Tasmania or Victoria. Probably it does not occur here.

Scala platypleura, *spec. nov.* Pl. iv., fig. 6.

Shell moderately solid, whorls 8, increasing rapidly. Protoconch two whorls, smooth, convex. Whorls well rounded. Suture deep, simple. Varices running forward below, solid, rather low, doubly flanged so that a free edge projects slightly on either side, edges minutely cut, surface slightly irregular, subangular below the suture, 15 on the body-whorl. Aperture roundly quadrate, with an oblique gutter at the base of the columella.

Sculpture.—Obsolete subdistant spiral incisions mounting the varices.

Length, 5 mm.; spine, 2·6 mm.; width, 2·3 mm.

Hab.—Backstairs Passage 22 fathoms, 2 dead. Type in Dr. Verco's collection.

The second shell is rather thinner, and its varices are not quite so solid.

Diagnosis.—From *S. zelebori*, Frnfd., its nearest ally, it is distinguished by more numerous varices, and its incisions, which are quite different from the more distant spiral liræ of the N.Z. form. It differs from *S. jukesiana*, Forbes, in the more rapid increase of its whorls, its fewer and much more solid varices, which also run forward and downwards instead of backward.

Scala acanthopleura, *spec. nov.* Pl. iv., fig. 8.

Shell rather solid, whorls 8, rapidly increasing. Protoconch conical, smooth, sharp, 3 whorls, homostrophe. Varices solid, half the width of the interspaces, numerous, 20 on the body-whorl, tuberculate, 4 tubercles or prickles on the penultimate, 7 on the body-whorl, microscopically axially striate. Interstices very minutely closely spirally lirate, liræ mounting the varices. Aperture round, with a shallow gutter at the junction of the basal lip and the columella, which is thus slightly twisted and toothed. The varices wind round the columella as 7 oblique plaits ceasing at the inner lip, which here is thin and erect.

Length, 4·1 mm.; spire, 2·6 mm.; width, 2·6 mm.

Hab.—104 fathoms, 35 miles S.W. of Neptune Islands, 5 dead.

Type in Dr. Verco's collection.

Scala crassilabrum, Sowerby, jun.

Scalaria crassilabrum, Sow., jun., Thes. Conch., vol. i., p. 105, p. 87, pl. xxxv., figs. 115, 116, 1847; Tryon, Man. Conch., vol. ix., p. 82, pl. 17, f. 32, 1887.

The localities given are the Philippines and Central America, and, though the regions are remote, our shell answers to the description and figures. Dredged in deep water, St. Vincent Gulf. One example, measuring 12·75 mm. by 3·5 mm.

Scala granosa, Quoy.

Turritella granosa, Quoy, Zool. Voy. Astrolabe, vol. iii., p. 138, t. 55, f. 29, 30; *Scalaria granulosa*, Quoy, Tryon, Man. Conch., vol. ix., p. 80, pl. xvi., f. 11, 1887; No. 198, Handlist of Aq. Moll. of S. Aust., Adcock, 1893; *Scalaria ballinensis*, E. A. Smith, Ann. Mag. Nat. Hist. (6), vii., 1891, p. 139, only a smooth form, teste Hedley, Proc. Lin. Soc. N.S.W., 1901, pt. iv., p. 701, pl. xxxi., f. 21.

Taken alive at Encounter Bay, in crevices of rocks (Dr. Perks). It must be a very littoral species, as no example has been dredged by me.

Scala australis, Lamarck.

Scalaria australis, Lam. Anim. s. Vert., 2nd edit., vol. vi., p. 228, sp. 6, 1843; Delessert Recueil, t. 33, f. 11; Thes. Conch., p. 103, sp. 82, pl. xxxv., f. 135, 1847; Tryon Man. Conch., vol. ix., p. 76, pl. xvi., f. 90, 1887; No. 197 Handlist of Aq. Moll. of S. Aust., Adcock. *Hab.* "the Seas of New Holland."—M. Macleay."

Taken alive on the beach at Corny Point, Spencer Gulf (Dr. Perks), and Middleton (D. J. Adcock). It must be very limited in its range as regards depth, for I have not taken a single individual alive or dead by dredging.

Scala consors, Crosse and Fischer.

Scalaria consors, Crosse and Fischer, Journ. de Conch., vol. xii., 1864, p. 347; xiii., 1865, p. 43, pl. 3, figs. 11, 12; Tryon, Man. Conch., vol. ix., p. 74, pl. 13, f. 11, 1887; No. 196, Handlist of Aq. Moll. of S. Aust., Adcock, 1893. Type locality, St. Vincent Gulf, S. Aust.

In the Brit. Mus. the tablet has on its face, "*S. consors*, Cr. and Fischer, Ceylon, G. F. Angas," and on its back, "Type." It has a peripheral keel. Mr. J. C. Melville cites it from Bombay, and refers it to *perplexa*, Pease. I have a note without any reference. "Angas sent shells from S. Aust. to Crosse, for description, and among them were *S. delicatula* and *S. consors*, their habitat being given as St. Vincent Gulf; and then sent the type of *S. consors* to the Brit. Mus. as from Ceylon." No shell answering to its description has been found in S. Aust.

Scala valida, *spec. nov.* Pl. iv., fig. 7.

Shell elongate, imperforate, 9 whorls. Protoconch conspicuous, submammillate, $1\frac{3}{4}$ whorls, at first smooth, then with gradually developing axial costæ; it ends abruptly with a faintly averted edge, and is followed by spirally striated sculpture. Spire-whorls uniformly convex. Suture deep, subcanaliculate. Body-whorl convex, with a bold, square, subtuberculate peripheral rib; base somewhat concave. Aperture slightly oblique, roundly oval, faintly flattened anteriorly: border well defined, smooth, and flat; at the base its outer margin is not curved, but straight. Varices 12, slightly advanced at the upper suture.

Sculpture.—Axial ribs, 18 in the body-whorl, about as wide as the interspaces, prominent, round, tapering at each end, terminating at the peripheral rib, which widens to meet them, and so becomes undulatingly tuberculate. Spiral liræ 12 on the body-whorl above the periphery crossing the costæ and extending to the aperture: 7 spiral liræ on the base increasing in width towards the axis. The interstices between all liræ spiral and basal and the edges of the peripheral rib are punctate.

Ornament.—The shell is whitish. Three obscure spiral light-brown bands, one tinging the peripheral rib, one just below the centre of the whorls, and one midway between this and the upper suture. The last band is chiefly represented by a small brown blotch on the rib behind each variceal costa.

Length, 6·4 mm.; spire, 2·7 mm.; aperture, including the rim, 1·6 mm.; width, 2·3 mm.

Hab.—Backstairs Passage, deep water, 6 recent, none alive.

Type in Dr. Verco's collection.

Variations.—The spiral liræ may be only 9 or may be 17. One shell is 6·9 mm. in length, with 9 whorls.

Scala morchi, Angas.

Scala (*Cirsotrema morchi*), n. sp., Proc. Zool. Soc., Lond., 1871, Jan. 3, p. 15, pl. i., f. 7; type locality, Port Jackson; op. cit., 1871. Jan. 17, p. 90, sp. 23; Tryon, Man. Conch., vol. ix., 1887, p. 82, pl. 16, f. 7.

Some twelve examples of this shell have been dredged by me in the deeper waters of St. Vincent and Spencer Gulf, and one at 104 fathoms, 35 miles south-west of the Neptune

Islands. In the British Museum is one shell labelled, "*S. morchi*, Angas; Port Jackson, G. F. Angas"; it is not affirmed to be a type; but it quite agrees with Angas's description. The axial and spiral ribs and ridges are of about equal prominence, and there is no peripheral rib. There are varices at irregular intervals which run downwards and backwards on the spire; these are not noted in the definition of the type. It recalls the *S. suturalis*, Hinds; but this has a valid peripheral rib, which appears as a lira in the suture, and its axial costæ are more marked, and it is a larger shell, being eight lines in length, with ten whorls, instead of five lines with nine whorls. Our S. Aust. examples vary very greatly. First the peripheral rib is quite valid, and the axial costæ end abruptly upon it, and the base has only spiral liræ. In one this just appears in the suture as a lira. In others this rib is less and less marked, and may be quite absent. The axial costæ also differ in validity, much surpassing the spiral ridges, or equalling them, or being less prominent; they may end at the peripheral rib, or extend beyond the periphery, and gradually fade out on the base. The spiral ridges may vary in number and in size and in the degree to which they modify the axial costæ. But all have the irregular varices and a minute punctate surface.

These considerations suggest the identity of *S. morchi*, Angas, with *S. suturalis*, Hinds. I do not know whether the latter has the punctate sculpture, and as it is a much larger shell, and comes from a remote region, this is left *sub judice*. Whether *S. valida*, Verco, and *S. invalida*, Verco, will also come within the specific definition of *S. morchi*, Angas, must be left until more material is gathered: at present intermediate forms are wanting. One example of *S. morchi* supplied an operculum, figured on pl. iv., figs. 1, 2, which is similar to that of *S. aculeata*, Low., and tends to confirm the generic position of this rather atypical Scala.

Scala invalida, *spec. nov.* Pl. iv., figs. 9, 10.

Shell rather thin, translucent, elongate, imperforate, 11 whorls. Protoconch deflected, 2 whorls, nearly smooth; the first round, the second angulate just above its centre, and ending in a varix. Spire whorls 8, regularly convex: suture deep, simple. Body-whorl round with the merest peripheral angulation. Aperture subrotund, flattened by the base of the body-whorl, margin thickened externally.

Sculpture.—Very crowded, fine axial and spiral liræ, punctating the whole surface. The axial liræ vary somewhat in thickness; they continue over the base and the callus of the aperture, so as to reach nearly to its inner margin, leaving only a narrow rim smooth. Deep in the suture are tubercles on the upper border of each whorl, about 24 on the body-whorl. Varices at irregular intervals, one on the second whorl, one on the fifth, and one at the aperture. They curve forwards towards the upper suture.

Length, 10·4 mm.; breadth, 3 mm.; body-whorl, 3·5 mm.

Hab.—St. Vincent Gulf, deep water, one recent.

Obs.—This species may prove to be an extreme variant of *S. morchi*, Angas, in which the radial and spiral costæ have been suppressed or reduced to punctating lirellæ.

Scala (acrilla) minutula, Tate and May.

Scalaria (acrilla) minutula, Tate and May, Proc. Roy. Soc. of S. Aust., xxiv., 1900, p. 95; Proc. Linn. Soc. N.S.W., 1901, pt. 3, p. 379, pl. xxv., fig 41; type locality, Tasmania; type in Hobart Museum.

Hab.—Fowler's Bay (R. Tate), St. Vincent Gulf.

Crossea, A. Adams.

Crossea labiata, Ten.-Woods.

Crossea labiata, Ten-Woods, Proc. Roy. Soc., Tasm., 1875, p. 151; type locality, Long Bay, Tasm.; No. 200 in Handlist Aq. Moll. of S. Aust., Adcock, 1893; Hedley, Proc. Linn. Soc. N.S.W., 1900, p. 500, pl. xxvi., f. 18; Tate and May, Census of Marine Moll. of Tasm., Proc. Linn. Soc., N.S.W., 1901, pt. 3, p. 379.

Dredged dead St. Vincent Gulf 9 and 5 fathoms (Verco), Beach Holdfast Bay, Aldinga, West Coast (R. Tate).

Crossea concinna, Angas.

Pros. Zool. Soc., Lond., 1867, p. 911, t. 44, f. 14; Tryon, Man. Conch., ix., p. 85, pl. 17, f. 45, 1887; Tate and May in Census of Marine Moll. of Tasm., Proc. Linn. Soc., N.S.W., 1901, pt. 3, p. 380; Conchyl. Cab., Mart. and Chemn, Bd. 1, Abt. 28, p. 261, t. 41, f. 10, 1902.

Dredged dead St. Vincent Gulf and Backstairs Passage, 17 fathoms, 7 dead.

Crossea cancellata, Ten.-Woods.

Proc. Roy. Soc., Tasm., 1878, p. 122. Type locality, Blackman's Bay, Tasm. *Delphinula johnstoni*, Beddome, Proc. Roy. Soc., Tasm., 1882, p. 31, and 1883, p. 169: *Crosseia cancellata*, Ten-Woods, Tate and May, Census Marine Moll. Tasm., Proc. Linn. Soc., N.S.W. 1901, pt. 3, p. 381, pl. xxiii., fig. 1.

Dredged off Newland Head, 20 fathoms, 5 dead.

(?) Terebra dyscritos. Pl. iv., figs. 3, 4, 5.

Shell solid, long, narrow. Whorls 7. Protoconch 2 whorls, homostrophe, convex, with 20 fine spiral incisions ending abruptly in a varix, white. Spire whorls with angulation at one-fourth the distance from the lower suture; uniformly concave between the angulations; with axial costæ, valid, rounded nearly as wide as the interspaces, and spiral liræ, wider anteriorly, wider than their interspaces, crossing the costæ, six above the angulation, and two below it; fine accremental striæ under the lens. Suture distinct, linear, undulating, convex between the costæ. Body-whorl oblong with two median rounded carinæ, the upper larger, more prominent, forming the angulation (in the spire whorls), the lower producing the upper margin of the suture, tuberculated by the axial costæ, which cease at the lower one; six spiral liræ above them, two between them, and ten of varying size below them on the concave base. Aperture subtriangular, outer side straight, inner sigmoid. Outer lip thin, slightly excavated just below the suture for one-sixth of its extent to form a shallow sulcus, with a margin feebly thickened and everted, then excavated again to the upper carina, an acute short projection between the two excavations; edge crenulated by spiral liræ and carinæ. Basal lip begins at the lower carina and is concavo-convex to the anterior notch. Columella concavo-convex from behind forwards.

Dimensions.—Length, 9·1 mm.; width, 2·7 mm.; aperture, 2·8 mm.; body-whorl, 4·8 mm.

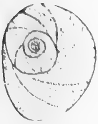
Locality of type, St. Vincent Gulf, 22 fathoms with 6 other examples, 100 fathoms off Beachport, one broken, 110 fathoms 6, 130 fathoms off Cape Jaffa, 2 broken.

Ornament.—The type is white, but a co-type shows a brown tinting of the two carinæ and of that part of the axial costæ connecting them, most marked at the tubercles of junction. This shell is 10·1 mm. long, and shows fifteen spiral liræ at the base.

Observations.—The living mollusc has not been taken, so the radula and the operculum (if any) are not known. Its generic position is very doubtful, and even its family is questionable. Some conchologists who have seen it refer it with doubt to the *Terebridæ*, and propose the creation of a new genus for its reception. Its infra-sutural sulcus, barely thickened at the margin, suggests *Pleurotomidæ*, but it is difficult to find a genus for it here.

Explanation of Plate IV.

Fig. 1, 2, Operculum of *Scala morchi*, Angas.
,, 3, 4, 5, ? *Terebra dyscritos.*
,, 6, *Scala platypleura*, n. sp., Verco.
,, 7, ,, *valida*, n. sp., Verco.
,, 8, ,, *acanthopleura*, n. sp., Verco.
,, 9, 10 ,, *invalida*, n. sp., Verco.
,, 11, *Cingulina diaphana*, n. sp., Verco.



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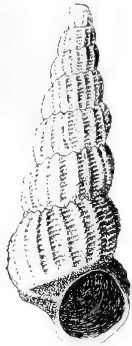

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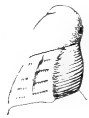

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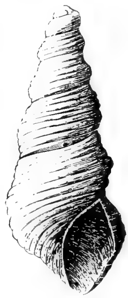

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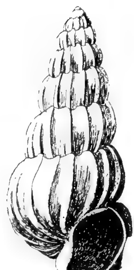

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Hussey & Gillingham, Printers, Adelaide.

Madreporaria from the Australian and New Zealand Coasts.

By John Dennant, F.G.S.

[Read October 2, 1906.]

Plates V. and VI.

The following corals have been submitted to me for description:—From South Australia, by Dr. Jos. Verco and the late Professor Tate; from New South Wales, by Messrs. Hedley and Petterd; and from New Zealand by Mr. Henry Suter. They are arranged in 15 species and as many genera. Nine species prove to be new, three were described by Moseley from the "Challenger" dredgings, two are corals described by Ten. Woods from the coast of New South Wales, and one is a varietal form of a tertiary fossil.

TURBINOLIDÆ.

Genus Flabellum, Lesson.

Flabellum australe, Moseley, Report on Corals, 1881, pp. 173-4, pl. vii., figs. 4, 5.

This coral was dredged at 120 fathoms off Twofold Bay by the "Challenger" Expedition, when eleven specimens were obtained. Lately it has been dredged in very large numbers 20 miles north-east of Port Jackson, by Messrs. Hedley and Petterd, at a depth of 250 fathoms. It has also been dredged by Dr. Verco at 90, 120, and 130 fathoms off Cape Jaffa, and at 110, 150, and 200 fathoms off Beachport.

The specimens are generally of large size, but none reach the dimensions of Moseley's largest example, viz., 57 mm. high and 65 mm. broad. The largest sent to me is 38 mm. high and 44 mm. broad.

Genus Sphenotrochus, Milne-Edwards and Haime.

Sphenotrochus emarciatus, Duncan; var. **perexigua,** *nov.*

A fossil coral from the Australian tertiaries was described by Duncan in 1865 under the name of *Sphenotrochus emarciatus.** Two years later this author re-described the same coral, and in exactly the same words, but with a new specific name, viz., *S. excisus.*† As he gave no reason for the change, and I know of none, the older name is here restored. The

* Ann. and Mag. Nat. Hist. vol. xvi., p. 2, pl. viii., fig. 2.

† Q.J.G.S., vol. xxvi., p. 298, pl. xix., fig. 86.

fossil coral is very abundant in the eocene beds of almost all localities, and is also sparingly found in the Gippsland miocene. A coral from Dr. Verco's later dredgings off the South Australian coast exactly resembles in outward appearance the common tertiary fossil, the only difference being that its calice is narrower in proportion to its length. I think it may rank as a variety, but certainly no more. The major and minor axes of the calice are as 180 to 100. In the fossil the relative proportion of the axes is as 150 to 100, and in an exceptionally compressed specimen as 166 to 100. Duncan gives the ratio of the longer to the shorter axis in the fossil as 2 to 1, but he is certainly wrong.

In all, nine specimens of the recent coral were obtained, and the calices show the same number of septa, and the same confused appearance of the columella, that Duncan mentions in regard to the fossil.

Height, 6 mm.; length of calice, 4·5 mm.; breadth of calice, 2·5 mm.

Dredged east of Neptune Island at 45 fathoms; at 90 and 130 fathoms off Cape Jaffa; and at 49 and 150 fathoms off Beachport.

Genus Trematotrochus, Tenison Woods.

Trematotrochus Hedleyi, *spec. nov.* Pl. v., figs. 1*a*, *b*.

This is a *Trematotrochus* of the same type as the fossil one first described by Woods, viz., *T. fenestratus*, but is broader and less pointed at the base; the perforations in the wall are also larger. If any doubt still lingered as to the complete perforation of the wall in this type of *Trematotrochus*, it would be dispelled by looking at the examples now described, since, when viewed against the light, the openings show almost as distinctly inside the calice as on the outside of the wall.

The corallum is conical, and tapers by a double curve to the rounded base. At the actual margin it is slightly constricted, and broadens out just below to its greatest circumference. The calice is circular and shallow.

The septa are in six systems, with three cycles. The first and second orders are exsert, sparingly granular, equal, and extend to the columella; they are stout compared with the tertiaries, which, like those of its fossil analogue, *T. fenestratus*, are extremely thin and reach but a very short distance in the calice. There is a distinct columella, which is papillary superiorly, but becomes solid below, where the larger septa fuse with it.

The costæ, which correspond with the septa, are stout and equal, those of the third order being quite as large as the rest. They are formed of a series of large, loosely-joined, flattened granules. The primaries and secondaries reach the base, and the tertiaries nearly so. The intercostal spaces are large and are crossed at regular intervals by very thin bars, which form the fenestrated ornament characteristic of the genus.

Height, 5·5 mm.; diameter of calice, 3·5 mm.

Dredged by Messrs. Hedley and Petterd, 20 miles north-east of Port Jackson, at a depth of 250 fathoms. Five examples were obtained, two of which are perfect, though their mural perforations are clogged by sediment. The drawing of the corallum is from a third specimen, one-half of which is well preserved, and the other half imperfect; the two remaining examples are fragmentary.

The calice of *T. Hedleyi* almost exactly reproduces that of *T. fenestratus*, the common eocene coral, but in the shape of the corallum the two species differ widely, the former being somewhat barrel-shaped, while the latter is long and has a pointed base. *T. Clarkii*, the miocene *Trematotrochus*, is also barrel-shaped, but its calice shows an additional cycle of septa. The other species of the genus, both fossil and recent, which have been described, differ more markedly from the present one.

Genus Trochocyathus, Milne-Edwards and Haime.

Trochocyathus Petterdi, *spec. nov.* Pl. v., figs. 2*a*, *b*.

The corallum is small and curved. It is divided into two approximately equal portions, the upper of which tapers very gently downwards to the commencement of the lower half, when it suddenly contracts and then terminates in a narrow bluntly-pointed base. The calice is circular, shallow, and crowded with septa. At first sight it appears to be divided into 15 equal parts by as many principal septa, with three others of higher order in each division. A close examination, however, shows that there are in reality six systems, of which only one is perfect, *i.e.*, with its full complement of tertiaries; another has one tertiary only, while in the remaining four these septa are entirely wanting. The quaternaries and quinaries are regularly developed between the fifteen principal septa. The total number of septa is thus 60. Those of the fourth and fifth orders are equal in thickness, but much smaller than the rest. All the septa are wavy, and the quaternaries especially so. Their margins are entire, and their sides are studded with rows of strong, bluntly-pointed granules. Irregularly shaped pali are placed in front of the secondaries and tertiaries, which are rather shorter than the primaries.

The columella occupies much space, and consists of numerous papilli, which, though irregular in shape, are on the whole more rounded than the pali.

The costæ correspond to the septa, and are formed of closely-packed, flattened granules, bearing horizontal spines which project into the narrow intercostal spaces. They descend perpendicularly on the wall, until they bend round with the curvature of the inferior portion of the corallum. The principal costæ are slightly larger than those of higher order. The latter sometimes unite on the wall, and then continue to the extremity of the base as a single broad costa, or all three of those lying between the principal costæ may broaden out independently. The specimens show considerable variation in the arrangement of the costæ on the basal portion of the corallum. The base itself is peculiar. It really extends from the commencement of the convex curve of the corallum, and is formed of three or four costæ, which are much broader than any of those on the wall proper. There is no epitheca.

Height of corallum, 4·5 mm.; diameter of calice, 4 mm. The coralla are not quite uniform in shape, the curvature being occasionally less than in the type, while the base again may be more sharply pointed.

Dredged by Messrs. Hedley and Petterd 20 miles north-east of Port Jackson, at a depth of 250 fathoms. Nine specimens were obtained, of which the type is perfect, and the others in tolerable order.

Genus Deltocyathus, Milne-Edwards and Haime.

Deltocyathus rotæformis, Tenison Woods, Linn. Soc. N.S.W., vol. II., pp. 306-7, pl. v., fig. 2.

The description and drawings of this coral given by Tenison Woods are correct. His examples, six in number, were dredged off Port Stephens by the late W. Macleay, at a depth of 71 fathoms. After the lapse of many years, it has now been dredged by Messrs. Hedley and Petterd, at 250 fathoms, 20 miles north-east of Port Jackson (11 examples); and also by Dr. Verco, at 104 fathoms, 35 miles south-west of Neptune Island, South Australia (147 examples). The latter gentleman also found the coral in considerable numbers and at varying depths, up to 200 fathoms, off Cape Jaffa and Beachport. Two of the New South Wales specimens are slightly larger than any from South Australia.

The alternation of the costæ with the septa is a remarkable feature of the species, and serves to distinguish it from all others in the genus.

Genus Kionotrochus, *nov.*

A Turbinolian coral, having a rounded free base, and an essential styliform columella. Septa arranged in a series of deltas. Wall entire and with prominent granular costæ. Pali absent. No epitheca.

The relations of the genus are with *Deltocyathus*, but there are no pali. It is allied also to *Turbinolia* by its styliform columella, but departs from that genus by its shape, by the arrangement of the septa, and by the absence of intercostal fossettes.

Kionotrochus Suteri, *spec. nov.* Pl. v., figs. 5*a*, *b*.

The numerous examples of this small coral are not quite uniform in outline. The majority are short, and approximately hemispherical in shape, like the example figured, but a few are slightly taller; others again are low, almost discoid forms.

In adults the corallum is free, with a rounded convex base, which shows a very small scar of former attachment at its centre. Very young individuals are fixed generally to shell fragments, and the corallum then has a flatly adherent base and a perpendicular wall. The gradations from such forms to those with a free rounded base is clearly traceable amongst the smaller specimens. The scar of former attachment becomes less and less conspicuous as the corallum increases in size.

The calice is circular and widely open. The septa are exsert and in six systems, with three cycles. They are slightly serrated at the margin, and their sides are beset with numerous strong, bluntly-pointed granules. The primaries are longer and stouter than the secondaries, and these again than the tertiaries. The latter curve round and join the secondaries near the columella, but so deep down that in a fresh, well-preserved specimen the junction is quite inconspicuous. In worn examples, however, the deltoid combinations, formed by the union of these septa, become well marked.

The columella is prominent, and in perfect specimens consists of an irregular pillar, having buttress-like supports and a central styliform projection. It is connected inferiorly with the primary and secondary septa by slender processes; in much-worn specimens the columella presents a fascicular appearance.

The costæ are continuations of the septa, but are stouter. They are highly granular, and form 24 equal, strongly-projecting ribs on the exterior of the corallum. The first two orders continue to the centre of the base, near which the tertiaries unite with the secondaries. In the intercostal spaces, which are very narrow, the wall of the corallum is thin, smooth, and entire.

Height, 3·5 mm.; diameter of calice, 4 mm.

This interesting coral was dredged at a depth of 110 fathoms by Mr. Henry Suter and Mr. Charles Hedley about 15 miles outside Great Barrier Island, New Zealand. It is evidently very abundant, as a large number of specimens have been sent to me. About 20 of them are full-grown and tolerably perfect; 20 others are also adult, but worn; in addition, there are more than 30 of the juvenile discoid forms previously mentioned, a few of which are still attached to minute shell fragments.

Genus Paracyathus, Milne-Edwards and Haime.

Paracyathus vittatus, *spec. nov* Pl. v., figs. *3a, b.*

The only example of this small coral is attached by its entire base to a fragment of shell. It was dredged some years ago by Dr. Verco, at a depth of 17 fathoms off Point Marsden, Kangaroo Island.

The corallum is low and almost cylindrical in shape, with a slight constriction just above the broadly adherent base. The main portion of the wall is covered by a stout, rough epitheca, but near the summit this terminates abruptly, and a narrow band of well-marked costæ succeeds, surrounding the margin of the corallum. At the actual junction of the epitheca and costal band the latter slightly overlaps, and its lower edge forms a distinct, sharply-defined rim.

The calice is shallow and elliptical, its major and minor axes being as 100 to 88. The septa are in six systems, with four cycles. The first two orders are exsert and equal, the tertiaries are both smaller and shorter, while the quaternaries are extremely slender, and barely project into the calice. All extend as costæ beyond the wall, retaining their relative size, but those of the fourth order, though still slender, are prolonged, and become a prominent feature of the costal band. All orders of septa are beset with long and stout granules, placed at right angles to their sides; the edges have thus a dentate appearance, though their upper surfaces are in reality plain. The costæ are also granular, but less so than the septa. Pali in more than one crown are placed before the primary and secondary septa, and separated from them by a deep and wide notch. They are of irregular shape, lobed, and sparingly granular.

There is a strong fascicular columella, with occasional nodules on its surface.

Height of corallum, 3·5 mm.; depth of costal band, 1 mm.; diameters of calice, 4 mm. and 3·5 mm.

Genus Caryophyllia, Lamarck.

Caryophyllia planilamellata, *spec. nov.* Pl. vi., figs. 4*a*, *b*.

This is the first *Caryophyllia* discovered in Australian waters. It is true that Milne-Edwards and Haime recorded one such species, viz., *C. Australis**, but, as shown by Brüggemann,† it certainly does not belong to the genus. The present species has been lately dredged in great numbers by Dr. Verco in the South-East of South Australia. Many of the specimens are very fine, and were dredged up alive.

The corallum is conico-cylindrical and more or less curved. It does not taper much till the commencement of the curve, when it diminishes rapidly. The specimens vary a good deal in outline, some being lengthened out and much twisted inferiorly, while others are both shortly and regularly curved. As a rule there is a small pedicellate base, though some examples, especially those with a long distorted basal curve, terminate in a bluntly-rounded point. Several coralla are still attached to shells, or other foreign substances, and in one instance a long slender corallum is adherent by its base to the side of a larger one.

The wall is covered with a fine, glistening, granular epitheca, with the costæ, which correspond with the septa faintly traceable beneath it. There is besides a tendency to the development of occasional knobs or protuberances on the wall. Many of the specimens also show numerous serpulæ, etc., on their surface.

The calice is shallow, widely open, and elliptical; the ratio of its axes is about as 100 to 88. In the type calice there are 10 primary and 10 secondary septa of approximately equal length, 18 tertiary much shorter, and 38 still smaller quaternaries. Prominent, upright, and regularly-shaped pali are placed before the tertiaries. As there are only 18 tertiaries in this calice, two half-systems being without them, the pali are also 18 instead of 20. Another calice shows exactly the same arrangement. In a third example I counted 19, and in a fourth 20 pali. The number of septa in the calices of adult forms, like those quoted, does not, therefore, differ greatly, the systems being normally 10 and the number of cycles 4. Both pali and septa are straight, moderately thin lamellæ; they agree also in being quite plain, *i.e.*, free from either spines or granules. Deep down, the pali are connected with the tertiary septa by a straight, thin, lengthened process; in other words, the pali are continuous with the tertiary septa, a deeply-cut notch marking the junction of the two structures.

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* Ann. Sci. Nat., Ser. 3, Zool., vol. x., p. 320, pl. viii., fig. 2.

† Ann. Nat. Hist., vol. xx., p. 310.

There is a prominent columella consisting of seven or eight twisted ribbon-like laminæ arranged longitudinally in the fossa. The pali are connected with it by stoutish processes.

The specimens vary in size as well as in outline; the largest is 47 mm. in height, without counting the curve, and its calice is 26 mm. by 23 mm. in diameter. The type calice is 18 mm. long and 16 mm. broad. The majority of the adult examples are about 30 mm. in length.

Dredged off Cape Jaffa at from 120 to 300 fathoms, and off Beachport at 110 fathoms.

The only species with which *C. planilamellata* needs to be compared is *C. communis*, which was described by Moseley in the "Challenger" reports. His specimens came from theNorthern Hemisphere, with the exception of a single broken one, which is recorded from the Cape of Good Hope.

I have not seen any examples of *C. communis*, but Moseley's drawings show a species with spined or granulated pali, whereas in the Australian species these structures are perfectly plain. Again, the latter has normally a pedicellate base, and in some instances is still attached, while C. *communis* is said to be constantly free and without sign of former adherence.

In 1878 Tenison Woods described a curious little coral which was dredged off Port Jackson under the name of *Dunocyathus parasiticus*, the genus being new, and founded on that species alone. Duncan proposed to absorb the genus, considering that the solitary specimen of such a very small coral was not of sufficient value.* Very numerous specimens have now been obtained, and though they do not fully support Woods's diagnosis, the genus, slightly modified, may be conveniently retained. Instead of being immersed, the corallum generally rises for some distance above the polyzoon to which it is attached, and then shows distinct costæ. The septa are very deeply notched at their columella ends, and their central tooth-like projections may be fairly classed as pali. The coral has the habit of a Turbinolian, though a slight amount of endotheca is noticeable in some examples.

Genus Dunocyathus, Ten. Woods (emend.).

Corallum simple, parasitic, rarely immersed, but usually rising to some height above the polyzoon to which it is invariably attached. Septa dentate; costæ prominent; one row of pali. No epitheca.

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* Revision of the Madreporaria, p. 25.

Dunocyathus parasiticus, Tenison Woods, Proc. Linn. Soc. N.S.W., vol. II., p. 305, pl. V., fig. 4.

The description of the species by Woods is in the main correct, but needs the following additions. The specimens are attached to a polyzoon, which is always of the same species, viz., *Bipora cancellata*, Busk. A few individuals are immersed, but the great majority rise above the polyzoon, and show broad prominent costæ on the wall. These do not correspond with the septa, but occupy the alternate spaces between them. The third cycle of septa consists of very short, thin lamellæ.

A large number of examples were dredged by Dr. Verco, 35 miles S.W. of Neptune Island, at 104 fathoms, and off Cape Jaffa, at 90 fathoms. The species was also found, but not so plentifully, at 130 fathoms off Cape Jaffa, and from 110 to 200 fathoms off Beachport. A single example was sent to me by Mr. Hedley, who dredged it at 250 fathoms off Port Jackson. Woods's type, it will be remembered, came from that locality, but at a depth of only 45 fathoms.

GENUS CERATOTROCHUS, Milne-Edwards and Haime.

Ceratotrochus recidivus, *spec nov.* Plate VI., figs. 1*a*, *b*; 2*a*, *b*, *c*.

Numerous examples of this coral were dredged by Dr. Verco, and all exhibit a remarkable peculiarity, viz., that each is invariably attached to the interior surface of a fragment of a similar corallite. A typical and fairly tall corallum is attached to an earlier fragmentary one in a manner which indicates budding from a parent calice. A few short septal laminæ are still visible where the base of the new corallite fuses with the margin of the old wall (pl. vi., fig. 2*a*). Another example in the collection has its wall split longitudinally into four nearly equal portions; these are still loosely held together, and enclose an elliptical calice, which at its margin shows a very thin inner wall separate from the outer one (pl. vi., fig. 2*b*). A third specimen is further advanced, the old wall being now represented by semi-detached fragments only, above which a young corallum rises. The calice, which is also elliptical, is well developed, and has its full complement of septa. Many detached wall fragments, showing the remains of septa on their internal surfaces, are also mingled with the dredged material sent to me.

I think it is evident from the specimens that growth from a parent calice, due to internal budding, has taken place. Usually this appears to be single, but examples occur where two coralla are fixed to the same fragment. Sometimes these are independent of each other, or they may be partly joined at their sides (pl. vi., fig. 2*c*). It must be especially noted that there has been no external budding, since in every case the new coralla are attached to the internal surfaces of wall fragments. The mode of growth in this species is, therefore, quite distinct from that observed in *Parasmilia fecunda*, Pourtalès,* or in *Balanophyllia rediviva*, Moseley.†

The coralla vary greatly in size, some being quite minute; still these are attached to wall fragments just as in the case of the larger individuals. It should be noted also that, though there are several highly elliptical calices amongst the material, the majority are circular or nearly so.

The following description of the corallum and calice in this species applies to two of the largest examples in the collection, the corallum of one and the calice of the other being referred to (pl. vi., figs. 1*a*, *b*).

Corallum long, tapering, slightly curved, and adherent at its base to the internal surface of a small fragment of the wall of the parent corallite. This fragment still bears indistinct remains of the old septa.

The calice is almost circular and deep. There are 36 septa, which are apparently arranged in seven systems, most of which are defective. The number of cycles is four; the first and second orders are approximately equal, the third smaller, and the fourth very short. The calice of the corallum figured contains 42 septa, but in it the same arrangement into seven unequal systems holds. An irregular septal development is, in fact, observed in all the examples, even the youngest. The septa are arched, slightly exsert, and minutely granular on their sides.

Deep down in the central fossa the columella consists of a few, usually five or six, pointed projections. There are faint indications of costæ, corresponding with the septa, on the wall, which is thin, covered with a glistening, brownish epitheca, and rises just above the calicular margin.

The species is a *Ceratotrochus*, of the same type as *C. typus*, var. *Australiensis*, which Duncan described from the tertiary beds of Victoria.

Height from margin of wall to attached base, 17 mm.; diameter of calice, 7 mm. There are only three specimens of this size, the remainder being much smaller.

All were dredged by Dr. Verco at 90 fathoms off C. Jaffa, and at 104 fathoms, 35 miles S.W. of Neptune Island, South Australia.

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* Deep-sea Corals, p. 21, pls. i., iii., vi.

† Report on Corals, pp. 193,4, pl. xv., figs. 10-12.

ASTRÆIDÆ.

Genus Homophyllia, Brüggemann.

Homophyllia incrustans, *spec. nov.* Pl. vi., figs. 3*a*, *b*.

This very small solitary coral is incrusting on the surface of a valve of *Chione roborata*. It presents the appearance of being moored to the shell by its very slender costæ, which, as prolongations of the septa, project beyond the wall. The latter is extremely short, and so much concealed by the projecting costæ that a close scrutiny is required to determine its presence. There is a delicate epitheca, which is not continued on the costæ.

The calice is sub-circular and convex, with a slight depression at the centre. The septa are stout, and vary in size according to order. They are in six systems, with four cycles. The primaries are free, and the remaining orders form six deltoid combinations. The secondaries are joined near the columella by the tertiaries, and the latter again fork near the wall to form the quarternaries. In the centre of each loop, thus formed, a thin septum represents the continuation of the tertiaries. The septa are dentated, and strongly spined. The columella is small and inconspicuous; it appears to be formed of two or three flat and lobed papilli.

A scanty endotheca is visible between some of the septa.

Height, about ·5 mm.; diameters of calice, 4·5 mm. and 4 mm.

A single specimen only of this diminutive coral is known. It was dredged in St. Vincent Gulf, and was handed to me by the late Professor Tate many years ago. I place it provisionally in the genus *Homophyllia*.

FUNGIDÆ.

Genus Bathyactis, Moseley.

Bathyactis symmetrica, Pourtalès, *sp.*

Fungia symmetrica, Pourtalès, Deep-Sea Corals, 1871, p. 46, pl. vii., figs. 5, 6.

Bathyactis symmetrica, Moseley, "Challenger" Reports, vol. ii., 1881, pp. 186, etc., pl. x., figs. 1-13.

Numerous examples of this well-known coral were dredged by Dr. Verco at 104 fathoms 35 miles S.W. of Neptune Island, but all are fractured. A single whole example was, however, obtained off Cape Jaffa, at a depth of 130 fathoms. This is 7 mm. in diameter.

The species has been very fully described by Moseley, who reports that it was dredged by the Challenger Expedition at depths varying from 30 fathoms up to 2,900 fathoms, and in all parts of the world. Amongst other localities mentioned, specimens were obtained between Kerguelen Island and Melbourne, but at a great depth.

EUPSAMMIDÆ.

Genus Leptopenus, Moseley.

Leptopenus discus (?), Moseley.

Leptopenus discus, Moseley, "Challenger" Reports, vol. ii., pp. 205-8, pl. xiv., figs. 1-4; pl. xvi., figs. 1-7.

A number of coral fragments placed in my hands by Dr. Verco and by Messrs. Hedley and Petterd belong certainly to the above remarkable genus, but their identification with the species named must be regarded as provisional. Though there is not a single perfect example present, every segment shows the lace-like pattern of the septa, costæ, and wall, which is characteristic of the genus. The majority of the fragments represent from one-fourth to one-sixth of the whole disc, which has been broken radially from the centre to the circumference, and in the line of either the free primary or secondary septa. The bifurcation of the predominant tertiaries is conspicuous in every fragment, whether large or small. The only noticeable difference between Moseley's examples and the Australian ones is in the length of the costal spines. In the former they are long, but in the latter quite short.

The segments show a coral somewhat smaller than Moseley's species and about 15 mm. in diameter. The extreme diameter of the "Challenger" examples is given as 25 mm., including, of course, the long spines.

Possibly the Australian coral may be new, but this can only be decided by an examination of entire specimens.

In all 24 fragments were dredged, viz., by Dr. Verco, off Cape Jaffa, at 90 fathoms; off Beachport, from 100 to 200 fathoms, and 35 miles S.W. of Neptune Island, at 104 fathoms. Messrs. Hedley and Petterd dredged a few segments of the same coral 20 miles from Port Jackson, at a depth of 250 fathoms. The examples described by Moseley were all found in the Southern Hemisphere, but at much greater depths, viz., from 1,600 to 1,950 fathoms. The nearest locality is in the Southern Indian Ocean, lat. 46° 16′ S., long. 48° 27′ E.

Genus Notophyllia, Dennant.

This genus, founded in 1899 to receive three species of tertiary fossils, is, I now find, represented also by a recent coral in which the generic characters are well marked. The close connection, to which attention has before been called, between the Australian corals of the present day and those found fossil in adjacent tertiary beds is thereby again strongly illustrated.

Notophyllia recta, *spec. nov.* Pl. v., figs. 1*a*, *b*.

Corallum small, short, and compressed. The base is wedge-shaped, and much like that of *N. gracilis*, mihi. There is no epitheca, and the wall is highly vesicular and porous. A series of fine granular lines, longitudinally arranged, and placed between the septa, enclose the vesicular portions of the wall. The wedge-shaped base is also markedly granular and porous.

The calice is moderately deep and very elliptical, the ratio of the long and short axes being as 2 to 1. The columella is straight, lamellar, and granular: together with the septa at the ends of the longitudinal axis it divides the calice into two halves. On each side of the end septa there are three smaller ones, or 12 for the whole calice, but they are not quite equal, those adjoining the full-sized end septa being the smallest. In all there are 26 septa, viz., 13 in each half of the calice, and, except the small ones just mentioned, they are long and sub-equal. All are thin, straight, and granulated like the columella. Their central margins are free for some distance, but lower down they are continued by short processes which reach the columella. Occasional pores are visible on their sides, quite close to the wall.

Height, 2mm. to 3 mm.; length of calice, 5 mm.; breadth of do., 2·5 mm.

The three examples from which the description of this species is written were dredged by Messrs. Hedley and Petterd at 250 fathoms 20 miles N.E. of Port Jackson. Two much-worn corals, one of which is double the size of those quoted, may possibly represent the same species; these were obtained by Dr. Verco off Cape Jaffa at a depth of 130 fathoms.

The present coral differs in many important points from *N. gracilis*, its nearest fossil congener. The latter is larger and has a distinctly different columella, while its septa vary more in size, and are arranged in six well-marked systems.

Genus Dendrophyllia, Milne-Edwards and Haime.

Dendrophyllia atrata, *spec. nov.* Pl. vi., figs. 5*a*, *b*.

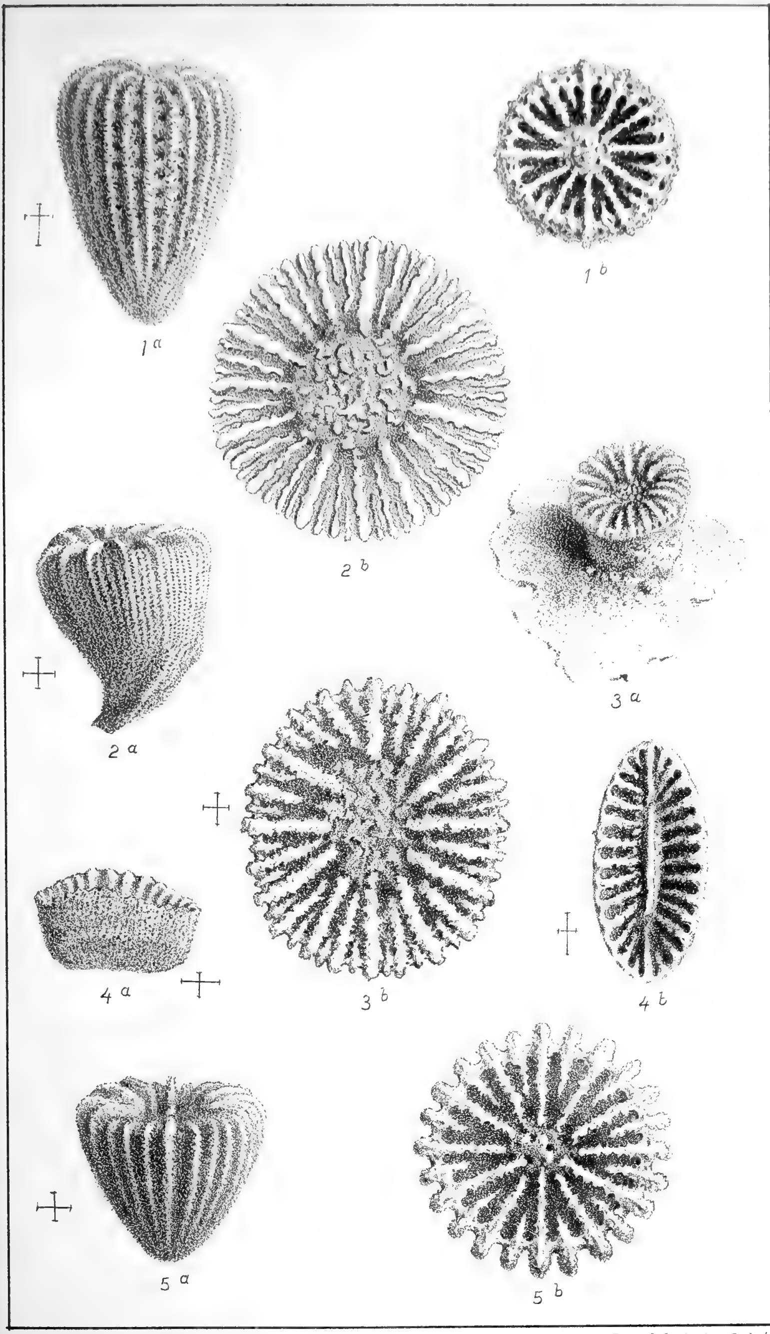
Numerous specimens of this coral have been dredged, and from various stations in St. Vincent's Gulf, etc., but all at shallow depths. There are a few bush-shaped colonies like the one figured, but several examples are solitary and adherent to shells or polyzoal fragments. That the species increases by budding is, however, demonstrated by the composite clumps, the gemmation being both lateral and subbasal. As a rule, the solitary individuals are small, and they probably represent buds which have become detached from the parent corallum or clump. In the latter the separate corallites rise at various angles from the base or parent corallum, and are short and cylindrical. A much-worn corallum bears several lateral buds which arise at right angles to its side, and in the case of one of them quite close to the calicular margin. Another specimen consists of two low corallites placed at an angle of 45°, and arising from a common basal expansion. A third interesting example is formed of a large individual adherent to a shell fragment with a smaller one growing from it close to its base, and at a similar angle to the last. A distinctly porous cœnenchyma is visible at the base of many of the specimens.

Broad, equal costæ stand out prominently on the wall of the corallites, especially close to the calices, but the basal expansion and also the lower part of the corallites become covered with a fine but granular epitheca. The costæ themselves are markedly granular; in the narrow spaces between them the wall is very thin and porous.

Exteriorly the corallites are light-coloured, but the interior of the calices is almost invariably dark-brown or almost black. On the type mass all the calices are dark-coloured, and, being very deep, are somewhat difficult to read, but a drawing is given of the calice of a perfect but solitary specimen which happens to be light in colour.

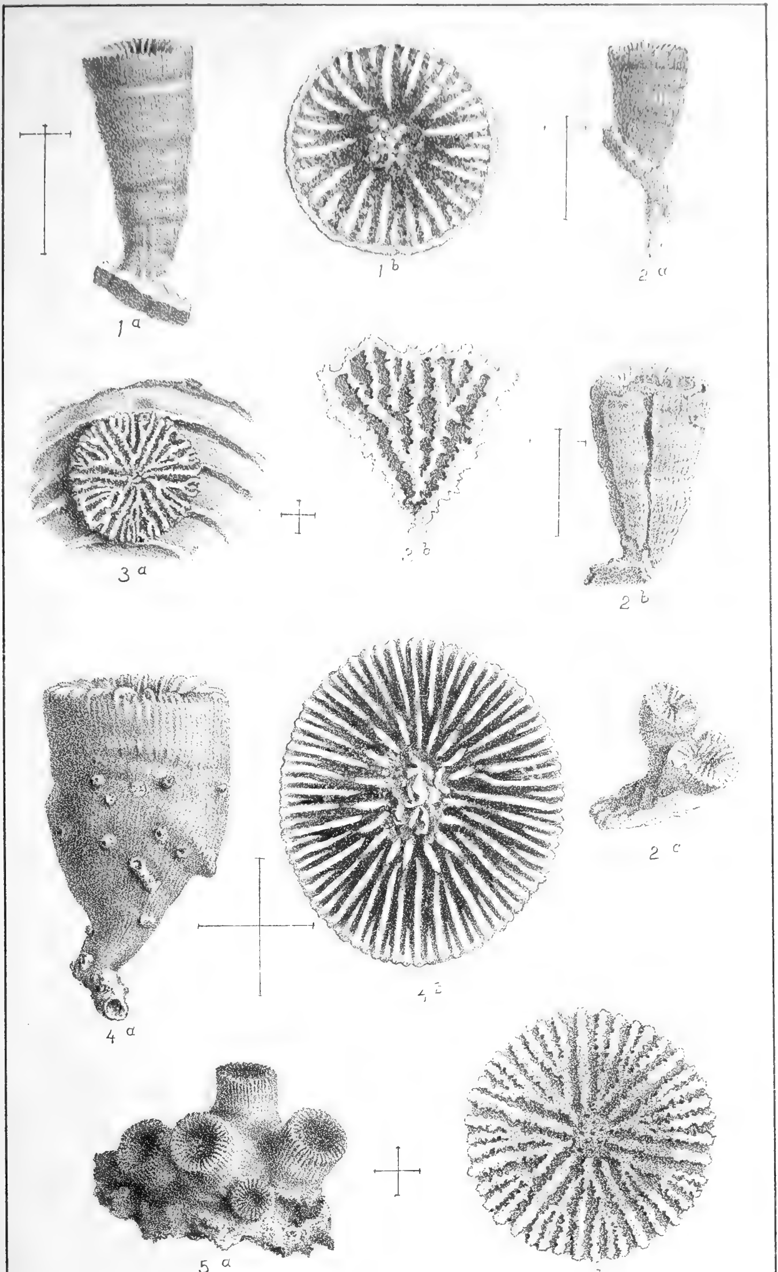
The septa are in six systems with four cycles. The primaries are free, the secondaries are joined by the tertiaries not far from the columella, and the quaternaries again unite with the tertiaries nearer the wall; there are thus six well-marked deltoid combinations in the calice. Adult specimens usually have the systems complete, but in younger calices the quaternaries are not fully developed. Thus the figured calice, which is perhaps not quite adult, has three systems complete and three incomplete; in the latter the quarternaries are wanting in one half of each system. The primaries are stout and the remaining septa diminish slightly in size according to order. All the septa are strongly spined, and so deeply dentated as to be superficially divided into a series of longitudinal segments. At the bottom of the fossa a considerable space is occupied by the columella, which consists of many papilli resembling in shape the inner ends of the dentate septa.

The bush-shaped colony figured, which is the finest specimen in the collection, has a height of 17 mm. from base to summit; it is 24 mm. long and 15 mm. broad. Its separate corallites have a diameter of 7 mm. and are about 5 mm. high. The calice chosen for illustration has a diameter of 5·5 mm.; its corallum is 3 mm. high.



R. Wendel, del et lith. ad nat.

Troedel & C° Print



R. Wendel, del et lith. ad nat.

Troedel & C° Print

The specimens were dredged in St. Vincent's Gulf, Investigator Straits, and Backstairs Passage, at depths ranging from 14 to 22 fathoms.

EXPLANATION OF PLATES.

Plate V.

1. *Trematotrochus Hedleyi*—*a*, corallum, magnified 6 diam.; *b*, calice of another example, magnified 8 diam.
2. *Trochocyathus Petterdi*—*a*, corallum, magnified 6 diam.; *b*, calice of same, magnified 10 diam.
3. *Paracyathus vittatus*—*a*, corallum with portion of shell to which it is attached, magnified 4 diam.; *b*, calice of same, magnified 10 diam.
4. *Notophyllia recta*—*a*, corallum, magnified 4 diam.; *b*, calice of another example, magnified 6 diam.
5. *Kionotrochus Suteri*—*a*, corallum, magnified 6 diam.; *b*, calice of same, magnified 8 diam.

Plate VI.

1. *Ceratotrochus recidivus*—*a*, corallum of a large example attached by its base to a wall fragment, magnified 2 diam.; *b*, calice of another example of equal size, magnified 4 diam.
2. *Ceratotrochus recidivus*—Three examples showing development of coralla, all magnified 2 diam.; *a*, with base immersed in the remains of an earlier corallum; *b*, with corallum split into 4 portions and calice elongated; *c*, two young coralla, joined by their sides, and attached at the base to the same wall fragment.
3. *Homophyllia incrustans*—*a*, calice and portion of shell which it incrusts, magnified 4 diam.; *b*, portion of calice showing one system of septa, magnified 12 diam.
4. *Caryophyllia planilamellata*—*a*, corallum, magnified 1¼ diam.; *b*, calice of same, magnified 2½ diam.
5. *Dendrophyllia atrata*—*a*, corallum, magnified 1½ diam.; *b*, calice of separate individual, magnified 6 diam.

On the Ionisation of Various Gases by the α Particles of Radium.—No. 2.

By W. H. Bragg, M.A., Elder Professor of Mathematics and Physics in the University of Adelaide.

[Read October 2, 1906.]

Plate VII.

Introduction.

In a paper with a similar title (Proc. Roy. Soc. of South Australia, vol. xxx., p. 1) I have given a preliminary account of an attempt to determine the relative amounts of ionisation produced in various gases and vapours by the α particle of RaC. The present paper contains an account of the further progress of this work.

In the first place I have here discussed the validity and the experimental details of the method used, and have brought forward evidence in favour of the hypothesis that $\delta\iota$, the ionisation produced in consequence of the expenditure of a small quantity of energy $\delta\epsilon$ by the α particle, is related to the latter quantity by the equation $\delta\iota = k\, f(v)\, \delta\epsilon$, where $f(v)$ is a function of the velocity of the particle only, and k a constant for each gas.

Secondly, I have given the result of the attempts to determine for several gases the constant k, which may be called the specific ionisation of a gas for α radiation, air being taken as the standard.

In conclusion I have discussed very briefly the form of the function $f(v)$, and such conclusions as it seems legitimate to draw from the results so far obtained. Amongst these is the following:—The ionisation per molecule (ks, where s is the stopping power) is closely connected to the molecular volume.

§ 1.

The method of this research has already been described briefly in the preliminary paper *(loc. cit.)*. For the sake of clearness, however, and in order to facilitate a discussion of the validity and the experimental details of the method, it will be well to insert a short description here also.

A small platinum plate is coated with a very thin layer of radium bromide, and placed below a horizontal ionisation chamber of 3 mm. width, at a distance which can be altered at will. (See pl. vii.). A set of narrow vertical tubes is placed over the radium, and stops all α particles which move in any direction which is not almost vertical. Thus the particles cross the narrow chamber at right angles to its greater dimensions, and all spend 3 mm. of their paths in the air within it. The resulting ionisation being plotted against the distance from the radium to the middle of the chamber, we obtain an "ionisation curve," as in Fig. 1, where ordinates represent distances and abscissæ represent ionisation currents. Each reading of current is the difference between two others, one measured when a very thin copper screen is placed over the radium, and one when it is not.

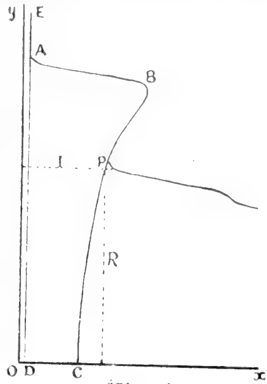


Fig. 1.

In this curve the portion AE is due to the β rays only, and represents the effect of such β radiation as is intercepted by the screen: the chamber is out of range of α rays. Let EA be produced to meet the axis of x in D. The portion ABP represents part of the effect of the α particles from RaC. If no other radio-active substances were present, the curve would show a continuation of the portion BP down to the axis of x, in some such manner as PC.

If the ionisation curve were completed in this way, the area $ABPCD$ would represent the total ionisation due to the α radiation from RaC. If now the air were removed, another gas substituted for it, and the area re-measured, a comparison of the values obtained would give the result which this research aims at. We may call it the specific ionisation of the gas. But the complete determination of the boundaries of the area is so long and complicated a process as to render this procedure impracticable. It can, however, be shown that the product of the co-ordinates of a certain point on the curve may be taken as a measure of the area of the curve, provided certain assumptions are made. The point is at the intersection of the top portion of the curve representing the effects of RaA with the side of that showing the effects of RaC. The co-ordinates of this point are comparatively easy to obtain.

Now, it might appear that it would be better to measure at one time the whole of the ionisation produced by the particle, rather than to determine the ionisation point by point along its path; since, if this were done, it would no longer be necessary either to find the exact form of the ionisation curve, or to depend upon the validity of assumptions.

We might spread a layer of radio-active material on the floor of an ionisation chamber, and so arrange the temperature and pressure of the gas in relation to the dimensions of the chamber that all the α particles completed their paths within the gas. But the potential gradient required to separate and collect the ions made by the α particle is generally very great. For example, in ethyl chloride at 30 cm. pressure and ordinary temperatures, about 1,000 volts per cm. is desirable, if saturation is to be certain. With such gas it would be necessary to make the height of the chamber about 4 cm., in order to allow all the α particles to complete their ranges; even if the radio-active material were uranium or polonium. Thus, a total potential of 4,000 volts would be required, and such large electro-motive forces are out of the question. If the pressure of the gas were lowered, less electric force would be sufficient; but the paths of the α particles would be longer, the chamber would need to be higher, and the total potential as great as ever.

It is absolutely necessary to use a narrow ionisation chamber if sufficient electric force is to be obtained without the use of enormous battery power. Clearly it would be no gain to use such a chamber if the radio-active material were spread on one of its walls. For in this case some of the particles would complete their full ranges within it, others only part, and an estimate of the ionisation to be expected would render it necessary to take into account the amount of the range completed by each particle as determined by the nature and physical conditions of the gas and the dimensions of the chamber, the reckoning being further complicated by the fact that the ionisation produced by the particle is not constant along its path. It is possible that an experiment might be arranged in which a thin sheet of α radiation entered the chamber through a slit at the side, and spent itself within the chamber without touching the walls. It would be necessary to make sure that the same portion of the range was completed within the chamber by the particle, no matter with what gas the chamber was filled. I have not yet tried this plan.

It will now be clear, I think, that the method actually used is not without its advantages. It avoids the use of very high potentials, and does not require lengthy and uncertain calculations. It has also this in its favour, that it gives the range of the particle in the gas, so that it is possible to make a sufficiently accurate estimate of the amount of any air that may be present. The presence of this air can then be allowed for.

Let us, therefore, proceed to consider the assumptions and approximations which the method requires.

In the first place it is necessary to consider whether any disadvantages are likely to arise from the use of a sheet of gauze as the lower wall of the ionisation chamber. The electric field must be distorted in the neighbourhood of the gauze; some very small portions of the chamber which are just over the openings in the gauze must be under feeble forces, and the ions made there be separated only when the potential is high. It is easy, however, to show that this effect is negligible by a consideration of the ionisations due to β rays. This ionisation does not show initial recombination, as in the case of the α rays; a fact first demonstrated by R. Kleeman, formerly of this University. In Fig. 2 are drawn the upper parts of the ionisation curves of ethyl chloride under different potentials. It will be seen that in the portion which repre-

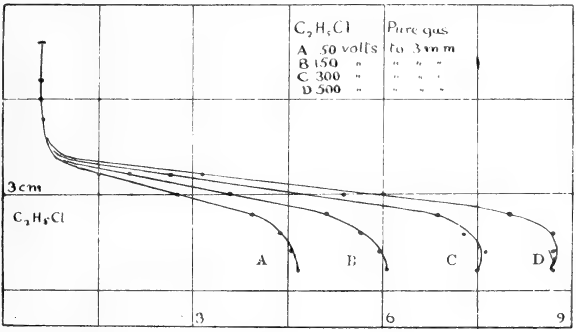


Fig. 2.

sents the effects of β rays only. saturation is complete when 50 volts are applied to the 3 mm. chamber: but the ionisation due to α rays is far from being collected completely by ten times that potential. Now, if the field distortion due to the gauze were appreciably effective we should find the β rays also producing an ionisation which appeared to increase at higher potentials; and there is no trace of any such effect. The same result shows that, although ions are very apt to be drawn through a gauze by a strong field on one side, yet in this case nothing of the sort takes place. To prevent it, a second gauze has been placed 3 mm. below the first, and earthed, so that there are strong, equally-balanced fields on both sides of the latter.

A thin, uniform metal sheet might replace the gauze, but unless it were very thin it would cut off more of the range than can generally be spared; and if it were thin it would be liable to flexure by the powerful electric forces, so that the depth of the ionisation chamber might become indeterminate.

We must now consider the assumption that the area of the ionisation curve may be represented by the product of the co-ordinates RI as already defined. This is really equivalent to the supposition that the ionisation resulting from the expenditure of a quantity of energy $\delta\epsilon$ by the α particle is equal to $k f(v)\,\delta\epsilon$, where $f(v)$ is a function of the velocity of the particle and k is a constant, depending on the nature of the gas molecule. It implies in the first place that the area of the ionisation curve in any gas is not dependent on pressure and temperature, and that, if the form of the curve is altered by a variation of these conditions, it is only in so far that all the ordinates are multiplied by some factor, and all the abscissæ divided by the same factor. It implies, in the second place, that the ionisation curve of one gas can be made to coincide with the curve of any other gas, by multiplying all the ordinates by some factor, and all the abscissæ by some other factor. Let us examine the evidence in favour of these statements.

If the hypothesis is true RI must be independent of pressure and temperature. As regards pressure, some results were quoted in a paper "On the Recombination of Ions in Air and Other Gases,"* which showed this to be correct in the cases of air and ethyl chloride; and further evidence will be found in the results given at the end of this paper. For, without having made any exhaustive comparison of the values of RI at different pressures in each gas, I have often used various pressures in the determination of the specific ionisation of a gas; and the general agreement between the results obtained is good evidence that pressure is without effect.

In the same way, since many determinations in the case of the same gas have been made at different temperatures, the close agreement shows also that temperature has no influence on the ionisation. More direct confirmation can be obtained from the following results. During a number of the determinations of RI, the ionisation chamber was connected in parallel with a second chamber containing a uranium layer. The ionisation currents acted against each other. Thus the values of the currents in the radium apparatus could be determined by balancing against the uranium; the latter was always at the temperature of the room and therefore formed a fixed standard. The extent of the surface of the uranium could be varied by means of a semaphore, having a graduated

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* Trans. Roy. Soc. S.A., 1905, p. 187.

circle on the same axis. It was then found that although the RI in air appeared to decrease as the temperature of the radium apparatus was raised, yet when the readings were expressed in terms of the uranium scale, the value of RI was constant. The decline was merely apparent, and due to leakage through the heated glass insulators. The actual values of RI were:—

Five determinations, 20° to 60° C.: 320, 326, 318, 314, 314; mean, 319.

Five determinations, 60° to 80° C.: 296, 314, 311, 334, 327; mean, 316.

The experiments were made at various times, and some of the irregularities are probably due to slight alterations in the amount of RaC present.

Furthermore, it has already been shown with respect to ionisation in general that pressure and temperature have no effect (Patterson, Proc. Roy. Soc., 69, p. 277, 1901, and "Phil. Mag.," Aug., 1903). I have thought it well, however, to reconsider the point with special reference to the circumstances of this experiment.

It is convenient at this stage to state that temperature does not seem to have much effect on initial recombination. The latter decreases rapidly as pressure is lowered. This has been shown by Kleeman and myself ("On the Recombination of Ions, etc."). But when the alteration in density occasioned by a rise of temperature has been allowed for, there appears to remain only a slight diminution in initial recombination, which can be ascribed to the direct result of the increase in temperature. This is shown with some clearness in some experiments which I have made with CO_2. They may be tabulated as follows, the ionisation at an electric force of 1,000 volts per cm. being taken as 100:—

CO_2	Ionisation at 1,000 volts per cm.	Ionisation at 333 volts per cm.	Ionisation at 166 volts per cm.
(a) Pressure, 651 mm., 20° C.	100·0	95·0	90·2
(b) Pressure, 760 mm., 72° C.	100·0	96·8	94·0

A repetition of the experiment gave practically the same result. The pressures and temperatures were so arranged that the density was the same in each experiment.

I also tried the experiment with ethyl chloride, but the results were not so definite; that is to say, change of temperature produced no very obvious effect.

It is further assumed that the curves for different gases are of the same form; in other words, that the function $f(v)$ is the same for all gases.

A complete test of this hypothesis would require an accurate delineation of the ionisation curve in the case of each gas. As has already been said, this would be a difficult task, inclusive, indeed, of our present purpose. But a comparison of the curves in different gases, so far as they have been obtained, shows that the principle is at least approximately true. For example, the ratio of the range of RaC to that of RaA is the same in all gases within errors of experiment, and again the ratio of the maximum abscissa of the RaC curve to the abscissa I is also constant, so far as I have measured it. As examples of the constancy of the first of these two ratios, I have at different times found it to be 1·46 in air, 1·47 in pentane, 1·47 in ethyl chloride, 1·44 in carbon dioxide, 1·48 in ethyl alcohol, and 1·49 in ethylene. The differences here are probably experimental only. As regards the second ratio, I have found it to be 1·36 in air, 1·37 in ether, 1·44 in ethylene, 1·35 and again 1·41 in ethyl chloride. This ratio is much more liable to error than the former; for all ionisations are harder to measure correctly than ranges, and the peak of the ionisation curve is an especially uncertain point. Also there is a special difficulty due to the existence of a peculiar phenomenon, which must now be considered.

It is to be observed that the ionisation curves in different gases will not correspond unless the potential employed is enough to saturate at all points of the path of the α particle. More electric force is required as the particle slows down. This may be deduced from figures given in the paper "On the Recombination of Ions, etc.," p. 196. It is there stated that the ratio of the saturated ionisation current to that at 25 volts per cm. in the case of the ions made by the α particle of RaC at a distance of 6·25 cm. from its origin was found to be 1·29; whereas, when the distance was reduced to 5·05 cm., it was found to be 1·19. Each of these ratios is the mean of four determinations. (By an arithmetical error, one of the latter is incorrectly given in the paper quoted: 1·23 should be 1·20.)

Again, the effect is clearly shown by the curves of Fig. 3, which represent the results of experiments on a mixture of ethyl chloride and air. It will be seen that the curve does not show the characteristic increase of ionisation with distance when the electric force is small, the reason being that it is so much more difficult to collect the ions made by the α particle at the end of its path.

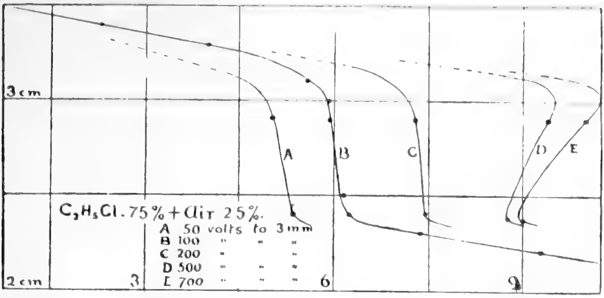


Fig. 3.

It is necessary to refer to one more assumption which is made in calculating the results, viz., that the *RI* of a mixture can be determined from a knowledge of the *RI* of each component. For example, it is supposed that, the *RI* of air being 100 and of ethyl chloride 132, then the *RI* of a mixture in such proportions that the α particle spends half its energy in each is 116.

For I have not been able to prevent the leakage of air into the apparatus when raised above ordinary temperatures, and it is necessary to measure and allow for the air present in each experiment. The apparatus holds very well when not heated; but it is sometimes necessary to raise the temperature to 60° or 70° C. in order to obtain a sufficient density of the vapour under treatment. Fortunately, however, the air present may be a considerable fraction of the gas when measured by pressure, and yet be of little importance when measured in terms of the energy spent in it. Thus the correction for air present is usually quite small, as will be seen from a consideration of the numerical results in § 2.

The assumption is by no means an obvious one. If any part of the ionisation in a gas is secondary, and is due to radiation originating in one molecule and acting on a neighbouring molecule, it might well be that complications would arise in a mixture of gases. I have made several direct attempts to find whether any such effects existed: the results of some of them are shown in the following tables. Each table refers to a set of experiments carried out consecutively. The percentage of gas in each mixture is determined from the stopping power, and the percentage of energy spent in the gas is then calculated. The value of *RI* for the gas is calculated by multiplying the observed value for air by the specific ionisation of the gas, as taken from the final tables given at the end of the paper. For example, in the first set, *RI* for air is 198·5, and *RI* for ethyl chloride is taken to be $189{\cdot}5 \times 1{\cdot}32$

=262. The RI for each mixture is then calculated. In the table the calculated and observed values are put side by side, and it will be seen that there is a good agreement:—

	Percentage of Gas.	Percentage of Air.	Percentage of Energy spent in Gas.	Pressure in mm.	Temperature.	RI observed	RI calculated.
C_2H_5Cl :							
1.	0	100	0	760	37	198·5	—
2.	88·5	11·5	94·5	421	37·5	253	259
3.	39·7	60·3	61	437	38	235	237·5
4.	17·3	82·7	33	433	38	220	220
5.	8·5	91·5	18	441	38·2	212	210·5
6.	0	100	0	760	39	198·5	—
C_2H_5Cl :							
1.	0	100	0	760	32	200·5	—
2.	91·5	8·5	96	294	34·5	258	260
3.	35·3	64·7	56·5	310	36·5	232	235
4.	0	100	0	760	37	198·5	—
C_5H_{12} :							
1.	0	100	0	760	41	202	—
2.	83·5	16·5	95	321	43	262	264
3.	19·2	80·8	45·5	351	45	232	229·5
4.	0	100	0	760	45·6	195	—

Nevertheless, in a number of cases in which I have attempted to calculate the value of RI of one gas from a knowledge of the values of RI for air, and for a mixture in known proportions, I have obtained an unexpectedly high result, and when I began some direct experiments on the question I was quite prepared to find that the ionisation of a mixture of air and gas was more than the sum of the ionisation of air and gas separately. Further experiment will, no doubt, make everything quite clear. In the meantime it is sufficiently evident that the principle is at least nearly true. For the purpose of this investigation it may be taken as quite true, since the correction to be made for the presence of air is, at the most, only small.

The quantity I, as measured, includes a small proportion of β ray ionisation. It must be shown that this does not harm the result.

In the form of apparatus which I use the ionisation in the portion AE of the curve (see Fig. 1) is nearly 6 per cent. of the ionisation at P, and I have not found enough variation from gas to gas to justify an attempt at correcting for it. Of course, the quantity is only small.

The curve shows only this β ionisation above A; that below is hidden. But I have found by experiment that it varies very little throughout the whole distance from the axis of x. This I did by placing over the radium just enough tinfoil to cut off all the α rays.

In the foregoing will be found, I think, sufficient justification for the choice of the method of this paper, and for the assumptions made during the calculation of the results.

In the previous paper I have already given a brief description of the process of an experiment. Some points, however, deserve reconsideration in the light of further experience, and some changes have been found convenient. These are best discussed in relation to an actual experiment; I will take a determination of RI in carbon bisulphide.

I have found it best to separate experiments whose object is to determine RI from those whose object is to find the stopping power of the gas. In the former the chief difficulty lies in overcoming initial recombination. This requires the pressure of the gas to be low, and the applied potential to be high. A little leakage of air into the apparatus, which can hardly be avoided under these circumstances, is no serious disadvantage, since the proportion of air can be found from a knowledge of R, and of the pressure and temperature at the time when R is measured; and these data are easily obtained. In the latter, any moderate voltage will do, since the range does not depend on potential; but it is desirable to have as much gas as possible, and no leakage of air during the experiment, so that when the bulb containing a sample of the gas is taken away and weighed in order to find the proportion of the mixture, it may truly represent the condition of things during the earlier part of the experiment. It is best to work at a high temperature, if such is required to fill the chamber with gas which is nearly at atmospheric pressure.

Carbon bisulphide vapour is well superheated at a temperature of 30° and a pressure of 25 cm. The apparatus is, therefore, heated to that temperature; and RI for air is first measured.

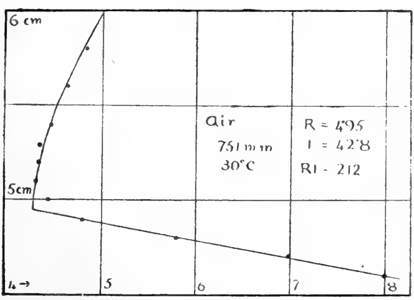


Fig. 4.

Fig. 4 shows the readings obtained, and the curve which is drawn to find R and I. These are determined to be 4·95 and 42·8 respectively, so that $RI = 212$, the temperature being 30° C., and the pressure being 75·1 cm. The apparatus is then exhausted and filled with CS vapour to a pressure of about 24 cm. It is known from a separate experiment that 1,000 volts per cm. is a saturating potential gradient, and a battery of 300 volts is therefore put on to the 3 mm. chamber.

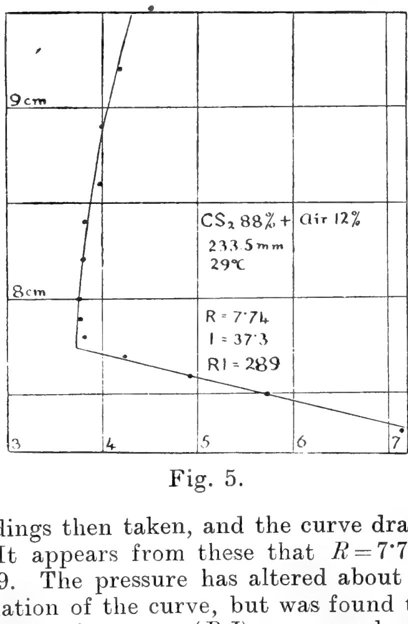


Fig. 5.

The readings then taken, and the curve drawn are shown in Fig. 5. It appears from these that $R = 7·74$, $I = 37·3$, so that $RI = 289$. The pressure has altered about 1 cm. during the determination of the curve, but was found to be 23·35 at the moment when the corner (R, I) was passed. The temperature at the same time was 29°. Now, the stopping power of CS_2 is 2·20, and the stopping power of the mixture is (comparing with the previous experiment)—

$$\frac{.495}{774} \cdot \frac{751}{233·5} = 2·06$$

Hence—

If x be the percentage of gas, we must have

$$x \times 2·2 + 1 - x = 2·06 \therefore x = 88·5.$$

The vapour is then cleared out of the apparatus, and dry air admitted. The value of RI for air is again determined, as shown in Fig. 6, and found to be 214.

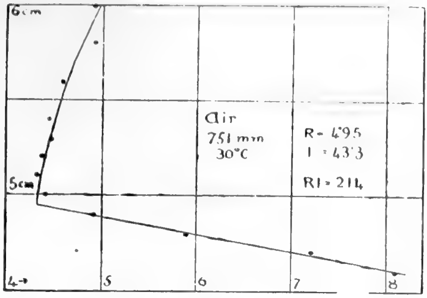


Fig. 6.

In the second experiment the proportion of gas to air, by pressure, is as 88·5 to 11·5; but, according to the energy spent by the a particle, as 88·5 to 11·5/2·2, *i.e.*, as 94·5 to 5·5. Hence the true value of RI is found from the equation

$$\cdot 945\ RI + \cdot 055 \times 213 = 289$$

$$\text{whence } RI = 294$$

Hence specific ionisation of $CS_2 = 294/213 = 1{\cdot}38$.

The results of this particular experiment are recorded in the second line of the results for carbon bisulphide in § 2.

It seems probable that the determination of the ionisation in various cases due to the a rays may be of considerable importance, and I therefore attach a drawing of the apparatus which I have used (pl. vii.) in the hope that it may save the time of any other workers in this direction.

In the figure, P is one of three glass pillars which support the high potential plate. I have also used a glass plate, as shown by the dotted surface, to insulate the upper plate of the ionisation chamber. Sulphur and ebonite do not stand the heat. The upper gauze, gg, is the lower wall of the chamber, $g'g'$ is the lower gauze and is earthed; it is supported by three brass pillars, only one of which is shown. The vertical tubes are shown at TT, and the radium plate at RR. The semaphore, ss, is made of thin sheet copper, and can be turned round so as to uncover the radium. It may be worth while mentioning that I have found it better to keep the plate, QQ, "out of sight" of any insulating material connected with the high potential plate; if this is not done, then the creep of electricity over the insulators which is apt to occur when the potential is changed exerts a troublesome electrostatic effect. $DEFG$ is the outline of the electric oven. The tube A goes to the manometer, B to a bulb used in the determinations of stopping power, and C to a bulb which contains the liquid whose vapour is being treated.

§ 2.

The following tables contain the results of the determination of the constant of specific ionisation due to α rays. These have all been made recently, except when the contrary is stated. I have rejected a large number of earlier measurements. In the case of each experiment with a gas, the value of *RI* for air was found immediately before and immediately afterwards. It varies somewhat from day to day, and generally increases during any long series of experiments, since the warmth and dryness are conducive to the better retention of the emanation. The radium plate is not quite in so good a condition as it used to be, being covered with a very thin film of dirt and grease (mainly from the taps). This could, no doubt, be removed by a red heat, but I am unwilling to handle the radium film so roughly just now. The presence of the film slightly lowers the ranges, about ·5 to 1 mm. in air; and rather blurs the corners of the ionisation curves:—

Volts per cm.	Pressure in cm.	Temperature.	Percentage of Gas by Pressure.	Per centage of Gas by Energy.	*RI.*	*RI* (corrd.).	*RI* (air).	Ratio.
	Pentane.							
1670	25	44·5	83·5	95	262	265	198	1·34
,,	32·7	43	79·5	93·5	261	265	198	1·34
,,	23·75	35	91·5	97·5	261	263	197	1·33
,,	29·4	37·8	88·5	96·5	265	267	197	1·35
,,	38·5	40	81	94	271	275	200	1·37
,,	39·6	37·5	91	97	277	279	208	1·34
1000	32·6	39	88·5	96·5	281	284	208·5	1·36
,,	25·6	40	88·5	96·5	282	285	209	1·36
								Mean, 1·35
	Carbon Bisulphide.							
1670	25·8	40	91	96	282	285	209·5	1·36
1000	23·35	29	88·5	94·5	289	294	213	1·38
,,	30·1	40	91	96	284	287	209·5	1·37
								Mean, 1·37
	Ether ($C_4H_{10}O$).							
1000	24·2	29·7	82·5	94·5	274	277	214	1·295
1670	24·7	30	86·5	95·5	277	280	214	1·31
,,	26·2	49·5	87	96	270	273	207	1·32
								Mean, 1·31

Volts per cm.	Pressure in cm.	Temperature.	Percentage of Gas by Pressure.	Percentage of Gas by Energy.	*RI.*	*RI* (corrd.)	*RI* (air).	Ratio.
	Chloroform.							
1670	26·1	50·5	86	95	262	265	207	1·28
,,	23·5	50	86	95	262	265	207	1·28
,,	27·4	54	83	94	260	264	202	1·31
								Mean, 1·29
	Ethyl Chloride.							
1670	23·3	14	89	95	244	247	191	1·29
3000	38	16	93	97	270	272	204	1·33
,,	58	26	91·5	96·5	266	268	203	1·32
1670	26·2	72	81	91	202	211	166	1·27
,,	31·8	60	85	93	238	242	186	1·30
,,	32·8	60	85	93	239	243	186	1·30
,,	29·4	34·5	91·5	96	258	261	199·5	1·31
,,	42·1	37·5	88·5	94·5	253	256	198·5	1·29
								Mean, 1·30
	Carbon Tetrachloride.							
1670	25·0	60·7	89	97	257	259	197	1·315
,,	22·8	61	72	91	259	265	199	1·33
,,	27·9	61	83	95	253	256	199	1·285
,,	25·7	54	81	94·5	264	267	204	1·31
,,	26·4	53·5	90	97·5	264	266	202	1·32
								Mean, 1·31
	Ethyl Iodide.							
1000	29·2	65	75·5	91	223	228	177	1·29
1700	25·2	68·5	90·5	97	261	263	207	1·27
								Mean, 1·28
	Ethyl Alcohol.							
1000	34·8	72	85	98	213	216	174	1·24
,,	33·0	67	73	85	217	224	184	1·22
								Mean, 1·23
	Methyl Alcohol.							
1000	35·9	65	92	94	217	219	179	1·22
	Methyl Iodide.							
1000	35·35	47	88	95	210	213	160	1·33
	Benzene.							
1670	27·4	62	71	89·5	226	232	181	1·28
,,	27·2	61·5	77·5	92·2	235	240	185	1·30
1000	25·6	67	89	96·5	251	253	194	1·30
1670	29·3	67	88	96	248	250	198	1·26
,,	27·0	67	83	94	252	256	198	1·29
								Mean, 1·29

Volts per cm.	Pressure in cm.	Temperature.	*RI.*	*RI* (air).	Ratio.
	Acetylene.				
1000	Atmo.	54	274	223	1·23
,,	,,	37·5	298	232	1·28
,,	,,	30·5	294	229	1·28
,,	,,	70	252	201	1·25
					Mean, 1·26
	Ethylene.				
1000	Atmo.	34·5	290	227	1·28
	Carbon Dioxide.				
1000	Atmo.	20	235	215	1·09
,,	,,	72	192	176	1·09
,,	,,	31	237	225	1·05
					Mean, 1·08
	Nitrous Oxide.				
1000	Atmo.	29	240	229	1·05
	Oxygen.				
1000	Atmo.	20	247	226	1·09

Of the measurements recorded in the above tables, those for acetylene, ethylene, carbon dioxide, and nitrous oxide were made some time ago. But they are probably quite correct enough to rank with the rest, which have for the most part been made recently, since they are not affected by temperature and initial recombination difficulties. The measurements most likely to contain error are those of the alcohols and methyl iodide, the latter because I have been unable from lack of material to repeat the one somewhat ancient determination, the former because for some reason the alcohols are very difficult to manage in my apparatus. They are apt to cause—particularly methyl alcohol—very large normal leaks, though other vapours, such as benzene, have no such effect. I believe the cause to be connected with the presence of minute particles of fluff, which bridge across the walls of the ionisation chamber, being stretched along the lines of force. Although the apparatus is guarded with plugs of glass wool, yet things of this sort seem to find their way into the chamber at times, and it is possible that the methyl alcohol sets them free from the sides or base of the apparatus to which they are fastened by traces of grease. I have only once had the apparatus in perfect working order with methyl alcohol; at that time I had gone over the working parts with a magnifying glass to find and remove every foreign particle, and had washed the whole apparatus out with methyl alcohol itself. These good conditions lasted only a short time, and unfortunately a second cleansing process was not equally effective.

I must point out that the results for benzene and acetylene are now close together. In the preliminary paper I believed them to differ considerably, and used them as an illustration of the want of direct connection between the energy spent and the ionisation produced. It will be seen later that this effect is now clearly shown, but I was unfortunate in using a comparison of benzene with acetylene as an illustration.

§ 3.

Though our knowledge of the process of ionisation by the α particle is as yet only small and imperfect, it does not seem out of place to draw together what facts we do know, and to endeavour to connect them by some thread of argument, which may be useful for a time.

In the first place there is the fact that the ionisation produced by the α particle increases as its velocity diminishes. Now, Rutherford has recently shown (Phil. Mag., Aug., 1906) that the particle spends energy at a uniform rate along its path. It follows, therefore, that the ionisation produced is not proportional to the energy spent. In my preliminary paper I have already given a reason for supposing that the energy spent and the ionisation produced are not directly connected, viz., that the former is related to the atomic weight by a simple law and the latter is not.

As a temporary hypothesis let us suppose that there is an intervening link; that the α particle produces a primary effect A, which in turn produces a secondary effect B. The latter consists of ionisation, the former may or may not do so. It is in the production of the primary effect that the energy of the particle is spent.

Since the energy spent is related to the atomic weight by a simple law, since it is independent of velocity, and since there is a critical speed at which all ionisation ceases, which speed is the same for all atoms, it appears clear that A is a sub-atomic effect. It consists in the performance of some act which always involves the expenditure of the same amount of energy; and the stopping power of an atom is proportional to the number of times that the act is performed within it. The effect might consist, for example, in some operation upon a common constituent of all atoms, such as an α particle. The critical speed might be that at which the moving α particle failed to penetrate, or, more generally, act upon the α particle of the atom.

In the next place consider the effect B. The proportion of ionisation to energy spent varies from molecule to molecule, and is dependent on the velocity of the α particle. The results described in this paper show that, as already said, $di = k\, f(v)\, de$. The nature of the function $f(v)$ is of great interest. In two previous papers I have made attempts to find it. In the first (Phil. Mag., Sept., 1905) I showed that if we assumed the ionisation produced to be proportional to the energy spent, and both to v^n, and also assumed all the energy to be spent on ionisation, then the form of the curve was most readily explained by taking $n = -\frac{1}{2}$. Later Rutherford showed that the energy of the α particle was not all spent on ionisation, but that much still remained when ionisation ceased. Using his figures, I then pointed out that with this modification of the hypothesis it seemed probable that $n = -2$ (Phil. Mag., Nov., 1905). But Rutherford's recent work shows that the hypothesis is still fundamentally wrong, because the ionisation is not proportional to the energy spent. His results settle the whole question.

If $v =$ the velocity of the particle, r the range yet to be run, d a constant, which Rutherford estimates at 1·25 cm., then his conclusion is that v is proportional to $\sqrt{(r+d)}$. Now I have shown (Phil. Mag., Nov., 1905) that the ionisation produced by the particle during the last r cm. of its path is proportional to $\sqrt{(r+d)} - \sqrt{d}$ where $d = 1·33$. The two values of d may be taken to be the same. Hence di/dr is proportional to $1/\sqrt{(r+d)}$, *i.e.*, to $1/v$; which means that $f(v) = 1/v$, or that the ionisation produced at different points of the path in any gas is proportional to the time spent by the α particle in crossing the atom.

The formula which I have used here for the ionisation was calculated on the hypothesis that the α particle lost its ionising power abruptly, and that the slope of the top of the ionisation curve was due to the effects of the thickness of the Ra film. Bronson's results (Phil. Mag., June, 1906) seem to show that the loss of ionising power is not quite so sudden as I supposed it to be. But I find that this does not affect the calculation of the form of $f(v)$. For we may take an extreme view and suppose the whole of the top slope to be due to a gradual decay of the α particle's powers, and none to the thickness of the radium layer. In that case the form of the ionisation curve represents the effects of one particle. Now, the ionisation at 6·5 cm. (in air) for RaC is nearly 4/3 of the ionisation at 5 cm. At the former distance $r + d = ·5 + 1·25 = 1·75$, and at the latter $2 + 1·25 = 3·25$. But $\sqrt{3·25}/\sqrt{1·75} = 1·36$; which is very nearly 4/3. Thus the ionisation on this hypothesis also is inversely proportional to $\sqrt{(r+d)}$, and the true explanation of the top slope must lie between the two extremes.

It seems clear, then, that the ionisation in the molecule is proportional to the energy spent in it (*i.e.*, to the stopping power, or the amount of the effect A), to the velocity of the α particle inversely, and to a quantity k, constant for any one gas, but varying from gas to gas. It is this quantity which is given in the last column of the tables above.

The velocity of the α particle might enter into the formula because A is effective in producing B in proportion to the derangement of the atom or molecule consequent on the presence of the particle within it, and therefore to the time during which the intrusion lasts. There is something odd about this conclusion, which suggests a reconsideration of the position.

At this stage, therefore, it is natural to raise the question whether the effect A really is the cause of the effect B, whether, that is to say, the energy spent by the α particle goes to the production of ions, or the ionisation energy comes from some other source and the α particle merely pulls the trigger in its passage through the molecule. The fact that the ionisation produced varies as the time of passage is certainly indicative of the truth of the latter hypothesis; whilst the occurence of the stopping power in the expression for the ionisation is not necessarily evidence against it, because the factor k might be taken in conjunction with s, and ks might be found to represent not some derivative of the energy spent by the particle within the molecule, but some inherent property of the molecule which determined the ionisation produced in consequence of the pulling of the trigger.

The quantity ks represents in the first place the specific ionisation of the molecule; that is a relative measure of the ionisation produced in a molecule when an α particle passes through it at a given speed. Now, it is an extraordinary thing that the values of ks which I have obtained for different molecules prove to be nearly related to already well-known molecular constants, such as the molecular volumes, molecular refraction constants, and so on.

In the following table the values of k, s, and ks of a number of substances are given in the first three columns; the fourth contains the volumes of the molecular volume v, and the fifth the ratio v/ks. The values of the volumes were for the most part taken from the tables in Ostwald's Lehrbuch der Allgemeinen Chemie, 2nd edition, p. 356, etc., but those of C_2H_2 and C_2H_4 were calculated from the general equation for obtaining the molecular volumes of organic compounds, and the values for CO_2, O_2, and H_2 were adopted on the assumption that they fell into line with the same equation. This is justifiable, since my immediate object is to show a relationship between *ks* and the atomic volume in combination. As a matter of fact, the molecular volume of O_2 *per se* has been found by Dewar to be 27·4 (Chem. News, June, 1898). This is close to the value in the table, viz., 24·4. But Dewar also finds H_2 to be 28, which is much larger than the value used in the ordinary formula.

	$k \times 10^2$.	$s \times 10^2$.	$ks \times 10^2$.	v.	$v/ks \times 10$.	B.	$ks/B \times 10^2$.
C_6H_6 ...	129	333	430	96·0	223	75·5	5·8
C_5H_{12} ...	135	359	485	117·0	242	87·5	5·5
C_2H_4 ...	128	135	173	44·0	254	43.0	3·9
C_2H_2 ...	126	111	140	33·0	236	36·0	3·9
$C_4H_{10}O$ ...	132	333	440	106·0	241	83·0	5·3
C_2H_6O ...	123	200	246	62·0	252	47·0	5·2
CH_4O ...	122	143	174	42·5	244	—	—
CCl_4 ...	132	400	528	104·0	197	80·0	6·8
$CHCl_3$ ...	129	316	408	85·0	208	72·0	5·7
C_2H_5Cl ..	132	236	312	71·0	227	55·5	5·6
CH_3I ...	133	258	343	66·0	193	52·0	6·6
C_2H_5I ...	128	312	400	86·0	215	68·8	5·8
CS_2 ...	137	218	299	62·0	207	50·0	6·0
CO_2 ...	108	147	159	35·4	222	30·0	5·3
N_2O ...	105	146	153	—	—	29·0	5·3
O_2 ...	109	105	115	24·4	212	19·0	6·1
H_2 ...	100	24	24	11·0	460	8·6	2·8

The value of *k* for H_2 is set down as 100. This is only approximate, and is probably too high. Its accurate determination will require the construction of special apparatus.

The agreement between the ratios *v*/*ks* in the fifth column is not such as to show that *v* and *ks* are directly proportional; but it is good enough to suggest strongly that they both rest immediately on some more fundamental property. The case is even a little stronger than appears at first sight, since it is clear that H_2 contributes an abnormal amount to the molecular volumes; the ratio *v*/*ks* is high whenever H preponderates in the molecule. Moreover, the molecular refractions also run closely parallel, as is well known, with the molecular volumes, and in general the connection between the various physical properties of the molecule and its volume is more obvious than any connection with its molecular weight. Consequently the quantity *ks* is closely related to most of the physical properties of the molecule. As a second instance, I have put in the sixth column of the above table the respective values of Sutherland's molecular volume *B* (Phil. Mag., Jan., 1895), and shown in the last column that this also is closely connected to ks. According to Sutherland, B tends to be proportional to the electric moment of the molecule. In this case also the variations in the ratios (see the last column) seem to be due to abnormalities in B rather than in ks; *e.g.*, C_2H_2 and C_2H_4 would fall into line of the values of B for these substances were more in keeping with those for C_6H_6 and C_5H_{12}.

Since k is nearly the same for a number of gases, r/s is also nearly the same. Thus the molecular volume is connected, not very distantly, with the sum of the square roots of the weights of the atoms which make up the molecule.

Each of these physical properties which are so nearly related is partly additive, partly constitutive. For example, the molecular volume of an organic molecule depends in part on the sum of the volumes of the constituent atoms, and in part on the mode of constitution. This suggests that there is some fundamental and purely additive property of the atom itself, on which various semi-additive properties are based. For this reason it appears to be of great interest that the stopping power of the atom has shown itself to be simply additive, so far as experiment has tried it; and at the same time to be closely connected with the atomic volume, the atomic refraction, and the rest. The additive nature of the constant may be seen from the following table, in which the observed stopping powers of a number of gases are set alongside those calculated from assumed values for H, C, O, and Cl.

Assume $H_2 = \cdot 24$, $C_2 = \cdot 85$, $O_2 = 1\cdot 03$, $Cl_2 = 1\cdot 78$ (air molecule = 1):—

	C_2H_2	C_2H_4	C_6H_6	C_5H_{12}	CH_4O	C_2H_6O
Calculated ...	1·09	1·33	3·27	3·56	1·41	2·08
Observed ...	1·11	1·35	3·33	3·59	1·43	2·00

	$C_4H_{10}O$	CO_2	CCl_4	$CHCl_3$	C_2H_5Cl
Calculated ...	3·41	1·47	3·98	3·21	2·34
Observed ...	3·33	1·48	4·00	3·16	2·36

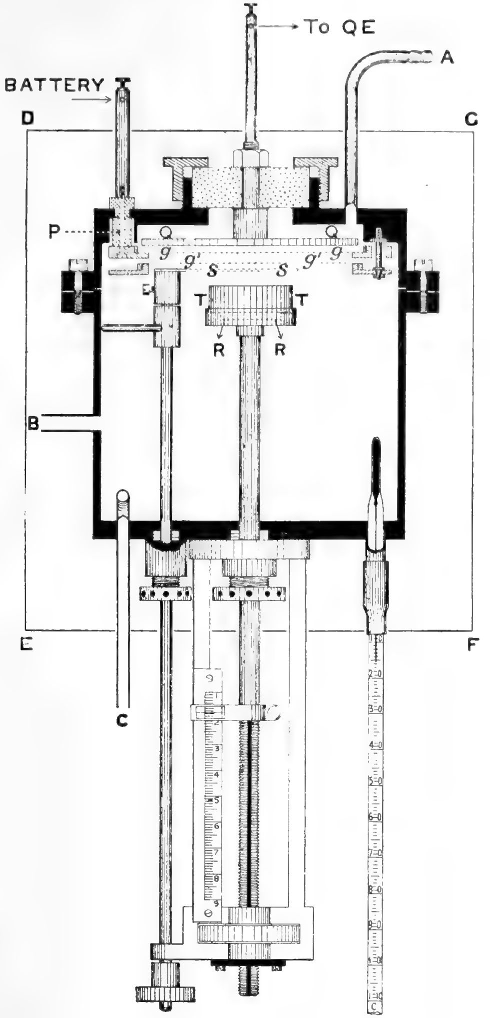
It is of course too early to say that the stopping power has been proved to be a perfectly additive property of the atom, yet it is clear enough that it is more so than any other known property, except one. The more nearly experiment shows it to be strictly additive, the greater will be its title to rank with mass itself. I hope to begin soon a fresh and more accurate set of experiments in the endeavour to find to what extent the additive law holds.

The near proportionality of the stopping-power to the atomic square root is an effect which is quite apart from its additive nature. Its existence is a connecting link between the atomic weight on the one hand and the atomic volume, refractive power, etc., on the other. The preliminary paper on this subject contained a table of stopping powers as found up to that time. I have made several new measurements of these constants, which are, I believe, an improvement on the old. This is particularly the case with the metals Au, Pt, Sn, Ag, Cu, and Al, since the specimens used were obtained as pure from Messrs. Johnson, Matthey, & Co. I find that if the stopping powers of S, Cl, and I are calculated from those of molecules containing them, on the assumption that the additive law holds, then these fit in very well with the metals. So also does Br fit in fairly well; it is quite possible that the divergence is due to experimental error, since the only measurement on a molecule containing Br was made at a very early stage of this enquiry. The divergence from the exactness of the square-root law, which I have previously pointed out, seems to occur only in the atoms whose weights are below 30; these have an abnormally low value, as may be seen from the table below (in which s for the air atom = 1). It is curious that a similar effect should occur in the case of the atomic heats:—

	H.	C.	N.	O.	Al.	S.	Cl.	Fe.	Ni.
s	·24	·85	·94	1·05	1·495	1·76	1·78	2·29	2·44
$\sqrt{\omega}$ ...	1·00	3·47	3·74	4·00	5·20	5·65	5·96	7·48	7·65
$s/\sqrt{\omega} \times 10^3$ ...	240	246	251	262	287	312	299	307	319

	Cu.	Br.	Ag.	Sn.	I.	Pt.	Au.	Pb.
s	2·46	2·60	3·28	3·56	3·44	4·14	4·22	4·27
$\sqrt{\omega}$ ...	7·96	8·93	10·37	10·9	11·2	13·95	14·0	14·35
$s\sqrt{\omega} \times 10^3$ ...	309	291	316	326	307	297	301	298

One other point invites some consideration. Whilst the saturated ionisation curve seems to be the same for all gases, yet the effects of initial recombination vary from gas to gas and from point to point on the curve. This fact can be explained by the consideration that the amount of the ionisation produced is an intramolecular effect, and is therefore independent of the physical conditions of the molecule and of the relations of one molecule to another, whilst the amount of initial recombination depends on extramolecular relations, on pressure, perhaps on temperature, and so on. The increase of initial recombination towards the end of the path of the particle may be due in part to the existence of a greater number of molecules that have lost more than one ion, since in such cases recombination would be harder to prevent. This raises the question as to how the ionisation is



Hussey & Gillingham, Printers, Adelaide.

distributed between the molecules which the α particle traverses. There does not appear to be any evidence, as yet, that the chance of an ion being formed from a molecule is dependent on whether the molecule has already lost one or more ions; rather the contrary. If this is the case, occasional molecules must lose several ions. Nor is it yet clear in what mode ionisation occurs. Does the α particle simply cause the removal from the molecule of one or more electrons? May there not possibly be a more complete disruption of the molecule, or even the atom? There is one curious parallelism in numbers which may have a bearing on this question. Ramsay and Soddy (Proc. Roy. Soc., 72, p. 204, 1903) found that 50 mmg. of radium bromide in solution evolved gases at the rate of ·5 cc. per day—*i.e.*, 2×10^{19} molecules per day. Now, Rutherford has shown that one gram of radium bromide, without its radio-active descendants, produces $3{\cdot}6 \times 10^{10}$ α particles per second. Each α particle makes 86,000 pairs of ions. Hence the number of ions made in one day by 50 mmg. is

$$3{\cdot}6 \times 10^{10} \times {\cdot}05 \times 60 \times 60 \times 24 \times 172{,}000 = 2{\cdot}7 \times 10^{19}.$$

This number is an inferior limit. A superior limit is found by considering all the radio-active products of radium to be present in full, in which case the number will be between five and six times greater. The close agreement of these numbers certainly fits in with the hypothesis that an actual disruption of the water molecule takes place in consequence of the passage of the α particle through it.

I owe my thanks to my assistant, Mr. A. L. Rogers, for the great care and skill with which he has made the apparatus used in this work, and drawn the plate illustrating this paper.

Note: October 22.—The greater part of § 3 of this paper has been written since the remainder was read.

DESCRIPTION OF PLATE VII.

Insulators shown by dotted surfaces.

QQ, upper plate of ionisation chamber.

P, one of three glass pillars supporting gg.

gg, upper gauze, forming lower plate of ionisation chamber, connected to battery.

g′g′, lower gauze, supported by three metal pillars, one of which is shown, earthed through pillars and metal of case.

SS, semaphore of thin sheet metal, worked from without by turning the long rod on which it is mounted.

TT, set of vertical tubes.

RR, radium plate.

DEFG, outline of electric oven.

On Certain New Mineral Species associated with Carnotite in the Radio-Active Ore Body near Olary.

By D. Mawson, B.E., B.Sc.

[Read September 4, 1906.]

Introduction.

The occurrence of carnotite, a vanadate of uranium and potassium, was reported by Mr. Chapman, the Government Analyst, as a filmy coating in the crevices of a sample of ore sent to him for analysis. As the yellow powder was scarce his determination rested on qualitative investigation only, but was substantiated by physical tests made by Professor Bragg, who demonstrated its high radio-activity. This information was made public in the daily press of May 3 last.

The same day Mr. H. Y. L. Brown, the Government Geologist, visited the locality of the find, Radium Hill,* situated 24 miles in a direct line east-south-east of Olary, and 1½ miles south-south-west of Teesdale's Dam. In the Adelaide press of May 5 appeared a short report made by him on return to the city.

Mr. H. G. Stokes, after a visit to the field, made comments through the press of May 9, doubting the correctness of the mineral determinations.

Extracts from the final official report appeared in the *Advertiser* of May 16, in which announcements were made by the Government Geologist and Government Analyst, and by Mr. G. A. Goyder, Public Analyst. In this report the Government Geologist, suspecting that the carnotite originated as a decomposition product, states:—"It appears most probable that it has been derived from the solution and redeposition of other uranium compounds below, and that, therefore, such ores, in addition, will be found by exploitation in depth." Both analysts reported the yellow compound to be probably carnotite. Magnetite and magnetic titanic iron were reported; also gummite.

Only within the last month have representative samples been obtained at the University. Extreme variation in physical characters, exhibited by different portions of the black mineral, at once attracted attention. It was evident that instead of a single black constituent previously described as

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* As this spot has so far remained unnamed, "Radium Hill" seems appropriate.

ilmenite or magnetic iron, five distinct varieties could be isolated. The high economic value of many such heavy black minerals attached additional interest to further investigation.

However, though iron and titanium could readily be detected by simple means, yet this was far from satisfying, as the variety of types could not be reconciled with known species. Added to this, the nature of the occurrence and the ore itself were suggestive of the presence of minerals of a rare type.

At this stage it was highly desirable that careful chemical analyses be made. The laborious work, rendered specially difficult by the presence of an excessively high percentage of titania, was undertaken by Professor Rennie and Dr. Cooke, with results as stated in the succeeding paper.

Mineralogical Notes.

The locality of the find was visited a fortnight ago, and the following observations made:—

On the original claim,* pegged out by Mr. A. J. Smith, there are several parallel veins, averaging a full two feet in width, and continuing in a direction N. 30° E. for a distance of several hundred yards. Altogether the ore has been traced for at least a quarter of a mile. The veins are nearly vertical, slightly underlying to the east, and run in the direction of the country; the latter is possibly Pre-Cambrian in age, and where best exposed is a metamorphic sandstone, in which mica flakes have been largely developed. In proximity to the lode, on either side, the mineralizing waters forming the vein-filling have metamorphosed the country, developing a selvage of solid black mica.

Basic dyke-like intrusions, many yards in width, have cut perpendicularly across the lode country in two places, respectively north and south of Smith's claim. These may have been introduced subsequently to the lode formation, though possibly contemporaneous and genetically connected with the ore bodies.

The outcrops of the lodes stand a few inches above the level ground, and are typically composed of heavy black minerals of somewhat varying types, and notable amounts of coarse black mica and highly-coloured vanadiferous decomposition products. In the case of the main lode a considerable bulk of quartz, usually tinted pinkish, occupies the central vein-filling. In it are occasional bunches of mica and sporadic masses of the heavy black minerals. The shoading of these latter minerals on the surface renders prospecting easy.

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* The ground was originally taken up, expecting that the black mineral so abundant would prove to be wolfram or tin oxide.

The veins are all of the pegmatite class, and no doubt have their origin in some intrusive mass below. The most western reef is somewhat different from the others, being chiefly composed of micaceous hæmatite and quartz, with occasional copper stains, and no radio-active minerals have so far been detected in the outcrop. The main reef is about 60 yards further east, and has been opened to a depth of 15 feet. The vein matter is distributed in a roughly symmetrical arrangement. A massive mineral (1) with an uneven iron-black fracture and specific gravity, about 6, composes laminated zones some four inches wide next the walls. On analysis this proved to be chiefly composed of iron and titanium, though, as evidenced in the thin slice prepared for microscopic examinations, it is not homogeneous. The central portion of the reef is occupied by a more compact body of a brighter black mineral (2), with slightly less specific gravity; also accompanied by quartz and a varying quantity of black mica. Occasionally streaks, scattered grains, and cuboid crystals of a rarer black mineral (3), with specific gravity in the vicinity of 4, are observable, which, on account of its very brilliant lustre and glassy fracture, is readily distinguishable. These latter two minerals have been shown by Professor Rennie and Dr. Cooke to contain over 50 per cent. of titania, a large quantity of iron, and a notable amount of rare earths, uranium, vanadium, and chromium.

So far as can be judged at present, the brilliancy of lustre indicates increased percentage of titania chiefly, and to some extent rare earths. Several degrees of brilliance are shown by primary heavy black minerals of the general type of (2), and it is inferred that analysis will reveal a considerable diversity in chemical composition. The mineral (1) is likely to be to some extent an alteration of (2), the heterogeneity exhibited by it aiding in this conclusion. Type (3) is best developed in the main vein, at the contact with the siliceous central filling, and has all the appearance of having formed at a period after the reception of the main bulk of the ore body. In such situations it is also frequently met with crystallized, embedded in the quartz, or presenting idiomorphic faces in its direction. The quartzose gangue in the central portions of this lode contrasts noticeably with the titanium-rich iron minerals and micas forming the general filling, and indicates, at least an alteration in character of the contributing circulation. The inception of the new chemical and physical conditions accompanying this change in circulation has been to partially alter the mineral (2) near the contact, leaving two additional minerals in its place, one resembling micaceous iron (4), the other a dull brownish-black ferriferous mineral

(5); from the extracted matter, the bright black mineral (3) appears to have had its origin.

Another reef 10 yards to the east is characterized by consisting chiefly of the heavy black minerals and abundant mica. It has been opened to a depth of 18 feet.

Still further east is another reef, chiefly composed of the heavy black minerals and quartz.

The portions of the lodes exposed by development show ample stains of the lemon-yellow powdery substance determined by the Government Analyst to be *carnotite*. It is found coating the black minerals and insinuated into microscopic cracks. Undoubtedly this substance is of secondary origin, the field occurrence indicating a derivation by decomposition of some primary constituent of the ore body; no doubt the black minerals referred to above.

In one part of the main lode a secondary micaceous mineral of a bright green colour is rather abundant, and, as it re-acts strongly for vanadium, is no doubt *roscoelite*.

Just as recorded in the cases of the Colorado and Utah occurrences, a large variety of yellowish and greenish minerals in various shades, both amorphous and crystalline, are also met with in this material. Their very sparse development has, so far, not allowed of sufficient quantities being collected for analytical purposes.

The bright black mineral (3) is an entirely new type, though details are not yet available for complete description. We propose to name it *davidite*, after Professor T. W. E. David, of Sydney University, whose personal ability, wise counsel, and enthusiasm have done so much to further the interests of the science and economic application of geology in Australasia.

Conclusions.

Carnotite is known from one other locality only, namely, as scattered occurrences in a Mesozoic sandstone formation, distributed through an arid district comprising western Colorado and south-eastern Utah, in the United States of America. Roscoelite has been reported from three other localities only—Placerville, in Colorado, and neighbouring locality, and Placerville, in California, both in the United States of America,* and at the Boulder Mine, eastern Coolgardie, Western Australia.†

* "On Carnotite and Associated Vanadiferous Minerals in Western Colorado," by W. F. Hillebrand and F. L. Ransome, p. 9, Bull. No. 262, U.S.G.S.

"Vanadium and Uranium in South-Eastern Utah," by J. M. Boutwell, p. 200, Bull. No. 260, U.S.G.S.

† See W.A. Geol. Survey Reports.

The further association of these rare minerals at Radium Hill is of special interest. The only known occurrences of carnotite are with roscoelite and other vanadium minerals. The existence of mineral vanadates of uranium, such as carnotite, on theoretical grounds, should not be unexpected, as these elements have a powerful mutual precipitating action.

In the case of the American deposits, deposition has taken place in fissures, and as a replacement in a Mesozoic sandstone formation, evidently from percolating waters. The ore bodies are wholly of aqueous or secondary origin. The South Australian occurrence is the result of weathering of certain rare and new minerals in pegmatite veins traversing Pre-Cambrian strata. This latter occurrence is specially interesting, for the fact that the primary source of the uranium and vanadium can be ascertained.

A further and most notable fact is that the element vanadium was first discovered by Seffstrom in the titanic iron ore deposit of Taberg, south-west of Lake Wetter, in Sweden. The Taberg ore is characterized by the presence of 0·12 per cent. to 0·40 per cent. oɪ vanadic acid. The ore stock has also in its field relations much in common with the Radium Hill lodes.*

No trace of gummite, as recorded in the official report, was noted in any of the lodes, and its occurrence is extremely doubtful.

Pegmatite lodes, of the character of those at Radium Hill, often carry tin and wolfram, though so far these substances have not been reported from the locality, and the absence of even traces of them in the analyses suggests that, likely, the ore body is a pegmatite of a basic rock, and that, in all probability, such minerals will be found entirely absent.

It may be mentioned that this type of ore deposit does not usually develop pitchblende, but uraniferous titanates, niobates, and tantatates, and thorium minerals may be expected.

Monazite is found in the same district, in the lode at the King's Bluff gold-mine, 28 miles north-west, which fact should stimulate local interest in quest of thorium minerals, and reinforce the possibilities of the thorium content of the Radium Hill ore.

This body of radio-active ore is, in the matter of quantity, much the most important yet discovered in Australasia. Its low grade, however, introduces serious difficulties to commercial enterprise in this direction. The high value of vanadium for hardening steel, and the fact that the titanium,

* See "The Nature of Ore Deposits," by Dr. R. Beck, trans. by W. H. Weed, p. 21, vol. i.

chromium, and uranium contents are utilized for the same purpose should induce a demand for the heavy black minerals for the manufacture of special steels.

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Preliminary Analytical Notes on the Minerals Described in the Preceding Paper.

By E. H. Rennie, M.A., D.Sc., and W. T. Cooke, D.Sc.

[Read September 4, 1906.]

At Mr. Mawson's suggestion, we have examined two of the minerals referred to by him in the previous paper. As regards the carnotite, we are so far able to confirm Mr. Chapman's results as to the presence in it of potassium, uranium, and vanadium, and we hope later to furnish quantitative details. As regards the dark-coloured mineral (No. 2 in previous paper), of which the carnotite appears to be a decomposition product, we have examined it qualitatively up to a certain point; but the difficulties of analysis are considerable, owing to the complex nature of the mineral. We have, however, ascertained that, in addition to titanic and ferric oxides, which are the chief constituents, there are present uranium, vanadium, cerium, and almost certainly thorium and other rare earths, traces of lime, and, we believe, also chromium and traces of manganese. The quantities of vanadium and chromium. however, if present, are very small, and in presence of uranium difficult to detect with certainty. As a result of this, and by reason of other matters which have occupied our time, we send these imperfect preliminary notes in the hope of being able at a future date to offer to the Society a more complete analysis.

A Note on the Localities attributed to Australian Lepidoptera by Mr. Oswald Lower, F.E.S.

By A. Jefferis Turner, M.D., F.E.S.

[Read October 2, 1906.]

It is hardly necessary for an entomologist to insist on the vital importance of strict accuracy in the record of localities. A definite locality is often of great assistance to the systematist in determining a species. Further, when the description of an obscure species is insufficient for its determination, and the type has been lost or destroyed, it may be possible by the examination of specimens, corresponding to the description and taken in the exact locality of the type (such specimens have been styled *topotypes* by Lord Walsingham), to determine the species with sufficient exactness. These are incidental advantages. The main points are:—(1) That the natural history of a species must be considered imperfectly known until its range has been ascertained (if possible both geologically as well as geographically, though entomologists have to be content with the latter); and (2) that the study of geographical distribution is recognized as an important branch of science. If accuracy in recording localities is of importance, it is equally a scientific duty to correct mistaken localities, or even to indicate what localities are doubtful, since doubtful localities as a basis for scientific generalizations are far worse than no localities at all. When such errors have been perpetrated on a considerable scale, the obligation becomes imperative.

In the present state of Australian entomology it is very difficult to detect errors in locality. So many new species are constantly being discovered, that an author may for years continue to assign to them incorrect localities, without suspicion being aroused. Even when suspicion is aroused, anything like positive proof is in the nature of the case difficult. But in the present instance I am able to adduce evidence which, I consider, amounts to demonstration.

In 1903 I had an opportunity of examining some of Mr. Lower's types of *Pyralidæ*. On inspection I had no doubt that in eleven instances (of which I give a list below), these types were obtained from Mr. F. P. Dodd, and that in every instance the locality label attached to the specimen, which was the same as the published locality, did not correspond to the locality from which the specimen was obtained.* My reasons for coming to this conclusion were:

(1) These specimens were mostly obscure species of *Phycitinæ* not likely to be obtained from the ordinary collector, but all of them had been sent to me by Mr. Dodd, and most of them were, so far as I knew, not obtainable from any other source. Mr. Lower had obtained to my knowledge many moths from Mr. Dodd.

(2) The specimens were mostly bred specimens in perfect condition. No other collector in Australia has done much work in breeding *Phycitinæ*.

(3) The condition of the specimens, their method of pinning and setting, and in some instances the peculiar kind of pin employed, exactly corresponded to Mr. Dodd's specimens.

Though this evidence was sufficiently cogent for my own mind, I thought it advisable to submit the specimens to Mr. Dodd, who recognized them as having been obtained from himself. Mr. Dodd usually attaches locality labels to his specimens, giving the locality, date, and collector's name. On being questioned by me as to this point, he replied that many of the specimens received by Mr. Lower from him (shortly before the publication of the descriptions) were so labelled. Some he had not labelled, but Mr. Lower, in taking them, undertook to affix the labels himself.

The first specimen in the following list was sent to me as the type of *Anerastria xiphimela*, Low., but, as I have already mentioned (P.R.S.Q., 1903, p. 119), I was unable to consider it the real type, as it did not correspond exactly to the description, and did not belong to the same genus as that in which Sir George Hampson, who had examined all these types, had placed the original. It seems to me more likely that Mr. Lower substituted another insect, which he believed to be the same species, than that Sir George Hampson should have made a mistake in the genus:—

* I have already referred to this discovery (P.R.S.Q., 1903, pp. 110, 126, 132).

Name.	Reference, Tr. R.S.S.A., 1903.	Published Locality.	True Locality.
Anerastria xiphimela (reputed type of)	Page 52	"Cooktown"	Townsville
Anerastria minoralis ...	52	"Mackay"	,,
Phycita deltophora ...	53	,,	,,
Nephopteryx orthozona ...	53	"Cooktown"	,,
Nephopteryx hades ...	54	"Brisbane, Mackay"	,,
Nephopteryx thermalopha...	55	,, ,,	,,
Nephopteryx metasarca ...	56	"Brisbane"	,,
Tephris glaucobasis ...	56	"Mackay"	,,
Homœosoma (?) melanosticta	58	"Derby, W.A."	Brisbane
Jocara thermoptera ...	59	"Broken Hill"	,,
Stericta aleuropa ...	59	"Mackay"	Townsville
Crambus photoleuca ...	51	,,	,,

It was hardly to be expected that Mr. Lower's errors should have been confined to the comparatively few species, of which I examined the types; and I have been able to collect some further instances. Here, of course, demonstrative proof is not possible, but I have been careful to include only examples in which the circumstantial evidence is strong; in some of them it appears particularly strong. Of course, I may possibly be in error in one or two instances.

Name.	Reference.	Published Locality.	True Locality.
Nephopteryx chryserythra	P.L.S.N.S.W., 1901, p. 662	"Cooktown"	Townsville (all entries)
Nephopteryx monospila...	,, ,,	"Broken Hill"	
Cryptophaga hyalinopa...	Tr.R.S.S.A., 1901, p. 82	"Duaringa"	
Cryptophaga panleuca ...	,, ,, p. 83	"Cooktown"	
Xylorycta pentachroa ...	,, ,, p. 83	"Broken Hill"	
Onychodes (?) rhodoscopa	,, 1902, p. 228	"Derby, W.A."	
Phycita leucomilta ...	,, 1903, p. 53	"Mackay"	
Heterographis molybdophora	,, ,, p. 57	"Derby, W.A."	
Endotricha desmotona ...	,, ,, p. 60	,,	
Noorda metalloma ...	,, ,, p. 65	,,	
Xylorycta philonympha..	,, ,, p. 229	"Broken Hill"	
Euzopherodes poliocrana	,, 1905, p. 104	,,	
* *Hypographa cyanorrhœa*	,, 1903, p. 191	"Alice Springs"	
Clupeosoma rhodea ...	,, 1905, p. 107	"Mackay"	

* If I am right in this identification, Mr. Lower's description is inaccurate in some particulars. The very peculiar bidentate frontal process does not leave much room for doubt.

This list might, by a reasonable use of conjecture, be considerably enlarged.

It is, of course, impossible to *prove* that the published locality in each or any instance in this list is erroneous. There is no inherent improbability that a Townsville insect may be taken in Mackay. Though it may be improbable that any given Townsville insect may be taken in Broken Hill, it cannot be claimed to be an impossibility. A few widely ranging species may be found in both localities. But these species would probably be known from many intermediate localities. The improbability in any case in the preceding list may not of itself be sufficient to sustain a charge of inaccuracy, but the cumulative weight of a series of such improbabilities may be sufficient. The evidential value of this list must be taken to be supported by that of the preceding list. In both instances the locality ("Townsville") is not recorded by Mr. Lower. Some of the insects in this second list I know to have been received by Mr. Lower from Townsville before the publication of his descriptions. All of them have been received from Townsville by myself.

The following is an additional list:—

Name.	Reference.	Published Locality.	True Locality.
Œnone xenopis	Tr.R.S.S.A., 1902, p. 227	"Broken Hill"	Birchip
Cryptophaga isoneura ...	,, ,, p. 236	"Victoria"	
Taxeotis xanthogramma ...	,, 1903, p. 186	"Broken Hill; Melbourne"	
Darantasia perichroa ...	,, ,, p. 187	"Stawell"	
Procometis periscia ...	,, ,, p. 200	"Melbourne"	
Heliocausta episarca ...	,, ,, p. 220	,,	
Pedois anthracias ...	,, 1902, p. 246	"Stawell"	
Lepidoscia melanogramma	,, 1903, p. 71	,,	
Procometis tetraspora ..	,, ,, p. 199	"Melbourne"	

This list, taken by itself, is of less value than the preceding. It can only be regarded as corroborative. Some of the published localities may be correct. But I believe these species were received by Mr. Lower from Birchip before description, and the omission of this locality has the same significance as the omission of the "Townsville" locality in the preceding lists.

Name.	Reference.	Published Locality.	True Locality.
Syntomis cremnotherma ...	P.L.S.N.S.W., 1900, p. 29	"Irrapatana, South Australia"	North-western Australia

This is a synonym of *S. xanthosoma*, Turn. (Tr. R.S. S.A., 1898, p. 93) a species which is locally abundant in North-western Australia, from which it has been received from several collectors. I received my type from Mr. George Masters, the Curator of the Macleay Museum, and if I am not mistaken Mr. Lower received an example from the same source before he published his description.

I think the evidence I have given is sufficient to show that Mr. Lower's localties are not always accurate, and that the scientific worker will be acting with commendable caution if he refuse to base any conclusions on such data except in so far as they have been corroborated by other observers.

Radium at Moonta Mines, South Australia.

By S. Radcliff (communicated by Prof. W. H. Bragg, M.A.).

[Read September 4, 1906.]

The ore deposits of Wallaroo and Moonta mines present many features of interest. Occurring as they do in rocks of extreme antiquity, and containing a very wide range of mineral species, as well as traces of many of the rare elements, it seemed just possible that one of the radioactive elements might be present in them.

The present investigation was commenced in June, 1905, to see if this were the case, and as the results so far obtained are of considerable interest, it seemed desirable to give some preliminary account of them.

In testing for radioactivity, I used a gold leaf electroscope sufficiently sensitive to detect anything possessing an activity approaching one-hundredth of that of uranium oxide (U_3O_8).

After a good deal of preliminary work, giving negative results, faint signs of activity were detected in one of the smelting work's bye-products, and this activity was subsequently traced back to some "concentrates" from Moonta. The fact that the bulk of the ore from Moonta mines passes through the crushing and concentrating plant before being forwarded to the smelting works rendered the identification of the active mineral a matter of some difficulty. Experiments on the concentrates indicated that the active mineral was probably of rather low specific gravity, and of such a character that it powdered readily when crushed. On putting the concentrates through a series of sieves of different degrees of fineness, the activity was found to concentrate to some extent in the finest product. Elutriation tests gave some indications as to the specific gravity. Further search resulted in a few specimens of activity, about one-twelfth of that of U_3O_8, being found in a heap of rough ore from Moonta, and following up the clue afforded by their general physical character a small deposit of active ore was ultimately located in the upper workings of a shaft at Moonta Mines, known as Treuer's Shaft. Shortly afterwards a second deposit was found in the workings connected with Taylor's Shaft, also at Moonta Mines.

The specimens from these two deposits are about equally active, but differ considerably in appearance and composition;

the deposits, however, have this feature in common, that they both occur in the vicinity of cross-courses. The active material is apparently of secondary origin. So far, only a few pounds of ore showing any marked activity have been found.

The Treuer's Shaft ore is of moderately high specific gravity, is nearly black in colour, and as a general rule considerably decomposed. The copper contents are high, as will be seen from the analyses given subsequently, and most specimens are characterized by the presence of small crystals of smoky quartz.

The active ore from Taylor's Shaft resembles brown coal as much as anything else, it breaks readily with a lustrous conchoidal fracture; some specimens are of very low specific gravity (1·55), and are remarkable for the large amount of carbon they contain.

Some considerable progress was made in the direction of isolating the active material before any detailed chemical analyses were made, and this preliminary work, done on a few grammes of ore, is of interest in that it determined the method for extracting and concentrating the activity from larger quantities of material.

On decomposing the finely-ground roasted ore with aqua regia, the insoluble residue was found to be nearly inactive.

The metals of the copper group were precipitated with sulphuretted hydrogen. With regard to this precipitate, on the only occasion when a measurement was made it showed distinct activity when first separated, but this diminished rapidly, and in twenty-four hours had practically disappeared.

The bulk of the activity appeared to concentrate in the hydrate precipitate, thrown down on the addition of ammonia to the filtrate from the copper group, after the sulphuretted hydrogen had been expelled and the iron in the solution oxidized. The filtrate from this on being evaporated down yielded a residue, which showed very little activity. One lot of hydrate precipitate dissolved in nitric acid yielded a small amount of precipitate of high activity on the addition of ammonium oxalate, but this result requires confirmation.

Further work having shown that the active constituent was not readily soluble in sulphuric acid, ten grammes of ore were treated as follows:—

The ore was decomposed as before with aqua regia, the insoluble residue filtered off, and the solution evaporated to a small bulk; a few c.c. of sulphuric acid were added, and the evaporation continued on an air-bath until white fumes were freely evolved.

The mass after cooling was taken up with water and heated for some time; a small amount of white precipitate remained insoluble. This was washed repeatedly by decantation, dried, and weighed. Its weight was ·007 gramme. I determined its activity to be a little over twenty times that of uranium nitrate, but the measurement was necessarily only approximate. The sample was forwarded to Professor Bragg in March last, and he made its activity to be about nine times that of U_3O_8, so the two measurements agreed fairly well. The activity of this sample gradually increased to 12.

I would like to take this opportunity of expressing my thanks to Professor Bragg for the interest he has taken in this research throughout, and for the time and trouble he has expended in making measurements on active products. On receipt of Professor Bragg's confirmation of the result that a radio-active element of higher activity than either thorium or uranium was present, more attention was given to the chemical composition of the ore. Mr. G. J. Rogers, A.R.C.S., the work's chemist, found uranium in both Treuer's and Taylor's Shafts material to the extent of several per cent., his highest result being 4·74 per cent. U_2O_5. I understand that Dr. Cooke has also detected uranium in a sample of ore in his possession. Mr. Rogers also found that the Treuer's ore contained a little carbon, and made an approximate quantitive determination of its amount in a typical specimen from Taylor's Shaft. Subjoined are his results on material from both shafts:—

TREUER'S ORE.		TAYLOR'S ORE.	
Cu	58·5 %	Cu	20·0 %
$Al_2O_3Fe_2O_3$	3·3	Fixed Carbon	10·0
U_2O_5	4·74	H Carbon	13·0
S	16·4	H_2O	5·0
Insoluble	6·0	Insoluble	17·8
Undet. (C H_2O Zn Pb)	11·0		

(The carbon includes some volatile hydro-carbon.)

All active specimens so far examined have been found to contain a little lead, but the amount is very small, much less than 1 per cent. A uranium determination was made on a very interesting specimen from Treuer's Shaft. It is apparently ordinary copper pyrites on quartz, and on one side there is a mustard-yellow incrustation which closely resembles carnotite. A piece of the pyrites was broken off, and gave on analysis 1·91 of U_2O_5. The preliminary work on the concentration of the activity having given satisfactory results, a kilogramme of ore from Treuer's Shaft (activity ·06) was worked up, the original scheme of treatment being only slightly modified. The powdered ore, after being roasted at a dull red heat for some time, was treated with hot dilute sulphuric acid to remove the bulk of the copper and some of the iron. This sulphuric acid solution was filtered off from the insoluble residue, and most of the copper electrolyzed out of it, using a platinum anode. As the copper contents of the solution decreased, a small amount of precipitate separated out. At the conclusion of the operation this was washed by decantation, and heated with dilute nitric acid to remove some metallic copper which had fallen from the cathode. After being again washed, this was dried, ignited at a low temperature, and tested. Its activity was about 5. Meantime the residue insoluble in sulphuric acid was treated with nitric acid, and the portion remaining insoluble after this treatment was filtered off, washed, and tested. Its activity was very low, much less than that of the original ore. The solution was evaporated down, and as evaporation proceeded a light-coloured rather bulky precipitate separated out. This was filtered off from the solution before the concentration was sufficiently great for crystallization to take place on the solution being allowed to cool. The evaporation of the solution was then continued to dryness on an air-bath. The mass was re-dissolved in water and allowed to stand for some time; a small amount of precipitate settled down from this. The solution was finally evaporated down again, a few c.c. of sulphuric acid added, and the heating continued until fumes were freely given off. This treatment yielded a third lot of precipitate, but its activity was low, and the amount obtained negligible. Practically all the activity comes out with the first crop from the nitric acid solution. About ·6 gramme of sulphate was obtained in this way from the kilogramme of ore, its activity being about 9. This sulphate is practically insoluble in hot or cold hydrochloric acid, and only very slowly soluble in nitric acid or aqua regia. It goes readily into solution, however, in warm nitric acid on the addition of a little chlorate of potash. The crude sulphate was therefore dissolved in this way, and freed from a little silica that had gone into solution on treating the ore with nitric acid; the sulphate was then re-precipitated.

The washed sulphate was digested for some hours with warm ammonium acetate solution, and the greater part of it dissolved readily. The insoluble portion was thoroughly washed, dried, and tested. Its activity was determined to be about 200; ·02 gramme of this was forwarded to Professor Bragg for examination, and his measurements of the rate of decay of the induced activity from this indicated that the major part of the activity was due to radium. This purified sulphate is of low specific gravity, and is bluish-white in colour when dry. On heating over a spirit-lamp the colour changes abruptly to pink, the change taking place below a red heat. The composition of this sulphate is a matter of great interest, as it obviously does not contain a great deal of barium. The amount available for experiment, so far, has been too small to admit of much detailed work being done on it, but a few experiments of a qualitative character have been made. Neither the weight nor the activity of this sulphate is much altered on treating it with a hot concentrated solution of caustic soda, but the washed product from this treatment is soluble in hydrochloric acid, giving a bright yellow solution. Part of this colour is due to iron, as a small amount of this is precipitated on the addition of ammonia. The addition of ammonium oxalate to the acid solution also results in a small amount of precipitate coming down after long standing. However, until enough of this sulphate has been collected to allow of quantitive work being done, it is impossible to say definitely how the activity will distribute itself, though I have good reason to believe that a product considerably more active than I have isolated so far can be got without much difficulty.

In reviewing the results of this preliminary work two points call for special comment. The first of these is the invariable occurrence of carbon in the active ores. So far, every specimen showing any marked activity has been found to contain it, usually to the extent of several per cent. Enough work has not yet been done to settle the question definitely as to whether the carbon is present in the active ores only, or whether it is also distributed through the inactive material in the neighbourhood of the active deposit. The distribution of the activity in the ore is very sharply defined in some cases. A small hand specimen may show very marked activity on one side, and be almost inactive on the other. The carbon contents do not appear to bear any quantitive relation to the activity. Some of the most active specimens contain very little carbon, and, on the other hand, some of the carbonaceous ore from Taylor's Shaft is only slightly active. Mr. Rogers has suggested, in view of these results, that, if it has not been done already, it might be well to try the Mansfield copper deposits for activity, as these also contain carbon.

Burton's observation, that the petroleum from a deep well in Ontario not only contained a large amount of radium emanation, but left a solid deposit on evaporation, which possessed permanent activity, is also of interest in this connection.

The second feature to which attention may be drawn in the case of the Moonta ores is the facility with which the radium may be extracted from them, and the extent to which the activity can be concentrated without having to resort to fractional crystallization. The best specimens of ore possess an activity about one-twelfth of that of U_3O_8. The first active product which I obtain from them has an activity of about 10, or one hundred and twenty times that of the original ore. My second product has an activity of 200, over two thousand times that of the original ore. Pitchblende residues, possessing an activity of four or five, after a great deal of expensive chemical work, yield a radium barium chloride of activity 60, or only fifteen times that of the residues, and fractional methods have then to be employed for further concentration.

In considering this question of concentration of activity, the extremely small amount of radium present in the ore—roughly, one part in twenty million—must be taken into account. This amount is so minute that it is improbable that it would be precipitated at all, even from solutions containing sulphuric acid, in the absence of other insoluble sulphates. In working up the kilogramme of ore the volume of the solution from which the active sulphate was finally separated out was not less than two litres, or forty million parts of solution to one of radium.

The fact that the insoluble sulphate, which carries the radium down with it, consists principally of lead and not of barium sulphate, accounts for the readiness with which the activity can be further concentrated, as the removal of the lead sulphate, by means of ammonium acetate, appears to leave practically the whole of the activity in the small insoluble residue.

In the event of active ores being found in quantity at Moonta, this readiness with which the radium can be extracted from them would, of course, be of economic importance, as it is questionable if the usual methods of separation could be applied with any prospect of profit to such low-grade material.

In conclusion, I desire to express my indebtedness to the General Manager of the Company, Mr. H. Lipson Hancock, for his readiness to facilitate the research in every possible way, and to the Manager of the Smelting Works, Mr. G. C. McMurtry, for suggestions as to the practical treatment of the ore, and also for checking a number of measurements on active products.

Notes on South Australian Marine Mollusca, with Descriptions of New Species.—Part IV.

By Jos. C. Verco, M.D., Lond., F.R.C.S., Eng.

[Read October 2, 1906.]

Plates VIII. to X.

Family PATELLIDÆ, Carpenter.

Genus Patella, Linné.

Helcioniscus tramoserica, Martyn.

Patella tramoserica, Martyn, Univ. Conch., t. 16; Reeve, Conch. Icon., Mon. Patella, 1854, pl. xiii. f. 27; Adcock, Hand-list of Aquatic Moll., S. Aust., 1893, No. 392; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, xv. (n. s.), p. 191; *Helcioniscus tramosericus*, Martyn, Pilsbry., Tryon's Man. Conch., 1891, xiii., p. 142, pl. lxx., figs. 49, 50, 51, 52; Tate and May, Proc. Linn. Soc., N.S.W., 1901, p., 411.

Patella diemenensis, Philippi, Zeit. f. Malak, 1848, p. 162; type locality, Hobart; Pilsbry., Tryon's Man. Conch., xiii., p. 155.

Patella variegata, Reeve, Conch. Icon., 1854, Mon. Patella, pl. 16, f. 36, *a*, *b*, and *c*.

Patella antipodum, E. A. Smith, Voy. Erebus and Terror, Moll., p. 4, t. 1, f. 25, 1874, teste Pilsbry., *op. cit.*, p. 142.

Pritchard and Gatliff, *loc. cit.*, give *Helcioniscus melanostomus*, Pilsbry., Tryon's Man. Conch., xiii., 1891, p. 151, pl. xxxii., figs. 67 and 69 as a synonym.

This is a very variable shell. The large yellowish or rose-tinged shell figured by Reeve is comparatively rare in South Australia. Some are wholly salmon-coloured without any rays, others have dark chestnut rays. There is a horn-coloured variety with yellow-brown rays, and fine black lines, mostly in pairs in some of the interspaces. The black lines may be quite wide, and be in all the interspaces, and they may be interrupted or reticulate. The variety *variegata* of Reeve is more common; of a yellowish tint, rather translucent, with more or less interrupted dark purplish rays and very iridescent interior. These merge into a larger, more hemispherical form of stouter build, recalling Philippi's description of *P. diemenensis*, which seems to be our usual variety, and these into one with very broad, dark, liver-coloured rays separated by narrow bands of white.

Helcioniscus illibrata, *spec. nov.* Pl. x., figs. 6 to 14.

Shell minute, rather solid, conical; apex blunt, scarcely anterior; posterior slope scarcely convex, anterior scarcely concave; no radial sculpture; some irregular growth lines.

Base not flat, sides concave; so that the shell rests on its ends: subcircular; margin simple. Apex pinkish, ground colour faint brownish pink. From just below the pink apex radiate four broad opaque white bands, which increase to eight.

Dim.—Height, 2·6 mm.; major diam., 2·7 mm.; minor diam., 2·25 mm.

Hab.—Spencer Gulf, dredged alive, depth unknown, 7 individuals.

The radula contains about 36 consecutive segments, each consisting of two marginals, two outer laterals, and one inner lateral. 2(2·1·0·1·2)2. The marginals are thin and colourless, with a long stem (fig. 8), the extremity expanded laterally in a central direction (fig. 11), and reflected (fig. 10); the outer one the larger and including the inner (fig. 11). The outer laterals are short, stout, very closely approximated, hooked at the end, and brown (figs. 8, 11, 14). The inner laterals are less approximate, much longer (figs. 8, 11, 13), articulate at their base with the outer laterals (figs. 9, 12), but are separable from them.

Obs.—I have called it a *Helcioniscus.* The dentition does not correspond with that of any of the *Patellidæ,* which seem all to have three marginals, whereas this appears to have only two. But for this its dentition is that of *Helcioniscus,* 3(2·1·0·1·2·)3, and *Patellina;* but its branchial cordon is incomplete, and this would place it in *Helcioniscus.*

The figures are not all drawn from the same radula, but from three radulæ obtained from three individuals of apparently the same species.

Patella ustulata, Reeve.

Patella ustulata, Rve., Conch. Icon., 1855, vol. viii., pl. xxxi., f. 88, *a, b;* Ten.-Woods, P.R.S., Tasm., 1877 for 1876, p. 49; also 1878 for 1877, p. 45; Tate and May, Proc. Linn. Soc., N.S.W., 1901, vol. 26, pt. 3, p. 411; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv. (n. s.), p. 193; *P. (scutellastra) ustulata,* Rve., Pilsbry., in Tryon's Man. Conch., vol. xiii., p. 101, pl. xxii., figs. 11, 12.

Patella tasmanica, Ten.-Woods, Proc. Royal Soc., Tasm., 1876 for 1875, p. 157; also 1877 for 1876, p. 49; 1878 for 1877, p. 45; Tate and May, *op. cit.,* p. 411; Pritchard and Gatliff, *op. cit.,* p. 193.

This species is not found in Adcock's Handlist, and was only represented by a few poor specimens among our collectors until recognized by me at Port MacDonnell in January of this year, when very many somewhat beach-worn specimens were found.

Patella aculeata, Reeve.

Patella aculeata, Rve., Conch. Icon., 1855, vol. viii., pl. xxxii., f. 90; Angas, Proc. Zool. Soc., 1867, p. 221, No. 221; Ten-Woods, Proc. Roy. Soc., Tasm., 1878 for 1877, p. 45; Brazier, Proc. Linn. Soc., N.S.W., 1883, p. 221; Tate and May, Proc. Linn. Soc., N.S.W., 1901, vol. xxvi., pt. 3, p. 410; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, xv. (n. s.), pt. 2, p. 193; *P. (scutellastra) aculeata*, Rve., Pilsbry., Man. Conch., vol. xiii., p. 100, pl. 25, figs. 20, 21, pl. lxii., figs. 71 to 75.

P. squamifera, Reeve, Conch. Icon., pl. xxxii., f. 94; Angas, *loc. cit.*, No. 225; Pritchard and Gatliff, *loc. cit*, p. 193.

Found in numbers on the rocks at Port MacDonnell. As Tenison-Woods says of *P. ustulata*, Reeve, it lives "below low water" on the rocks on the ocean shore; it is commonly covered with nullipore, is very liable to erosion when old, and then is almost indistinguishable during life from *Acmæa alticostata*, Angas. It may, if uneroded and not hidden, be almost black over the ribs and interspaces, or in the interspaces only, or in broken concentric rings, or of a wholly yellowish-brown tint. Internally some are uniformly white, but for a few brown smears at the apex; others have the spatula (which is never very distinct) tinged with deep chestnut, or blotched with black, or with a bluish reflex. The interior may be horn-coloured, with an indistinct ring of white or greenish-blue between it and the spatula, or bluish with smears of brown. The margin may be light brown or dark brown or black or purple, with white sulci at the ribs. There may be bluish radii from summit to border. The ribs may be very prickly, with erect scales, or only rugose. The interstitial riblets may vary in the same shell from one to six, and in different individuals there may be only one or as many as six in each.

Patella hepatica, Pritchard and Gatliff.

Patella hepatica, Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv. (n. s.), pt. 3, p. 194.

Acmæa striata, Pilsbry., (*non* Quoy and Gaimard), Man. Conch., vol. xiii., p. 47, pl. xxxv., figs. 27, 28, 29.

Taken dead on beach at Port MacDonnell.

Obs.—The last three species resemble one another, and differ from the *P. tramoserica* series in being crenulated along the inner margin. I found all three at Port MacDonnell; *P. aculeata* alive on the rocks, *P. ustulata* and *P. hepatica* on the beach. But I found forms intermediate between them, so that it became impossible to say whether they should be placed in one species or the other. In fact, I had grouped all together as *P. ustulata*, and made two varieties—at the one extreme with marked ridges, which were prickly, and at the other with only small uniform crowded ribs. Later, these were found to be on the one hand more prickly and costate than specimens of *P. aculeata*, from New South Wales, and on the other to be identical with *P. hepatica*, from Victoria. I feel confident that a larger series will unite these three as conspecific, and they will be called *P. ustulata*, Reeve.

Patella chapmani, Ten.-Woods.

Patella chapmani, Ten.-Woods, Proc. Roy. Soc., Tasm., 1876 for 1875, p. 157; Pilsbry., in Tryon, Man. Conch., 1891, vol. xiii., p. 101; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903 vol. xv. (n. s.), p. 193; Tate and May, Proc. Linn. Soc., 1901, vol. xxvi., p. 410.

Acmœa alba, Ten.-Woods, Proc. Roy. Soc., Tasm., 1877 for 1876, pp. 155, 156; Pilsbry., 1891, *op. cit.*, p. 54, pl. xlii., figs. 76-78; Tate and May, *loc. cit.;* Pritchard and Gatliff, *loc. cit.*

Tate and May, *loc. cit.*, identify it with *P. stellaeformis*, Rve., Conch. Icon., f. 48. It is rare in S. Aust., but has been taken at Port MacDonnell (W. T. Bednall) and at Royston Head, Yorke Peninsula.

Genus Nacella, Schumacher.

Nacella parva, Angas.

Nacella parva, Angas, Proc. Zool. Soc., 1878, pl. liv., f. 12; "*Hab.*, Holdfast Bay and Aldinga Bay; parasitic on seaweed;" Adcock, Handlist of Aquatic Moll. 1893, p. 9, No. 393. It has been found as far east as Aldinga Bay, and as far west as Fowler's Bay. It appears to be of limited *habitat*, for Pritchard and Gatliff do not record it in their Victorian catalogue, nor Tate and May in their Tasmanian Census. I have not seen it from W. Australia.

Nacella compressa, *spec. nov.* Pl. viii., figs. 11, 12.

Shell narrowly elongate, elliptical; sides straight, parallel; ends round. Apex overhangs one end (which is concave vertically, and slightly narrower than the other), barely oblique slightly to the left of the midline. Dorsum convex, rising higher than the nucleus. Sides nearly vertical; base flat, margin simple. Concentric growth lines, and microscopic radial scratchings.

Dim.—Length, 5 mm.; breadth, 1·6 mm.; height, 1·25 mm.

Locality.—Investigator Strait, 15 fathoms, 6 dead.

Diagnosis.—Its shape separates it from *N. parva*, Angas, which measures 5·6 mm. by 2·8, and is therefore twice as wide for the same length. It may be only a variant of this species, cramped by residence on very narrow zostera or other growth.

Nacella crebristriata, Verco.

Trans. Roy. Soc., S. Aust., 1904, vol. xxviii., p. 144, pl. xxvi., figs. 20, 21.

The only habitat given was South Australia, but Tate's shells almost certainly came from Moonta Bay, as they were in a tube with others which I have described in this paper as *Scutellina alboradiata*, sp. nov., and which have been obtained in numbers at Moonta Bay by Mr. Zietz.

Nacella stowæ, *spec. nov.* Pl. x., figs. 4, 5.

Shell oval, thin, translucent, narrower in front, about half as wide as long, its height less than half its greatest width. Apex at the anterior sixth, simple, non-spiral. Numerous fine diverging axial striæ, with crowded minute sublenticular accremental striæ. Apex red; sixteen equidistant, pink, increasing radial rays, each composed of two to four lines; white opaque blotches, irregular in shape behind the apex, somewhat concentrically arranged; a central linear one just behind the apex. Spatula shaped as in *Patella;* fairly distinct, margined in front opaque white; behind this pinkish-brown, which extends backwards in two short diverging flames; between these a white opaque flame extends back from the apex of the shell. The rest of the spatula is mottled with wavy, opaque, white blotches.

Dim.—Length, 5·3 mm.; breadth, 3·7 mm.; height, 2·1 mm.

Locality.—Shell sand, beach, Port MacDonnell, and King's Point, Encounter Bay (Miss Stow).

Family ACMÆIDÆ.

Genus ACMÆA, Eschscholtz.

Acmæa octoradiata, Hutton.

Patella octoradiata, Hutton, Cat. Marine Moll. of New Zealand, 1873, p. 44; *Acmæa saccharina, Linné, var. perplexa*, Pilsbry., Tryon's Man. Conch., 1891, vol. xiii., p. 50, pl. xxxvi., figs. 69, 70, 71; *Acmæa perplexa, Pilsbry.*, Taylor, Nautilus, 1892, vol. vi., p. 89; *Acmæa saccharina, Linné*, Tate and May, Proc. Linn. Soc., N.S.W., 1901, vol. xxvi., pt. 3, p. 411; *Patella perplexa, Pilsbry.*, Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv., pt. 2, p. 194; *Acmæa octoradiata, Hutton*, Hedley, Proc. Linn. Soc., N.S.W., 1904, pt. 1, p. 188.

This is very rare in South Australia. It has been found on the beach at Wallaroo Bay and at Port MacDonnell.

Acmæa alticostata, Angas.

Patella alticostata, Angas, Proc. Zool. Soc., Lond., 1865, p. 56, pl. ii., f. 11; type locality, Port Lincoln; Hedley, Proc. Linn. Soc., N.S.W., 1904, pt. 1, p. 189.

From Port MacDonnell, along the whole coastline to Western Australia, and recorded from Tasmania, Victoria, and New South Wales.

Obs—Angas, in Proc. Zool. Soc., 1867, p. 221, made his name a synonym of *Patella costata (Lottia costata)*, Sowerby, Moll., Beechey's Voy., t. 39, f. 2, 1839; and as *Acmœa costata*, Sow., his shell is referred to by Ten.-Woods, Proc. Roy. Soc. Tasm., 1877, p. 50, and *op. cit.*, 1878, pp. 44 and 45; Pilsbry, in Tryon's Man. Conch., vol. xiii., p. 51, pl. xxxvi., f. 72-77; Adcock, Handlist of Aquatic Moll., S. Aust., 1893, p. 9, No. 394; Tate and May, Proc. Linn. Soc., N.S. Wales, 1901, vol. xxvi., part 3, p. 411; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv. (n.s.), part 2, p. 194. But Hedley affirms them to be different species, *loc. cit.*

It may reach the size of 2 in. long, 1·7 broad, and ·8 high. It is nearly always narrower anteriorly, sometimes markedly so; very rarely it is quite elliptical. The height may be ·7 in. in a shell only 1·1 in. long, or only ·5 in 1·6, just twice as high proportionally. The shape may be acutely conical and straight-sided or flat-topped and convex-sided. The ribs vary from 14 to 27, increasing by intercalation with age. The interstices may be prettily ornamented with close-set fuscous crescentic lines, convex towards the apex; these may climb the sides of the ribs, or cross them; they are more marked in beach-worn shells. The interior may be wholly white, including the margin; even the spatula may be scarcely tinted or distinguishable. The latter may be blackish-brown, or of any lighter tint of brown, its anterior and posterior parts being usually much darker. The margin may have no colouration, or very dark spots may mark all or some of the interspaces between the ribs. In addition to these a light-brown band may completely margin the inner border, or this may be found alone of any darker tint up to a purplish black. More or less rusty colouration may be found between the spatula and the margin, generally in blotches.

Acmæa marmorata, Ten.-Woods.

Proc. Roy. Soc., Tasm., 1876 for 1875, pp. 156, 157, and 1877 for 1876, p. 53; Pilsbry., Tryon, Man. Conch., 1891, vol. xiii., p. 52, pl. xlii., figs. 66-70; Adcock, Handlist Aquatic Moll., S. Aust., 1893, p. 9, No. 399; Tate and May, Proc. Linn. Soc., N.S.W., 1901, vol. xxvi., pt. 3, p. 412; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv. (n. s.), pt. 2, p. 197.

Patella latistrigata, Angas, Proc. Zool. Soc., Lond., 1865, p. 154, and p. 186, No. 196A; Adcock, *loc. cit.*, 1893; Pritchard and Gatliff, *loc. cit.*; *Helcioniscus latistrigata, Angas*, Pilsbry., *loc. cit.*, p. 143.

Locality.—From Port MacDonnell to Port Victoria, Spencer Gulf.

Obs.—My largest individual from Port MacDonnell measures 24 mm. long, 22·5 wide, and 10 high. The altitude varies very greatly from 3·5 mm. in a shell 17 mm. long to 8·5 mm. in one 18 mm. long. When on the rocks they may be so rough and acutely costate as to be mistaken for *A. alticostata*, Angas. Usually with a flat base, it may rest on its ends, with the sides of the border much raised. As variations from the description by Ten.-Woods, the spatula may be white, with some brown clouding in its centre, the interior of the shell being a light brown, or the spatula may be black and the rest of the interior white except for black articulations of the border. The most constant feature in the ornament is the dark dotting of the spatula, but in the pallid examples this is very slight.

Adcock makes *P. gealei*, Angas, a synonym, and Pritchard and Gatliff give it priority, and *A. marmorata* as a synonym: but Angas's shell is a distinct species. *P. latistrigata*, Angas, from Aldinga, is a half-grown example, with broad radial stripes.

Acmæa calamus, Crosse and Fischer.

Patella calamus, Crs. and F., Journ. de Conch., 1864, p. 348; 1865, p. 42, pl. iii., figs. 7, 8; Tate and May, Proc. Linn. Soc., N.S.W., 1901, vol. xxvi., pt. 3, p. 412; *Acmæa calamus, Crs. and F.*, Angas, Proc. Zool. Soc., Lond., 1865, p. 186, No. 200; Pilsbry., Tryon, Man. Conch., 1891. vol. xiii., p. 54, pl. xxxvii., figs. 3, 4; Adcock, Handlist Aquatic Moll., S. Aust., 1893, p. 9, No. 395; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv. (n. s.), pt. 2, p. 197.

Locality of type, St. Vincent Gulf, South Australia. I have taken it at Port MacDonnell, and dredged it from Backstairs Passage to Spencer Gulf, alive, at all depths from 5 to 17 fathoms. Most abundant in the shallower water.

Tate in Trans. Roy. Soc., S. Aust., May, 1897, thought it would prove to be a synonym of *Acmæa conoidea*, Quoy and Gaimard, and this suspicion seems to have been confirmed, as he lists it thus in his Tasmanian Census in 1901. He speaks of *A. conoidea*, in 1897, as though he had seen Quoy's type, and as having a circular aperture and five radial threads. But Quoy seems to have only had one shell collected at King George's Sound. This Deshayes had not seen (Anim. S. Vert., 2nd edit., vol. vii., p. 551), and Quoy does not describe it as having any radial threads, but as being "obtuse and rounded at the apex": this *A. calamus* never is, either alive or dead or rolled.

The dimensions given by Crosse are 12·5 mm. by 10 by 6, but they reach 16·5 by 14 by 7·5. The shell may be wholly white within and without, or the apical part may be white and the rest ornamented, either with tiny brown spots, more or less abundantly and irregularly scattered over the surface, or only as regular dots around the inner margin, or as short radial brown lines at the internal periphery, or as a continuous brown border. Some are uniformly chestnut brown. One form has abundant colour-marking, which may begin at the apex as six to eight rays, tending to break up into tessellations as they widen. This variety is often slightly polygonal instead of round, the angles being in the white rays; but it grades into the ordinary form.

Acmæa flammea, Quoy and Gaimard.

Patelloida flammea, Quoy and Gaimard, Voy. Astrolabe, Zool., vol. iii., 1834, p. 354, pl. lxxi., figs. 15 to 24; Lamarck, Anim. s. Vert. (2nd edition, Deshayes, etc.), vol. vii., p. 552, 1836; Tate and May, Proc. Linn. Soc., N.S.W., 1901, vol. xxvi., pt. 3, p. 411; Ten.-Woods, Proc. Roy. Soc., Tasm., 1877 for 1876, p. 51.

Acmæa flammea, Quoy and G., Pilsbry., Tryon, Man. Conch., 1891, vol. xiii., p. 57, pl. xxxvii., figs. 78-83; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv. (n. s.), pt. 2, p. 196.

Acmæa crucis, Ten.-Woods, Proc. Roy. Soc., Tasm., 1877 for 1876, p. 52; and 1878 for 1877, p. 53; Pilsbry., *op. cit.*, p. 58, pl. xxxvii., figs. 12, 13, and 17, 19; Adcock, Handlist Aquatic Moll., S. Aust., 1893, p. 9, No. 400; Tate and May, *loc. cit.*, p. 411; Pritchard and Gatliff, *loc. cit.*, p. 196.

Patella jacksoniensis, Reeve, Conch. Icon., vol. viii., 1855, pl. xxxix., figs. 127, *a*, and *b*; Tate and May, *loc. cit.*, p. 412; Pritchard and Gatliff, *loc. cit.*, p. 196; *Tectura jacksoniensis, Reeve*, Pilsbry., *loc. cit.*, p. 58, pl. xlii., figs. 71-75, and *var mixta, Reeve, loc. cit.* pl. xxxv., figs. 32, 33.

Patella gealei, Angas, Proc. Zool. Soc., Lond., 1865, p. 57 and p. 186, No. 198; not Adcock, *loc. cit.*, p. 9, No. 399; *Acmæa gealei*. *Angas*, Tate and May, *loc. cit.*, p. 412; not Pritchard and Gatliff, *loc. cit.*, p. 197.

Patella mixta, Reeve, Conch. Icon., 1855, vol. viii., pl. xxxix., figs. 129, *a* and *b*; Pritchard and Gatliff, *loc. cit.*, p. 196.

The type locality of *A. flammea*, Q. and G., is Hobart-town, and the type dimensions are small, 5 lines by 4 by 2½ high.

The type locality of *A. crucis*, Ten.-Woods, is Tasmania, and its dimensions are 31 mm. by 31 by 19 high. Ten.-Woods described this as a distinct species, but Tate and May and Pritchard and Gatliff unite them.

Ten.-Woods refers to *Patella cruciata*, Linné, as distinct from his *A. crucis*, because the former has "a white cross on a brown ground," instead of a brown cross on a white ground, and Pritchard and Gatliff agree. But Tate and May unite them, and make *A. cruciata*, Lin., the specific name, and the other two synonyms. I keep them distinct. Ten.-Woods also leaned to the identity of *A. flammea*, Quoy and Gaimard, and *A. subundulata*, Angas, and Pritchard and Gatliff unite them. Shells collected by me and identified by Angas's type in the British Museum have not been yet graded into Quoy's species, and are regarded as distinct.

A. jacksoniensis, Reeve (type locality, Port Jackson), is represented in Tate's collection of South Australian shells, but I am unable to separate them from *A. flammea*, Quoy and Gaimard, and agree with Pritchard and Gatliff, who unite them. The type locality of *P. mixta*, Reeve, is Port Phillip, Victoria. Tate and May make *jacksoniensis*, Reeve, a synonym of *A. gealei*, Angas, as a distinct species, owing to the pre-occupation of Reeve's name by Lesson. The two type shells of *P. gealei*, in the British Museum, from South Australia, presented by Mr. G. F. Angas, are 24 mm. by 21, regularly roundly oval in the base, with an almost perfectly regular thin margin, with no radial ribbing, nor any radiating dark colour bands. I think they are large albino variants of *A. crucis*, Ten.-Woods.

A. gealei, Angas, was formerly regarded in South Australia as a synonym of *A. marmorata*, Ten.-Woods, No. 399, Adcock's Handlist; and Pritchard and Gatliff gave it priority and made the latter the synonym; but examination of the type shows absolute non-identity.

The shell is certainly very variable. One form has numerous well-marked radial riblets, and a sharp apex, and may be regarded as the typical *A. flammea*, Quoy. A second has no radial riblets, or only obsolete, is a larger shell, and is the typical *A. crucis*, Ten.-Woods. A third has comparatively few radial costæ, which are broad and rude, and somewhat corrugate the surface, and is the *Patella jacksoniensis*, Reeve. A fourth is very like the second, but differs in having no radial colour markings, or radial ribs, and is the *A. gealei*, Angas. But all four can be graded into one another in continuous series. The comparative height varies, some shells being quite conical, and others very flat. The colour ornament may consist solely of the dark spatula, or a distinct broad Maltese cross may be present, or each arm may be broken up into two or more brown lines, or brown lines may intervene between them, or only brown radii may occur, or the ornament may be a brown-and-white tessellation or reticulation at the apex only, or all over the shell, or combined with the cross. The inner border may be wholly white, or have a brown border, or be articulated brown and white, or show only the four broad ends of the brown cross. Among all the specimens collected I have not found one coloured like *A. cruciata*, Linn., with the white rays at the centre of the front and back and sides, and the brown between.

Acmæa conoidea, Quoy and Gaimard.

Patelloida conoidea, Q. and G., Voy. Astrolabe, Zool., vol. iii., 1834, p. 355, pl. lxxi., figs. 5 to 7; Lamarck, Anim. s. Vert. (2nd edition, Deshayes, etc.), vol. vii., p. 551.

Acmæa conoidea, Q. and G., Angas, Proc. Zool Soc., Lond., 1865, p. 186, No. 199; Pilsbry., Tryon, Man. Conch., vol. xiii., 1891, p. 53, pl. xxxvii., figs. 84, 85; Adcock, Handlist Aquatic Moll., S. Aust., 1893, p. 9, No. 396; Tate and May, Proc. Linn. Soc., N.S.W., 1901, vol. xxvi., pt. 3, p. 412; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv. (n. s.), pt. 2, p. 195.

Type locality, King George's Sound, Western Australia, taken alive, only one example.

Tate regarded it as conspecific with *A. calamus*, Crosse and Fischer, and made this a synonym, but this is a mistake.

Port MacDonnell, on rocks above low water.

Acmæa subundulata, Angas.

Proc. Zool. Soc., Lond., 1865, p. 155, and p. 186, No. 202; Ten.-Woods, Proc. Roy. Soc., Tasm., 1877 for 1876, p. 52; Adcock, Handlist Aquatic Moll., S. Aust., 1893, p. 9, No. 398; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv. (n. s.), pt. 2, p. 196.

Tectura subundulata, Angas, P.Z.S., 1867, p. 220, No. 218.

Angas's type locality was Port Lincoln. I have dredged several alive at seven fathoms in St. Vincent Gulf; in Hardwicke Bay, three miles off shore; and in Eastern Cove, Kangaroo Island, and collected it on the ocean beach, Kangaroo Island, and at Normanville. These have been identified from Angas's types in the British Museum by me.

Ten.-Woods, *loc. cit.*, was doubtful if it would not be found identical with *A. flammea*, Quoy, and Pritchard and Gatliff, *loc. cit.*, record it as a synonym of Quoy's species; but, after comparison with a large number and various forms of this variable shell, I cannot recognize it as conspecific.

(?) Acmæa punctata, Quoy and Gaimard.

Patelloida punctata, Q. and G., Voy. Astrolabe, Zool., vol. iii., p. 365, pl. lxxi., figs. 40, 42.

The type locality is King George's Sound, Western Australia. I have two shells dredged, of almost the same size, 6 mm. by 4 by 2·25, with the apex carried well forward, and slightly antecurved, exceedingly finely closely radially striated under the lens, the base level, inner margin smooth. White or yellowish externally, with two circles of light-brown spots, about 9 in a circle. Internally white; one shows the spatula distinctly in light brown. Quoy describes his shell as *smooth*, and figures it with *three* rows of spots.

It differs from a young *A. calamus*, Crosse and Fischer, in being less round, with its apex more excentric and antecurved, and in having much finer and more crowded striæ. It differs from *A. subundulata*, Angas, in being less elevated, less orbicular, with a sharper and more antecurved apex, and in its colour.

Acmæa septiformis, Quoy and Gaimard.

Patelloida septiformis, Quoy and Gaimard, Voy. Astrolabe, Zool., 1834, vol. iii., p. 362, pl. lxxi., figs. 43, 44; Lamarck, Anim. s. Vert. (2nd edition, Deshayes, etc.), 1836, vol. vii., p. 550; *Tectura septiformis, Q. and G.*, Angas, Proc. Zool. Soc., Lond., 1867, p. 220, No. 219; *Acmæa septiformis, Q. and G.*, Ten.-Woods, Proc. Roy. Soc., Tasm., 1877, p. 50; Pilsbry., Tryon, Man. Conch., vol. xiii., 1891, p. 55, pl. xxxvii., figs. 93, 94; Adcock, Handlist Aquatic Moll. S. Aust., 1893, p. 9, No. 397; Tate and May, Proc. Linn. Soc., N.S.W., 1901, vol. xxvi., p. 412; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv. (n. s.), pt. 2, p. 195.

A. scabrilirata, Angas, Proc. Zool. Soc., 1865, p. 154, and p. 186, No. 201; Pilsbry., Tryon, Man. Conch., 1891, vol. xiii. p. 56; Pritchard and Gatliff, *lot. cit.*

A. petterdi, Ten.-Woods, Proc. Roy. Soc., Tasm., 1877, p. 155; Pilsbry., *op. cit.*, p. 54; Tate and May, *loc. cit.;* Pritchard and Gatliff, *loc. cit.*

Obs.—Tate and May say *A. petterdi* is the senile form.

The shell varies in altitude from 18 mm. long, and 4·5 mm. high, to 14 mm. long and 6 mm. high. Some have a cap occupying up to one-third or one-fourth of their size, with comparatively steep sides, with an abrupt assumption of the ordinary depressed shape, looking like one *acmæa* mounted on another. The base is in some uneven, resting on the front and back edges possibly because their roost was not flat. The radial liræ may be marked from apex to base, and numerous, or very few, or absent, even when not rolled or eroded. The surface may be uniformly horn-coloured, or white, with radial black-brown widening bands, or with reticulated or roundish tessellated markings. The inner margin may be articulated brown and white, or have a uniform brown margin or be wholly white. The interior may be whitish, opaque glistening white, bluish-white, or with the outer colour showing through. The spatula may be dark chestnut-brown and very distinct, or almost invisible.

The surface is generally in very good condition, but some are markedly pitted with round shallow holes, especially about the summit, evidently due to boring by molluscs, and not to erosion.

Locality.—From Port MacDonnell to Fowler's Bay; rather common.

Acmæa cantharus, Reeve.

Patella cantharus, Reeve, Conch. Icon., vol. viii., 1855, pl. xl., f. 131; Pritchard and Gatliff, Proc. Roy. Soc., Vict., 1903, vol. xv. (n. s.), pt. 2, p. 195; *Acmæa cantharus*, *Reeve*, Pilsbry., Tryon, Man. Conch., 1891, vol. xiii., p. 55, pl. xxxvii., figs. 1, 2; Tate and May, Proc. Linn. Soc., N.S.W., 1901, vol. xxvi., p. 412.

The type locality is New Zealand. Tate and May list it as a distinct species. Pritchard and Gatliff cite it as a synonym of *A. septiformis*, Quoy and Gaimard. A shell from Port MacDonnell, collected in numbers, is probably Reeve's shell. *A. septiformis*, Quoy and Gaimard, is also abundant there. The two forms may run into each other, but the intermediate grades have not been taken. It is larger, much less depressed, narrower anteriorly, with the apex much nearer the front margin. It is very greatly and roughly eroded, and does not show any radial striæ on the uneroded part. The colouration consists of radial brown or back stripes, varying in number and width. Internally they are very dark, a blotchy brown or a uniform blackish brown, lighter or whitish at the summit. The margin is articulated brown and white. The muscle scar is very plain as a white horseshoe, and here the shell is translucent, especially at the anterior part. Possibly they may be senile examples of *A. septiformis*, though their marked erosion contrasts strongly with the usually well-preserved surface of these.

Family FISSURELLIDÆ.

Genus Emarginula, Lamarck.

Emarginula superba, Hedley.

Records of the Aust. Mus., 1906, vol. vi., pt. 3, p. 216, pl. xxxvii., figs. 7, 8; type locality, 250 fathoms, east of Port Jackson.

My specimens have been identified by Mr. Hedley from his type. His shell was bleachd, so to his description the following may be added:—Colour light pinkish-brown, deepest over the expanded posterior surface, gradually fading anteriorly towards the slit. It is deeper in concentric rings, which leave blotches on the bounding lamina of the slit fasciole; nine are counted in the lower two-thirds. Alternate primary ribs are white from apex to margin, and are separated by one primary and two secondary ribs, which are coloured. The anterior four of these white rays on each side of the slit are separated only by the one rib, the secondaries being absent. The colouring of the shell confirms the propriety of the name "*superba*."

Individuals vary. Mr. Hedley's figure is almost uniformly elliptical. Some South Australian examples are much expanded posteriorly, being broadest on a level with the apex, and thence are attenuated anteriorly. These are also much flatter towards the margin posteriorly than the type. Others are elliptical, but less flat posteriorly than the type, and rather more compressed laterally, and have more crowded and erect imbricating concentric scales.

Locality.—90 fathoms, off Cape Jaffa, 10; 130 fathoms, 17; 300 fathoms, 1; 100 fathoms, off Beachport, 6; 110 fathoms, 3; 150 fathoms, 3; 200 fathoms, 1. Some were quite recent, many were broken, all were dead.

Family SCUTELLINIDÆ, Dall.

Genus SCUTELLINA, Gray.

Scutellina calva, *spec. nov.* Pl. viii., figs. 9, 10.

Shell minute, thin, conical, white; apex nearly central, directed away from the opening of the muscle scar; anterior slope uniformly convex; posterior concave, just below the apex, then barely convexly sloping to the margin. Summit smooth, but for some accremental lines, then with crowded, well-marked axial striæ, distinctly granulated with concentric striæ. Base oval, margin level and simple.

Dim.—Height, 2 mm.; major diam., 2·8 mm.; minor diam., 1·8 mm.

Locality.—300 fathoms, off Cape Jaffa, 31 examples, dead; 130 fathoms, 9 dead.

Diagnosis from *Helcioniscus illibrata*, Verco.—It is less solid, has a curved apex, flat base, axial liræ, no colour markings.

Obs.—I have called this little shell provisionally a *Scutellina*, because its apex is directed away from the opening of the muscle-scar; though its summit is nearly central. Its specific name indicates its bald apex.

Scutellina alboradiata, *spec. nov.* Pl. viii., figs. 1, 2.

Shell minute, thin, depressed conic. Apex simple, subcentral, slightly anterior, directed slightly away from the opening of the muscle-scar. Base level, oval, somewhat narrowed anteriorly. About eighteen very low, rounded, scarcely perceptible ribs or radial undulations, and microscopic accremental striæ. Internal surface radially scratched. The ribs are ornamented with opaque white radii, rather wider than the diaphanous interspaces.

Dim.—Height, 2·2 mm.; maj. diam., 3·3 mm.; min. diam., 2·4 mm.

Locality.—Moonta Bay, Spencer Gulf; collected in numbers in shell sand by Mr. A. Zietz. Several individuals were in Tate's collection, labelled "*Scutellina*, sp., S.A.," in the same tube as shells which I lately described as *Nacella crebristriata.* So probably the locality of *N. crebristriata* is also Moonta Bay.

Diagnosis.—From *Nacella crebristriata*, Verco; it is less solid, more rounded, has its apex less excentric, and fewer and less valid ribs. From *Scutellina calva*, it is narrowed anteriorly, has no crowded axial liræ, is white-ribbed. From *Cocculina tasmanica*, Tate and May, its apex is more central and leans backwards.

Obs.—In some examples the opaque radii are much narrower, or a wide and a narrow one may alternate. The opaque lines are not continuous, but composed of arrow-heads, with their points towards the margin, or of zig-zags, or dots.

Its generic location is somewhat dubious.

Family TROCHIDÆ.

Genus Basilissa, Watson.

Basilissa radialis, Tate; var. **bilix,** Hedley, sp.

Pl. x., figs. 1, 2, 3.

Seguenzia radialis, Tate, Trans. Roy. Soc., S.A., xiii.; 1890, p. 192, pl. ix., f. 6.

Astele bilix, Hedley, Records Austr. Mus., vi., pt. 2, 1905, p. 48, f. 13.

Shell depressedly conical, of seven and a quarter whorls, including a homostrophe smooth protoconch of one and a quarter whorls.

Spire somewhat gradate. In the first whorl one marked spiral rib; in the rest two becoming gradually more valid and distant. In the third whorl a secondary threadlet between these; in the fourth a threadlet between the first spiral and the upper suture; in the fifth two tertiaries, one between each spiral and the secondary threadlet. In the sixth, or body-whorl, another spiral rib appears below and nearly equal to the lower of the two spirals; it forms the periphery and the suture, and, separated from its fellow by a furrow, gives an apparent canaliculate suture. The base is flatly rounded with eight equi-distant, nearly equal, concentric rounded spiral liræ, as wide as their interspaces. The surface is cancellated by crowded narrow erect lamellæ, crossing the spirals and sinuous, but not following exactly the outline of the labrum, and ending at the outer basal lira. Crowded radial striæ cancellate and granulate the base, and extend to the lira nearest the umbilicus. Aperture obliquely quadrate, with a large posterior sinus in the outer lip, rather deeper than wide; a second at the baso-labral junction, beginning at the third spiral rib, about as deep as the infra-sutural one, and rather wider: and a third shallow and wide at the baso-columellar angle. Columella oblique, concave, expanded towards the umbilicus, truncate anteriorly. Inner lip thin from columella to posterior sinus, smooth. Interior of aperture smooth. Umbilicus deep, small, margined with oblique plicate tubercles.

Dim.—Alt., 3·6 mm.; diam., 3·4 mm.

Locality.—Shell figured and described (in Dr. Verco's collection), with four others, dredged, dead, 130 fathoms, off Cape Jaffa; 300, off Cape Jaffa, seven, immature and broken, and six large and complete, one quite recent.

Obs.—This shell was figured for description as a new species, but Mr. Hedley recognized it as his *Astele bilix*, which was an immature shell, and did not plainly reveal the apertural sinuses. He suggested its location in Watson's genus *Basilissa*, as emended by Dall, in Bull. Mus. of Comp. Zool., 1889, pp. 383-385. With this it corresponds closely. One individual shows very well the nacreous central claw-like process in the labrum, somewhat inflected, to which Dall refers. It very probably belongs to the section *Ancistrobasis*, Dall, though none of my shells show the internal thickening and grooving of the outer lip; but Dall points out that this character only occurs in adult shells.

Seguenzia radialis, Tate, an Eocene fossil from Muddy Creek, the type of which is in the Tate Museum of the University of Adelaide, has the two spirals which form the canaliculate suture closer together than our recent form: it has a prominent spiral threadlet above the second spiral rib and the first spiral rib is absent; so the fossil is less gradate, and the whorls are more sloping, and have more nearly uniform spirals. The base is flatter, the perforation and its bordering tubercles are larger. Dall, however, in discussing *B. costulata*, Watson, and var. *depressa*, Dall, notes the great variability of abyssal shells in general, and of that species in particular. The same consideration probably holds good in our shell, which has therefore been made only a variety of Tate's fossil species.

One individual with a perfect aperture shows the labrum to be very irregular, owing to the projection at the border, of every spiral rib and threadlet, into a minute marginal tooth, proportional to its size as a spiral, except those which end in the depth of the two labral sinuses.

Genus Scala, Klein.

Scala nepeanensis, Gatliff.

Proc. Roy. Soc., Vict., 1906, vol. xix. (n. s.). Pt. 1, p. 1. Pl. 1, fig. 5. "Shell sand, Ocean Beach, Point Nepean."

One example has been found in dredge-siftings, depth and locality not noted, probably St. Vincent Gulf.

Family TRICHOTROPIDÆ.

Genus Lippistes, Montfort.

Lippistes separatista, Dillwyn, sp. Pl. ix., figs. 6 to 9.

Turbo helicoides, Gmelin, Syst. Nat., p. 3598, No. 109; *Turbo separatista,* Dillwyn, Conch. Cab., vol. x., p. 298, pl. clxv., figs. 1589, 1590; Cat. Recent Shells, ii., p. 867, 1817; Wood, Ind. Test., p. 151, pl. xxxii., f. 126, 1825; *Separatista chemnitzii,* A. Adams, Proc. Zool. Soc., Lond., 1850, p. 45; Tryon, Man. Conch., ix., p. 45, pl. viii., f. 70; Rep. Challenger, Zool., xv., p. 428; *Trichotropis tricarinata,* Brazier, Proc. Linn. Soc., N.S.W., 1877, i., p. 313; *Separatista separatista, Dillwyn,* Hedley, Records Aust. Mus., iv., No. 3. 1901, p. 126, pl. xvii., f. 22; *Lippistes separatista, Dillwyn,* Hedley, Proc. Linn. Soc., N.S.W., 1902, p. 24; *Trichotropis blainvilleanus,* Petit, Journ. de Conch., ii., 1851, p. 22, pl. i., f. 5; Tryon, Man. Conch., 1887, ix., p. 45, pl. viii., f. 69; *Trichotropis gabrieli,* Pritchard and Gatliff, Proc. Roy. Soc. Vict., 1889, p. 183, pl. xx., f. 7; *ibid,* 1900, vol. xiii., p. 142.

Some years ago five shells were dredged by me, all dead, one in 13½ fathoms in Investigator Straits, off Point Marsden, Kangaroo Island; two in 16-18 fathoms, Backstairs Passage, and two in deep water, exact station unrecorded.

This form was named and described by me in manuscript as a new species chiefly because its whorls were curiously polygonal, with a tubercle on the carinæ at each angle. See pl. ix., fig. 6. But in 1899 I had the opportunity at the Natural History collection of the British Museum in London, of comparing it with various species of the *Trichotropidœ,* and Mr. E. A. Smith kindly assisted me.

Lippistes helicoides, Gmelin, from the Philippine Islands, with four shells on the tablet, were identical. On the back of the tablet carrying them was the following:—"*Turbo helicoides,* Gmelin," which meant that Mr. E. A. Smith had compared these four shells with Gmelin's description and found them to correspond. Gmelin's types are unknown; possibly he described only from a figure found elsewhere. Also, "*Separatista chemnitzii,* A. Ads., P.Z.S., 1850, p. 45, types, I. Bureas, Phil., H. Cuming." This means that these shells were in Cuming's collection, were obtained from Bureas Island, in the Philippine Islands, and are the types of *S. chemnitzii,* A. Ads. Also, "Mekran coast in Coll. Melvill," signifying that shells in Melvill's collection from the Mekran coast had been compared by E. A. Smith, and found to be identical. Mine were demonstrably conspecific, and Adams's shells were found to possess the same polygonal form, with the tendency to tuberculation at the angles. There is no question about the identity of our shell with Adams's species, and as this has been made a synonym of Dillwyn's species, Dillwyn's name should be accepted by us.

Watson, in the "Challenger" Reports, xv., p. 429, agrees with Beck in the identity of *S. chemnitzii*, A. Adams, and *T. blainvilleanus*, Petit. Mr. Gatliff acknowledges the identity of his species with Petit's. He has kindly allowed me to compare his type with my South Australian examples, and see their identity.

Mr. Gatliff also provided me with a living individual dredged in five fathoms, off the shores of Victoria. It is covered with an epidermis, extremely thin on the smallest whorls (possibly worn away), but well marked on the later. It is simple on the tabulated slope, on the base and in the umbilicus only varied by minute axial lines. On the three carinæ it is elevated into low spiral laminæ, which are connected by more marked axial laminæ. At intervals these are large, and projected forwards to form imbricating flounces, while between them may be 3 to 7 of the smaller ones. These flounces correspond with the tubercles at the angles of the polygonal whorls. They are figured in pl. ix., fig. 7, but very imperfectly, owing to its drying up.

From his living example I was able to extract the radula. This is very similar to that of *Trichotropis borealis*, Broderip, as figured in Fischer's Manuel de Conch., 1887, p. 689. It has a rachidian tooth with a multicuspidate margin, rather more finely serrated, a large transversely quadrangular lateral with a multicuspidate border and two simple arcuate sharp marginals. (Pl. ix., fig. 9.)

The operculum is horny, subtrigonal, with an apical nucleus (pl. ix., fig. 8), and fairly closely resembles that of *T. borealis*, Brod. The affinity of our southern subtropical form with that of the arctic form is thus demonstrated.

Lippistes meridionalis, *spec. nov.* Pl. ix., figs. 1, 2.

Shell turbinate solid, whorls five, rapidly increasing. Protoconch, one and a half whorls, convex, smooth, but for four equal and equi-distant liræ. It ends abruptly with a distinct border, not thickened or reflected. The spire whorl begins with a not quite smooth area, from which the granular spiral liræ gradually arise. Spire whorls are tricarinate. In the first the central carina is more prominent, in the second it is level with the others, in the third it is less prominent. Sloping scarcely convex from upper suture to posterior carina, vertical from this to lower suture. On the slope are four equidistant spiral liræ, one-third or one-fourth the width of their interspaces, increasing in size with the whorls. Base somewhat concave. A peripheral carina, less marked than those on the spire, forms the suture. Below it are four broad spiral bands, wider than their interspaces, and microscopically spirally incurved. Crowded axial lirellæ, about as wide as their interspaces cross the carinæ: every sixth or seventh one is strong; the next two or three are finer, and those following gradually increase. At the intersections are minute tubercles, which at intervals are comparatively large. The basal axials are less unequal. Aperture quadrangularly hemispherical, produced at the baso-columellar junction. Outer lip corrugated by the carinæ. Columella concave, with a tooth-like prominence below. Inner lip valid, applied to the base on its upper half. Perforation well marked, somewhat rimate.

Dim.—Alt., 3·6 mm.; diam., 2·9 mm.; aperture, 2·1 mm. by 1·6 mm.

Locality.—Type, 40 fathoms, off Beachport, dead, with two co-types; 110 fathoms, 2 dead.

Diagnosis.—From *Lippistes separatista*, Dillwyn. It is much smaller, and more solid, the protoconch is much smaller: the whorls increase less rapidly, have three liræ on the spire and four on the body-whorl, are lirated on the infra-sutural slope instead of smooth, have no polygonal shape, the base is lirated instead of smooth, axial lirellæ tuberculate the carinæ and continue to the columella, and the umbilicus is rimate.

Genus SEGUENZIA, Jeffreys.

Seguenzia polita, Verco, *spec. nov.* Pl. ix., figs. 3, 4, 5.

Shell white, smooth, glistening, turbinate, of six whorls. Protoconch one and a quarter whorls, homostrophe, smooth, round. Spire gradate, flatly concave, from simple suture (with a linear furrow) to central angulation, which is scarcely keeled; then sloping barely concave to the lower suture, first two whorls with fine numerous radial striæ from suture to angle, becoming gradually obsolete as microscopic accremental lines on the later whorls. Body-whorl with a central carina, which forms the suture; a second somewhat smaller some distance anterior, somewhat concave between; a third smaller and less distant; then six concentric liræ to the perforation, which is small and rimate. Aperture subquadrate; outer lip with a deep, narrow sinus at the suture, and a deep, wide notch at the junction of the basal and outer lip, a somewhat shallower one between them, and a smaller notch at the junction of the basal lip and the columella, which is truncated so as to form a blunt tooth.

The spiral angulation ends at the deepest part of the posterior sinus; the peripheral carina in the deepest part of the central sinus; the second carina forms the posterior boundary of the baso-lateral notch, whose deepest part lies between the third carina and the first basal lira. The columella is concave, smooth, thick, polished, and expanded, so as nearly to cover the perforation. The inner lip, applied to the base, extends from the columella to the suture, and is smooth.

Dim.—Height, 3·5 mm.; greatest diameter, 2·4 mm.

Locality.—300 fathoms, off Cape Jaffa, 10 dead.

Diagnosis.—It approaches *S. elegans*, Jeffreys, Proc. Zool. Soc., 1876, p. 200; Tryon, Man. Conch., vol. ix., p. 47, pl. viii., fig. 75; but is distinct in having the sutural sinus with a much smaller lamina between it and the suture, the sloping part of the spire-whorls longer, a different relation of the angulation and carinæ to sinus, and a less production of the baso-labral angle. It is also very similar to *Seguenzia monocingulata*, Seguenza, as figured by Dall, in Bulletin 37, 1889, of the United States Nat. Hist. Mus., p. 142, pl. lxii., figs. 88-89; but the sinuses in the aperture are different. They differ greatly, however, in the two figures given, so this species may prove eventually only a variety.

Genus Siphonaria, Sowerby.

Siphonaria stowæ, *spec. nov.* Pl. viii., figs. 3 to 8.

Shell small, moderately solid, oval, depressed. Apex subterminal one-eighth distant from posterior end, slightly to the left of the mid-line, oblique, inclining backwards from the central line, pointed and slightly projecting posteriorly. Posterior end nearly vertical, slightly concave. Dorsum subconvex, more rapidly descending anteriorly. Left margin straightly convex; right more rounded, faintly bulged at the site of the siphon, just in front of the middle point. Numerous subdistant rather rude ribs, equal in width to the interspaces, multiplying by frequent intercalations; rough, irregular growth lines. Interior smooth, margin invalidly crenulated. Ornament, ribs opaque white; dark brown specks, lines, and blotches, chiefly intercostal, plainer on the right side; internally light horn tint, a chestnut horseshoe around the posterior third, and broken blotches on each side of the siphon.

Dim.—Length, 7·5 mm.; breadth, 5·9 mm.; height, 3·25 mm. The radula contains about 94 rows of teeth, each consisting of a central denticle, with about 22 laterals on either side. The rachidian is narrow, with a small cusp tending to be bilobed. The laterals have large simple cusps, and these as well as the teeth grow gradually smaller the further they are from the centre. (Figs. 6, 7, 8.)

Hab.—Pondolowie Bay, in Spencer Gulf, on rocks above tide mark; 9 examples, alive. Fry in shell sand, King's Point, Encounter Bay (Miss Stow).

Obs.—The fry reveal a spiral nucleus of two full turns, dextral, smooth, and horn-coloured. In some, especially the smaller, the ribs are more distinct and the sculpture less rugged. Some have much more brown colouring, either in the intercostal spaces or in the internal horseshoe or both. One has the enlarged extremities of the horseshoe muscle-scar plainly painted. We have no other *Siphonaria* with its apex so near the posterior end. The largest example is 9·4 mm. by 6·5. I have named the species after Miss Stow, who collected the immature examples.

EXPLANATION OF PLATES.

Plate VIII.

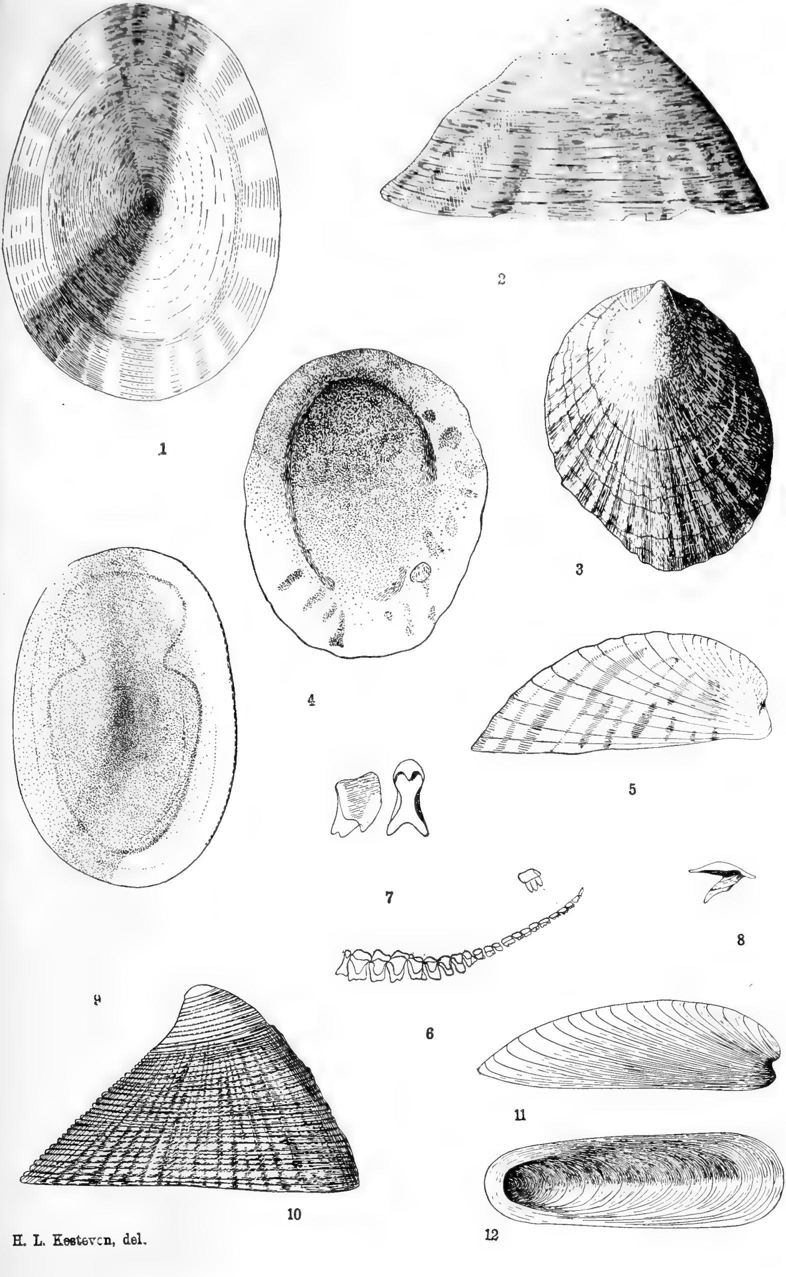
Fig. 1. *Scutellina alboradiata*, Verco.—Ventral view.
,, 2. ,, ,, ,, Side view.
,, 3. *Siphonaria stowæ*, Verco.—Dorsal view.
,, 4. ,, ,, ,, Ventral view.
,, 5. ,, ,, ,, Side view.
,, 6 ,, ,, ,, Radula.
,, 7. ,, ,, ,, Radula, rachidian, and first lateral from the other half.
,, 8. ,, ,, ,, Fifth lateral, side view.
,, 9. *Scutellina calva*, Verco.—Ventral view!
,, 10. ,, ,, ,, Side view!
,, 11. *Nacella compressa*, Verco.—Side view.
,, 12. ,, ,, ,, Ventral view.

Plate IX.

Fig. 1. *Lippistes meridionalis*, Verco.
,, 2. ,, ,, ,, Protoconch.
,, 3. *Seguenzia polita*, Verco.
,, 4. ,, ,, ,, Lip in profile
,, 5. ,, ,, ,, Basal view.
,, 6. *Lippistes separatista*, Dillwyn.—Spire, full view.
,, 7. ,, ,, ,, With epidermis.
,, 8. ,, ,, ,, Operculum.
,, 9. ,, ,, ,, Radula.

Plate X.

Fig. 1. *Basilissa radialis*, Tate, var. *bilix*, Hedley.
,, 2. ,, ,, ,, ,, Base.
,, 3. ,, ,, ,, ,, Outer lip.
,, 4. *Nacella stowæ*, Verco.—Ventral view.
,, 5. ,, ,, ,, Side view.
,, 6. *Helcioniscus illibrata*, Verco.—Side view.
,, 7. ,, ,, ,, Ventral view.
,, 8. ,, ,, ,, Radula, front view.
,, 9. ,, ,, ,, Laterals, side view.
,, 10. ,, ,, ,, Marginal, side view.
,, 11. ,, ,, ,, A second radula, front view.
,, 12. ,, ,, ,, Laterals, side view.
,, 13. ,, ,, ,, A third radula, front view.
,, 14. ,, ,, ,, A lateral, side view.



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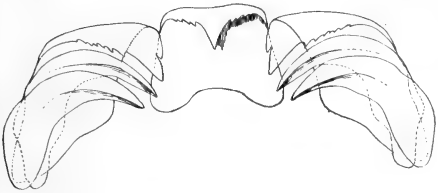

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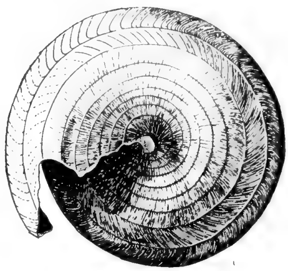

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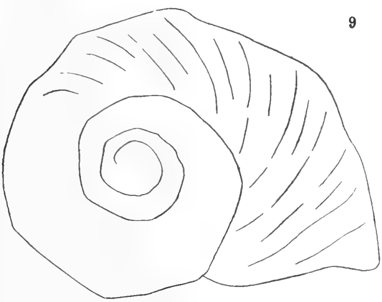

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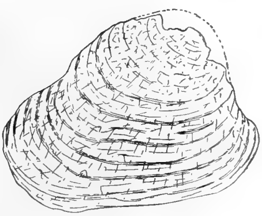

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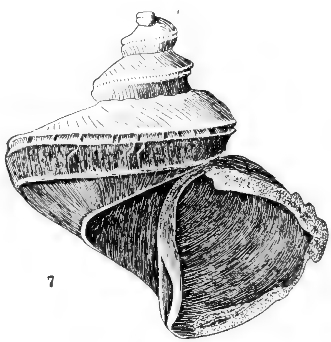

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H. L. Kesteven, del.

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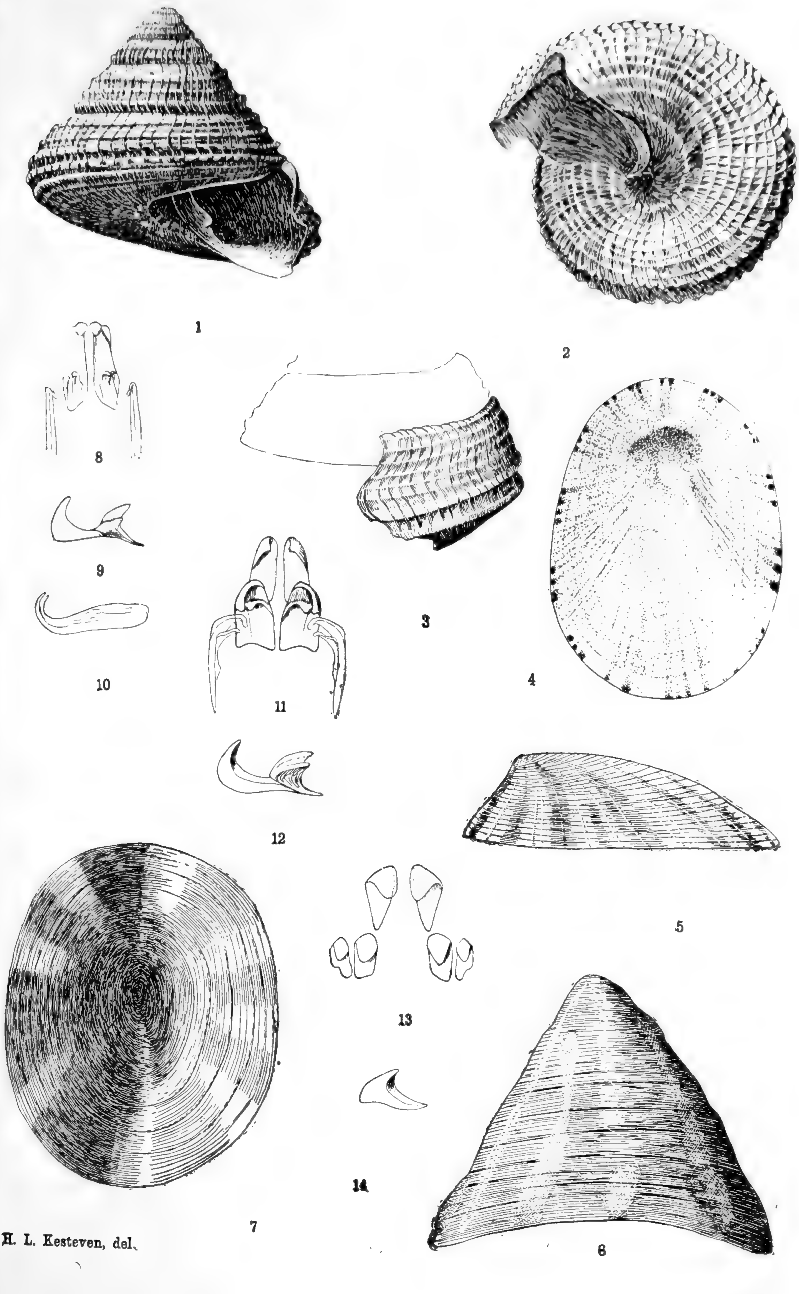

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Description of a New Caladenia.

By R. S. Rogers, M.A., M.D.

[Read October 2, 1906.]

Plate XI.

Mr. E. Ashby, of this Society, has handed me an orchid which he collected at Blackwood on September 16 of this year (1906).

It was blooming at a time when *Glossodia major* and *Caladenia deformis* were both fairly numerous in the vicinity, the former being at the beginning of its season, and the latter at the end. No other Caladenias were in flower, unless, perhaps, an isolated *C. patersoni*.

In habit and general appearance the new form so closely resembled the two species first mentioned, that it was unlikely to attract attention, unless by accident, or by a critical examination of the plants in its neighbourhood.

The following is its botanical description:—

Height, 8 inches.

Stem, slightly hairy. Two bracts, one fairly large and sheathing near the middle of the stem, the other smaller and subtending the flower.

Leaf almost glabrous; lanceolate with cuneate base, about 4 inches long by $\frac{1}{2}$-inch in its widest part.

Flower solitary, dark blue in colour, about the size of a well-developed *Glossodia major*. Segments of the perianth elliptic-lanceolate, nearly equal. Dorsal sepal 1 inch long, other segments rather less.

Labellum entire, $\frac{3}{8}$-inch long, dark blue, softly glandular, subsessile; distal end recurved, proximal half concave. Two well-defined rows of golf-stick calli extend from the base to about the middle of the labellum. Filaments purple, extremities white. Four tall sentinel calli (about $\frac{1}{8}$-inch high) of the same type, and attached to the base of the labellum, stand up vertically in front of the column. They constitute the most striking feature of the plant.

Column nearly as long as labellum, incurved, broadly winged in upper half, narrowly winged below. Dorsal surface pubescent. Anther point nearly a line long, slightly recurved.

A few days later another plant was discovered close to the first find. It conformed in every particular to the above description, except that the double row of calli was absent, leaving only the four sentinel calli on the labellum.

After a careful examination of the plants I am forced to one of two conclusions, either of which is equally interesting:—

(1) That this orchid is a new and, perhaps, sparsely distributed species, which may have hitherto escaped observation on account of its association with two other common species which it superficially resembles; or,

(2) That the new form is a cross between *Glossodia major* and *Caladenia deformis.*

The lack of total agreement between the two specimens makes the first hypothesis difficult to sustain, unless confirmatory evidence should be forthcoming. Then, too, few of our districts have been so systematically searched as Blackwood, and it seems improbable that a new species of this type should have escaped detection so long. In this connection, however, we must remember that certain species occur with singular infrequency. Some six years ago an isolated specimen of *Caleana major* was discovered at Mylor, but in spite of the most diligent search on the part of collectors, no other specimen has been found in the State since that time. The alternative conclusion, that it is a hybrid, is favoured by the slight disagreement between the two specimens, and on the whole seems to me to be rather the more reasonable hypothesis. However rare hybridization between genera may be in the case of most plants, it is certainly not unknown amongst the orchids, and probably indicates the arbitrary nature of certain distinctions, which have been used in their classification. Should a crossing between the two species mentioned be possible, the fact would suggest even a closer affinity between the Caladenias and the Glossodias than is generally conceded, and would seem to justify Reichenbach's contention that the latter genus should be included under the former.

DESCRIPTION OF PLATE XI.

A. Side view. B. Front view. C. Back view. D. Enlargement to show front view of column and labellum. E. Side view of column and labellum, showing golf-stick and sentinel calli.

Hussey & Gillingham, Printers, Adelaide.

THE GEOLOGY OF THE MOUNT LOFTY RANGES. PART II

(THE LOWER AND BASAL BEDS OF THE CAMBRIAN.)

By WALTER HOWCHIN, F.G.S., Lecturer in Geology and Palæontology in the University of Adelaide.

[Read July 10, 1906.]

PLATE XII.

CONTENTS.

I.—INTRODUCTION.

In a previous paper which I had the honour of placing before the Society * the geology of the maritime district bordering the Mount Lofty Ranges was described. The area included the older rocks of the eastern side of Gulf St. Vincent, and inland to Tapley's Hill; the western banks of the River Sturt, and the lower Onkaparinga Valley. The beds which came under notice in that communication were considered in the three following divisions:—

(a) A very thick series of purple slates, quartzites, and limestones, which form the upper members of the Cambrian beds, and are mainly covered, in the southern parts of South Australia, by the waters of Gulf St. Vincent, but are extensively developed in the Flinders Ranges. Some of the limestones of this series contain *Archæocyathinæ*, *Obolella*, and other characteristic Cambrian fossils.

(b) A calcareous series which immediately underlie the purple slates. Strong oolitic limestones occur near the top, but pass down into siliceo-calcareous slates, that gradually

* Trans. Roy. Soc. (S. Aus.), vol. xxviii. (1904), p. 253.

merge into the next following. Typically developed at Brighton, Reynella, and Hackham.

(c) Fine-grained and banded clay slates (ribbon slate), which are slightly calcareous. At Tapley's Hill, etc.

In continuation of the same subject, the present paper deals with the beds which follow in descending order, and are locally developed in the foot-hills and main elevations of the Mount Lofty Ranges. This carries the investigations (so far as a generalized description goes), of the Cambrian succession down to the basal beds.

The ground covered in the present paper is so extensive, and involves so many points of interest, that only a mere outline of the facts can be dealt with, leaving for future efforts a more detailed description of the several members of the series.

The greatly disturbed condition of the beds within the area presents many points of difficulty to the field geologist. The continuity of the beds is frequently broken by folding, over-folding, and faulting, and in a series such as now dealt with (where there is little to distinguish individual beds of the same class from each other) it becomes a most difficult task to determine the true order of succession. To fill in the outline will require detailed and prolonged investigations in the field.

II.—Cambrian Glacial Till.

In April, 1901, a "Preliminary Note" was read before this Society, submitting definite evidences of the glacial origin of a thick set of beds in our Cambrian series, covering a very wide area in South Australia. Previous observers have in one form or another, noted the existence of these beds, and in the following references I include all such as are known to me.

1859. A. R. C. Selwyn. "June 1. Ascended Mount Bryan [Razorback, north of the Burra], and found it composed almost entirely of an olive-green and brown schist, or 'shaal stein' breccia or conglomerate, . . . associated with the above, on the east flank of the hill, are bands of hard quartzose rock, occasionally with a laminated or gneissose structure; and near the base of the hill on the same side there appears to be a thin band or dyke of hornblendic granite, numerous fragments of which are scattered about on the surface, though I could not find any *in situ.*" Parl. Paper No. 20 of 1859, p. 8. [The granites observed by Selwyn occur as glacial erratics.].

1872. G. H. F. Ulrich. Report on the Welcome Mine [north of Umberatana]—"The underlay wall of this reef is well defined, and composed of a gritty silicified sandstone of a few feet in thickness, beyond which follows conformably a boulder-conglomerate, in very thick beds, the enclosed boulders of which consist mostly of quartzite." Parl. Paper No. 65 of 1872, p. 12.

1879. R. Tate. "Evidences of a missing chapter in the geological history of this province are afforded by the occurrence of rolled pebbles of stratified rocks in the oldest known of our sedimentary deposits. These are well-rounded quartzite pebbles, discovered by Mr. Scoular, in the grit bands in the basal beds of the Gawler Hills, and subangular pebbles of gneiss in the siliceous clay slates at Hallett's Cove." Pres. Add. Ad. Philos. Soc. (Roy. Soc.), vol. ii., p. xlvi. [The rocks at Hallett's Cove, referred to in the above paragraph by the late Professor Tate, are not *in situ*, but are blocks of the old Cambrian till, which were torn from their bed by land ice of a later age, and in this way became erratics in the newer till laid down at Hallett's Cove.]

1884. H. Y. L. Brown. Report on country east and west of Farina. "Other portions of the ranges [Mount Nor'-West] consist of argillaceous grit and conglomerate, quartzose grit, quartzite, kaolinized slates, and sandy shales. The conglomerate, besides pebbles of quartz, flint, lydianstone, and siliceous pebbles of all kinds, contains large boulders of quartz rock and quartzite two or three feet in diameter." Also, "Termination Hill . . . consists of quartzite and calcareous boulder conglomerate (comprising quartzite, quartz rock, cherty flint, granite, porphyry, and limestone), many of the boulders being of considerable size, interstratified with clay slates," etc. Parl. Paper No. 102 of 1884, p. 1.

"The conglomerate beds at Mount Nor'-West contain pebbles, boulders, and pieces of granite, quartz," etc. Ann. Report of Government Geologist, 1884, p. 9.

"The clay slates on the Sturt Creek contain boulders of pebbles of granitic rocks, quartzite, etc., imbedded, and occasional bands of grit, conglomerate, and limestone. The thickness of the quartzose bands is very irregular, and they thin out considerably in short distances; they vary from a hard quartz rock to a loose grit, and generally contain a considerable amount of felspar, and bear a strong resemblance to a decomposed granulite; in many cases it may be that the siliceous water, which, in the case of the clay and micaceous slates, deposited quartz in cracks and fissures in that of the sandstone, chiefly penetrated through the porous material, and silicified it through the entire mass." Ann. Report of Government Geologist, 1884, p. 10.

1884. H. P. Woodward. Report on Range to the east of Farina. "Towards the north-east end of the range these beds [clay slates and quartzite] gradually change their lithological characters into a conglomerate, with boulders from several tons in weight to small pebbles of quartzite, sandstone, granite, limestone, marble, and slate, scattered through a slaty matrix, of which there are large patches without any boulders or pebbles. These beds, from their resemblance to boulder clay, have most probably been formed in a similar manner, viz., by floating ice dropping boulders and pebbles on to clay-beds in process of formation. They are from their marked characters traceable through gradual change into gneiss and granite, where all the boulders, with the exception of the quartzites, are also changed into granite, but generally of a different texture from the matrix, so that, on weathering, the boulders come out in their original shapes. The slates are seen in small strips of country, mostly in the centres of anticlinals or by faults. The boulder slate runs from the Daly and Stanley Mines to Hamilton Creek and Billy Springs." Parl. Paper No. 40 of 1884, p. 3.

1885. H. Y. L. Brown. Journey to Silverton. "At Bimbowrie, granite and slate conglomerate, and mica schist. This slate conglomerate contains pebbles and boulders of granite, quartzite, etc, and is penetrated by small dykes of coarse granite." Parl. Paper No. 143 of 1885.

1891. H. Y. L. Brown. Further Geological Examination of Leigh's Creek and Hergott Districts:—"Along the northern boundary of the range, going from Petermorra, there are beds of ferruginous sandstone and boulder conglomerate, resting upon granitic and metamorphic rocks." Parl. Paper, 1892.

1894. H. Y. L. Brown. Report on the Peake and Dennison Ranges. The following clause probably refers to the beds in question:—"Near the borehole, some fourteen miles northward [of Anna Creek Railway Station], the strata are limestone, clay slate, conglomerate, and a siliceous brecciated conglomerate." Ann. Report, No. 25 of 1894.

1898. H. Y. L. Brown. Wadnaminga Goldfield:—"The slates and flags, as well as the limestone, in this vicinity, contain scattered boulders and pebbles of various varieties of granite, quartzite, sandstone, slate, limestone, and other rocks, sometimes forming a true conglomerate. Some of these boulders are very large, and, judging from their size and mode of occurrence, have probably been transported by ice action at an early period in geological history." Records of Mines. 1898.

1899. H. Y. L. Brown. Oladdie Station:—"The country rocks in this district are vertical and inclined flaggy slates, sandstones, limestones, and slate conglomerate." Parl. Paper, 1899.

1901. W. Howchin. Preliminary Note on Glacial Beds of Cambrian Age in South Australia. Trans. Roy. Soc., South Aus., 1901, p. 10.

1901. C. Chewings. Glacial Beds of Cambrian Age in Far North of South Australia. Trans. Roy. Soc., South Aus., 1901, p. 45.

1901. T. W. Edgeworth David. The Glacial Theory ["By an Investigator"]. *The Register* (S.A.), September 17, 1901. *The Advertiser* (S.A.), same date.

1902. Glacial Committee Report. Aus. Asso. for Advancement of Science, Hobart meeting, vol. ix., 1902, p. 190.

1902. W. Howchin. Report of South Australian Glacial Investigation Committee. *Ibid.*, p. 198.

1902. T. W. Edgeworth David. Note appended to Report of South Aus. Glac. Inves. Committee. *Ibid*, p. 199.

1902. E. F Pittman. Two photographs of glaciated boulders from glacial till, Petersburg, South Aus., *Ibid.*, facing p. 200.

1905. J. D. Iliffe and H. Basedow. Paper read before the Royal Society of South Aus., "On the formation known as Glacial Beds of Cambrian Age in South Australia." Abstracts published in Adelaide daily press, April 5, 1905, *et seq.*, in correspondence columns.

1906. J. W. Gregory. "The Dead Heart of Australia," p. 10, London.

The beds were, in the first instance, and for many years later, regarded as a "conglomerate," which is a formation very distinct from a glacial till, both in its origin and characteristics. The credit of first recognizing the true significance of these beds belongs to Mr. H. P. Woodward, some time Assistant Government Geologist in Adelaide: but their glacial origin could not be regarded as definitely determined until the discovery of undoubted glaciated erratics in the till beds of Petersburg and other places, in 1901.

Lithological.—A great uniformity of features is maintained over very wide areas, which makes the identification of these beds comparatively easy. The greater part of the deposits form a highly characteristic till—unstratified, with a ground mass more or less gritty. The beds are coarsely cleaved, with flaky surfaces in the direction of the cleavage, and producing, on weathering, rough serrated outcrops. The grain varies in the degree of siliceous cement, from an earthy mud-stone to a hard quartzitic base. The till includes erratics, promiscuously distributed, and up to eleven feet or more in diameter. Many of these erratics have no known location of parent rock in South Australia. It sometimes passes into a quartzite or coarse grit, with irregular boundaries. In most localities the till is, at certain horizons, interstratified with regularly bedded slaty zones, laminated, and destitute of erratics, and not infrequently with thin dolomitic limestones, which are generally gritty, and may contain erratics.

In common with most of the Mount Lofty Ranges, the beds give evidence of pressure and strain. The tectonic forces, operating from the east, have thrown the Mount Lofty beds into great north and south folds, which often develop into overfolds. The effects produced on the till by such pressure are strongly evident and very interesting. The included erratics, for example, have been forced to assume a position with their longer axis parallel to the planes of cleavage, whilst the fracture of a great many of these included stones in parallel lines across their short diameters, gives evidence of strain operating along the cleavage planes. The effects of such strain are further seen by the apparent distortion of some of these stones, and by the presence of fine parallel striæ on their surfaces, caused by rotation in their bed. Striæ thus caused are of a totally different kind from glacial striæ, and cannot well be confounded with the latter.

The dip of the beds varies greatly. In some of the northern areas, as at Orroroo and some parts of the Flinders Ranges, they exhibit anticlinal and synclinal foldings in large curves. At Petersburg, Appila Creek Gorge, and other places they are practically vertical. In the Sturt Valley they dip under the Tapley's Hill slates at a low angle, whilst on their eastern side they are reversed. In the Onkaparinga Valley they override the newer Tapley's Hill slates.

The glacial origin of the beds is determined—*(a)* by the typical features of the unstratified till; *(b)* the number, great size, and promiscuous distribution of the boulders; *(c)* the essentially foreign character of the included erratics; *(d)* the clear proof of glaciation on subangular erratics: *(e)* other minor features usually present in ice-laid material.

Form of Glaciation.—Mr. Woodward's suggestion of floating ice as the conditions under which these beds were laid down is undoubtedly correct. There is no instance of a hard glacial pavement that would indicate land-ice as the agent, but a continuity of deposit which shows that the material was laid down in an area of uninterrupted sedimentation.

Extent.—The beds occur in their natural order with the related divisions of the Cambrian series throughout the Mount Lofty and Flinders Ranges. In the anticlinal and synclinal foldings of these ranges the beds under description make scores of outcrops, over an area which may be regarded as a great triangle, having the Onkaparinga at its southern apex, and the Willouran Ranges, near Hergott, on the one side, and the extreme north-east of the Flinders Ranges, on the other, forming the base-line. Measured north and south they have an outcrop of 450 miles, and an east and west direction of 200 miles. The beds have been subjected to much faulting, which, in the case of strike faults, have repeated or obscured the beds, and by dip faults have broken the continuity of the outcrops.

A more detailed description of these beds is reserved for future publication.

A paper was read before this Society in April of last year by Messrs. Iliffe and Basedow, in which the authors gave a totally different explanation of the beds in question. This paper was not printed in the Society's Transactions, but lengthy abstracts from the paper appeared in the Adelaide daily press of April 5, 1905, and was supplemented by subsequent correspondence. The theory expounded by the essayists was that the beds in question owed their existence, "not to glacial but to cataclysmic action," in the form of a "thrust conglomerate," and that this "extends along a line of fault from the south of Adelaide far into the north." The "foreign stones" are accounted for by the supposition that "a fundamental series was first folded between overlying beds, the fold closed forming thin alternations of different lithological composition, and the older were then thrust up among the younger." Great emphasis was laid upon the "deformation produced by stress due to earth movements occurring in the rocks adjacent to and bordering on the conglomerate in the Sturt Valley." I do not intend to discuss the points at issue between Messrs. Iliffe and Basedow and myself. I do not think it necessary to do so. The observations of the gentlemen referred to were limited to one locality, and their theories are entirely unsupported by the facts. The fulness and clearness of the evidences for the glacial origin of these beds have received the unqualified acceptance of several distinguished geologists * who have been on the ground, and their special knowledge of this department of geological science confers on their opinions the greatest weight.

From the base of the glacial till there follows, in descending order, a thick series of quartzites, slates, phyllites, and limestones, which exhibit a certain uniformity of features. They are found in the country lying between the Sturt River and the main heights of the Mount Lofty Ranges. The very siliceous character of most of the quartzites confers on them great resistance to waste, with the result that they develop prominent ridges, forming the principal heights, and make precipitous cliffs and waterfalls in the lateral gullies. The associated slates give feature to the foot-hills and lesser heights by rounded summits and a rich verdure which springs from their productive soils.

The series is conformable, and with strong resemblances throughout, but for convenience of treatment it may be considered under the following sections:—*(a)* The Upper Quartzites (Mitcham and Glen Osmond beds); *(b)* the Thick (Glen Osmond) Slate; *(c)* the Middle or Thick Quartzite; *(d)* the Phyllites and Lower Limestone; *(e)* the Basal Grits and Conglomerates.

III.—Upper Quartzites (Mitcham and Glen Osmond Beds).

The junction of the till beds with the underlying quartzites can be conveniently studied in the Sturt Valley (Section 22, Hundred of Adelaide), and in the railway cutting near the Blackwood Metropolitan Brickworks. A good section is also visible in the Onkaparinga (Section 858, Hundred of Willunga). The beds immediately beneath the till are laminated and wavy in structure, and usually strongly flexured and contorted. They stand at a high angle, and, in places, override the till beds along its eastern margin; whilst the till beds override the superior Tapley's Hill slates on the Onkaparinga.

The Upper Quartzites, of which there are several distinct beds, outcrop along the foot-hills at Glen Osmond, Mitcham, Belair, etc., They have been extensively quarried throughout the Adelaide district, and many instructive sections can be seen. As they are much faulted, it is difficult to establish a clear correlation of the disjointed members of the series, but the main quartzite, worked at Glen Osmond

* See references, *ante*, under the names of Professor T. W. E. David, Professor J. W. Gregory, Mr. E. F. Pittman, and others.

and Mitcham (two miles apart), appears to be the same bed, and is about 100 feet thick.

The petrological characteristics of these quartzites are remarkably uniform and constant throughout the series. Macroscopically the stone is highly vitreous, and has a piebald appearance. This effect is produced by the presence of elastic felspar, of a white colour, distributed through the siliceous cement, in company with grains of quartz which are often confluent. The proportion of granular felspar to quartz grains ranges from 30 to 40 per cent. This constituent is sometimes excessively fine, and can only be clearly distinguished after the stone has been immersed in water. The stone may be regarded as a fine-grained, arkose sandstone or grit, derived from the waste of granitic rocks, and subsequently metamorphosed by the infiltration of silica from solutions. The proportion of siliceous cement present in the stone determines the economic use. Where the proportion of silica is relatively low the stone is used as a freestone for building; but where high it is best adapted for road metal. In many places fault breccias occur, and when these carry vughs, very fine nests of quartz crystals and tabular crystals of barite are sometimes found. An interesting series of petrological studies in South Australian quartzites was carried out by my late colleague, Dr. Woolnough, and published in the Transactions of this Society.*

IV.—The Thick Slate (Glen Osmond Slate).

The quartzites of the Glen Osmond and Mitcham districts are interstratified with slates which have an aggregate thickness exceeding that of the associated quartzites. In structure they vary from laminated shales, with slight evidences of cleavage, to slates in which the cleavage is complex, and obscures the bedding. The metamorphic effects on the slates increase with the relative depth, so that the lower beds differ much in structure and lithological aspects from the higher.

For purposes of identification the shales and slates of this series present equal difficulties as those connected with the quartzites. Beds widely removed in their vertical order are at times faulted against each other with no superficial evidences of such displacements. In the great fold movements to which this series has been subjected it has been the weak and yielding slates which have suffered the greatest deformation. The pressure which caused the earth-folds was

* Petrological Notes on some South Aus. Quartzites, &c., Trans. Roy. Soc. South Aus., vol. xxviii., p. 193.

directed from the east towards the west, and has resulted in the stronger quartzites making overfolds, and crushing or overriding the slates. The slate-bed which overlies the quartzite of the round hill at Mitcham, for example, has had a sharp throw-down to the west, as seen in an old quarry in a by-road, on the south side of the township. The beds are vertical, wavy in the grain, and exhibit several nearly horizontal thrust-planes in a movement from east to west, by which the vertical beds have been broken and slid along planes at right angles to the bedding. Fine examples of thrust can also be seen in cuttings on the new road between Magill and Norton Summit.

The thickest of these slate-beds occurs immediately below the Glen Osmond quartzite. The junction of these beds (which also exhibits a remarkable illustration of thrusts) can be distinctly seen in the large quarry which has supplied much of the building stones of Adelaide and district. The slates rise from beneath the quartzite, at a low angle of dip, and extend in the direction of Mount Lofty, as far as the Eagle-on-the Hill; down the Waterfall Gully, and in a northerly direction, they form the grassy foot-hills which run parallel with the ranges. In its upper portions it has the features of an earthy slate, with cleavage imperfectly developed, but near the base it is often a typical phyllite. This bed forms the dominant outcrop on the western flanks of the Mount Lofty Ranges, and is probably not less than 2,000 ft. thick.

Towards the bottom of this thick slate several beds of quartzite are intercalated. These can be seen on the Glen Osmond road, between the Eagle-on-the-Hill and Crafers, and also in the Fourth Creek (Morialta), where one of the beds makes a scarped cliff on the south side of the gorge, where the softer beds are strongly sericitic.

At the Fourth Creek and Stonyfell, as well as at other localities, the "thick quartzite" (which underlies the "thick slates," and will be described presently), has been sharply curved towards the west, sometimes overfolding, and has thereby thrown the overlying thick slates down to the west, forming the clay foot-hills referred to above. It is from this movement that the Glen Osmond slate-beds have such an extended area in a northerly direction. The stratigraphical sequence of these beds is materially simplified by the presence in them of a calcareous belt, which is moderately constant in its features, and forms a definite horizon in the series. It includes an impure limestone, locally known as "blue metal," which has been extensively used for road-making. The stratigraphical importance of these beds requires separate reference.

V.—"Blue-Metal" Limestone.

The stone is a blue-black carbo-argillaceous limestone, with some chert, which occurs in thin seams or as small pellets distributed through the limestone. The calcareous zone in the slates is about 30 or 40 feet in thickness, in which the so-called "blue metal" makes beds of stronger stone, varying from a few inches up to 10 or 14 feet in thickness. Its dark colour is distinctive, and the outcrops are usually marked by the presence of superficial travertine. The beds occur at intervals along the foot-hills adjacent to Adelaide, not on a continuous or uniform line of strike, but in faulted fragments. The main localities for their occurrence are as follows:—

Glen Osmond Road.—The relationship which this belt of impure limestone bears to the associated slates can be well seen in outcrops near the Mountain Hut Hotel, on the Glen Osmond Road. The beds are on the old road, about half a mile higher up than the hotel, and cross the new road in a north-west direction, just above the sharp turn which has obtained the name of the "Devil's Elbow." Here a large quarry has been worked in the stone, the "blue metal" having a thickness of about 14 feet, with a dip of 20° in a direction 20° south of west. The strike carries the beds along the hillside, and obliquely across the lower bend in the road, and beneath the Mountain Hut Hotel.

Mitcham.—What are probably the same beds occur in the thick slates on the south side of the Brownhill Creek, opposite the school on the public reserve. The main limestone is here 12 feet thick, with several thinner beds of limestone in the section. It has been quarried at several points. Dip south-east at 25°.

Beaumont.—The "blue metal" limestone is well exposed in Goldsack's quarries, near Beaumont, on the Burnside and Glen Osmond Road. The quarry face shows about 40 feet of stone, with 14 feet of "blue metal." The limestone layers are separated by laminated and calcareous slates, which are greatly puckered and compressed into small angular folds and little overfolds in the direction of the dip, which is west, at 25°-30°. The crush has developed a phyllitic structure in the slates. The beds curve around the north side of the hill and across a small gully to the east, and slope upwards to near the top of the ridge, where the dip is at a lower angle and apparently directed to the eastwards. A little short of the summit the limestone is cut off by a bar of quartzite (much penetrated by quartz), about 12 yards wide, and cuts across the strike. This is apparently a fault rock. On the east side of this quartzite, or fault rock, are grey slates.

Stonyfell.—This outcrop occurs about two miles north-east of the preceding one. A private road passes behind the wine cellars at Stonyfell, leading to several quarries in the "blue metal" limestone, situated on the ridge about a third of a mile to the west of the Stonyfell (Dunstan's) quartzite quarries. The "metal" is about 10 feet thick, but is somewhat uncertain in its quality. In some of the workings the associated calcareous slates afford beautiful examples of bedding crossed by cleavage planes that can be obtained in good hand specimens. The beds having suffered a downthrow to the west (as shown in Dunstan's quarries), are broken and uncertain as to dip. In one of the "blue metal" quarries a small fault with contrasted dip is seen; the one easterly at 20°, the other 20° south of west, at 20°. The general strike, however, is a little east of north, which carries the beds across the valley on the north side, where they have also been quarried.

Further outcrops of these beds can be traced in the olive plantation, about three-quarters of a mile to the north of Stonyfell, where they have been quarried at many places along the strike. The thickness of cover in most of the "blue metal" outcrops has led to a system of under-mining, by which large caves have been excavated and carried back on the line of stone as far as it was safe to do so. In this method, successive quarries are worked along the line of outcrop, as has been the case in those now described, as well as in most of the other outcrops of the "blue metal." The outcrops in this instance follow the south side of a dry gully through the olive plantations, and pass out of these grounds on the eastward (Sections 108 and 918, Hundred of Adelaide) to the head of the gully, where a quarry exposes very characteristic phyllites, with thin beds of the "blue metal." Here the beds roll in a shallow syncline with low dip to the south, and appear to run out to the east. A great thickness of these calcareous beds is exposed in the dry gully on the north side of the olive plantation, where the beds have been quarried at the bottom, and also in a small quarry on the north side of the valley. At the latter position the limestone beds are seen to be nearly horizontal and faulted against the slates, which are thrown down at a high angle. Much travertine appears on the surface from this point, northwards, towards Magill, but no "blue metal" beds are exposed, having apparently been cut off by the fault seen in the small quarry just referred to.

Magill.—About half a mile from the tram terminus at Magill several quarries in the "blue metal" beds can be seen on the north side of the old road to Norton Summit. The main quarry shows a face of 24 feet in all, with 12 feet of good "metal." Dip west at 35°. A little higher up, on the same bank, phyllites with a 6-feet bed of quartzite are seen in an old quarry. Here the beds show a sharp monoclinal fold, in which the septum has a dip to the south-west at 75°.

On the new road to Norton Summit, about half a mile above the Magill Reformatory, the "blue metal" beds are seen in a road-cutting, which is due north-east from the outcrop on the old road. The beds are not so strong as usual, but this may be partly due to weathering. Dip, 10° east of south, at 38°. The strike from this point (judging by the travertine surface) follows the foot of the low hills bordering on the plains. Similar indications appear at the mouth of the Fourth Creek and on the hill slopes south of the Fifth Creek. The presence of travertine cannot be taken, however, as a sure guide to the presence of a limestone beneath, as there is often sufficient diffused lime in the slates themselves to produce a considerable travertine cap.

Anstey's Hill and Teatree Gully.—On the main road between Paradise and Houghton (Section 5608, Hundred of Yatala), where the old and new roads of Anstey's Hill are nearly parallel to each other, black slate with bands of blue-black limestone cross the road, and can be traced along the strike on either side. The outcrop is very similar to the "blue metal" stone met with elsewhere, although the limestone is in places somewhat of a lighter colour than is usual for this bed. The outcrop on the road extends for about a hundred yards, and is followed on its eastward side by a ferruginous rotten sandstone and cherty quartz with phyllites.

The strike carries the beds, on the south side, across Payne's Gully and the next spur, and was traced in the same direction until not far from the north bank of the River Torrens. The exposures show the beds to be vertical, or intensely contorted into acute folds with the dip rapidly changing to opposite directions.

On the north side of Anstey's Hill road the beds can be followed down the valley and across the Water Gully road, where good sections of strong stone can be seen on the road and in Mr. F. Newman's garden. The beds take the next rise to the north (passing a little east of the old ironstone flux mine, Section 5632), where it is mostly evidenced by the presence of chert or cherty quartz on the top of the hill. From this point the beds descend and cross the Teatree Gully road, about halfway up the gorge. Here they make two (if not three) distinct outcrops. The stone is very strong, carries much chert, as do also the associated phyllites, and is quarried. In these sections there are extraordinary evidences of crush, with reversed faults showing push from the east.

The "blue metal" beds are nipped in between two ridges of the thick quartzite, which appears to be repeated here by a strike fault. One ridge runs from the River Torrens by way of Anstey's Hill to the bottom end of the Teatree Gully gorge; and the other, almost parallel, crosses Anstey's Hill road, about half a mile higher up, and strikes for the top of the Teatree Gully, where it has been extensively quarried. Between these two ridges of quartzites, the phyllites and "blue metal" beds have received a great nip (as already described), with much quartz veining that has prompted exploration for minerals, but without success. In all the other instances the "blue metal" beds outcrop on the western side of the thick quartzites, but in the Anstey's Hill and Teatree Gully sections they outcrop on the eastern side. This accords with the prevailing dip of the quartzites of Anstey's Hill, which is towards the east, and has been no doubt influenced by the strike fault which has given the beds an easterly tilt, and thereby also thrown the "blue metal" beds to that side.

Waterfall Gully.—That part of the gully which is below the First Waterfall, as well as the left bank of the stream, in its upper part as far as the Eagle-on-the-Hill, consists almost entirely of thick slates, which are presumably an extension of the thick (Glen Osmond) slates. A footpath leads up from the base of the waterfall to the ledge over which it plunges. On this path, just before reaching a rustic bridge which spans a small runner from the hill, an outcrop of the dark calcareous beds can be seen in the bank side. The beds have a dip, 20° south of east, at 46°.

General.—The repeated occurrence of this very characteristic horizon of carbo-argillaceous limestone and chert is of great significance with respect to the stratigraphical relationships of this much-disturbed district. Assuming that these occurrences represent one and the same set of beds, they indicate an horizon in the thick (Glen Osmond) slate, which becomes an important datum line for the determination of the associated quartzites, both above and below. Their anomalous position, in flanking the base of the Stonyfell quartzites (although really superior to them in position), is explained by the great fold along the western side of the range in which the thick quartzites participated. In this movement, the overlying slates were tipped over to the west, and, being softer than the quartzites, have suffered a more rapid denudation, which has placed them at a lower level than the underlying harder beds. The general trend of these limestone outcrops is along the western slopes of the foot-hills, and separately, curving upwards in an easterly direction towards the rise, die out before reaching the summit.

VI.—Small Dolomitic Limestone.

At a lower horizon in the thick (Glen Osmond) slates than that occupied by the "blue metal" limestone, a small, buff-coloured dolomitic limestone occurs. It does not appear to exceed from a few inches up to a foot in thickness, and from its thinness is often only indicated by loose fragments and travertine cover. It is associated with a fine-grained, laminated quartzite, which weathers smooth and of a buff colour, and carries a close superficial resemblance to a dolomitic limestone. Indeed, some specimens give a slight reaction for calcium-magnesium carbonate. It has a distinct outcrop, about a foot thick, on the west side of Waterfall Gully (high up); also at some old mine workings on the same side, but at a lower level. It has also been noted at Brownhill Creek, above Mitcham; on the north-east side of Greenhill road, where it is associated with lumps of magnesite or dolomitic travertine; on the spur between the Third Creek and Horsnell's Gully; and probably on the hillside, near the by-road, south of Fifth Creek, where a piece of dolomitic limestone was found in the surface travertine associated with the buff-coloured laminated quartzite, which usually accompanies this bed. A thin dolomitic limestone was found crushed in a fault plane, on the hill south of the Torrens Gorge, where it is associated with much quartz and chlorite.

VII.—The Thick Quartzite.

Anstey's Hill, the Black Hill, Stonyfell, and Mount Lofty form the most conspicuous eminences of the Mount Lofty Ranges, as seen from Adelaide. They have much in common. They each consist of quartzites of great thickness (probably not less than 1,000 feet), whilst a similar geological character has given rise in each case to a scrubby vegetation that clearly defines them in the landscape. In structure, the quartzite is seldom massive, but is divided up into relatively thin layers of solid stone, separated by partings of shale or mylonitic material. The composition of the stone is that of a clastic rock, consisting, in the main, of rounded quartz and felspar grains, similar to the other quartzites of the series. From the features which these several outcrops have in common, as well as other considerations which will appear in the sequel, it is believed that they represent the same geological horizon, although they form disconnected fragments.

Anstey's Hill is a prominent spur of the Mount Lofty Ranges, situated a mile and a half, in a direct line, north of the Torrens Gorge, and is traversed by the main road between Paradise and Houghton. It exhibits a thick series of quartzites, which in structure and composition bear a close resemblance to the thick quartzites which occur in the other localities referred to above. The cuttings on the road, as well as numerous quarries, give excellent sections of the beds. The beds dip east, or a little south of east, varying from 50° to 70°, which they maintain in a direction across the strike, for about a quarter of a mile, indicating great thickness. The outcrop is continuous to the River Torrens, and forms the precipitous hill on the north side of the waterworks weir.

On the east side of the great curve in the road, which goes around the north side of the hill, the quartzites take a lower angle of dip, and just before they disappear are horizontal, or perhaps have a slight dip to the west. There is here a sudden change to phyllites, with much thrust to the west. From the dip of the quartzites these phyllites should overlie them, and the "blue metal" beds, which outcrop a little higher up the road, point in the same direction. The phyllites are greatly disturbed, and it is probable that they are faulted against the quartzites. The relationship which the Anstey's Hill quartzites bear to a parallel ridge of similar stone on the eastern side is referred to under Section V.

The Black Hill, situated at the entrance of the gorge of the Fifth Creek (Montacute road) forms the greatest mass of quartzite in the Mount Lofty Ranges. Its steep sides and flat top, covered with a sombre scrub vegetation from top to bottom, makes it a conspicuous object from the plains, and has secured for it the appropriate name of the Black Hill. The hill rises 1,000 feet* above the plain, and consists of quartzite throughout. The stone is divided up into comparatively thin beds, separated from each other by partings of a more or less shaly nature. These partings consist mainly of sand grains mixed with thin laminæ of silicates, which give evidence of much shearing. There has evidently been considerable movement along the divisional planes, which would be planes of weakness under stress. Quartz has been developed, more or less, in these partings, and in a few instances a slight evidence of pegmatitic structure was recognized. In the Government quarry [Stone Reserve, Section 304, Hundred of Adelaide], about a quarter of a mile from the mouth of

* As near as can be judged from data kindly supplied by the Surveyor-General's and the Engineer-in-Chief's Departments, the Black Hill is 1,540 feet above sea level, and 1,140 feet above the plains at its base.

the gorge, there is a conspicuous fault dyke in the centre of the quarry, 2 feet thick, having well-defined walls, and hades 10° east. The dyke consists of brecciated quartzite and quartz, the whole mass thickly penetrated by dendrites.

The beds being thin and much jointed, the stone is only used for road metal, and is easily won. The dip of the beds swings round between south-west and south-east, at from 18° to 25°. The steepness of the face, the extensive jointing of the beds, and the dip being towards the gorge, have had the effect, in wet weather, of bringing down great slides of stone, damming the creek and blocking the road.

The Fourth Creek (Morialta).—The thick quartzite, which forms the high range on the north side of the Fourth Creek, is undoubtedly the same as that of the Black Hill, but it is a distinct fragment. The Black Hill is determined by faults, both on its west and south sides. The west fault is a continuation of the great displacement which runs along the western slopes of the hills, and the fault on the south side follows the direction of the Fifth Creek. The latter has broken the continuity of the thick quartzite, and thrown it further to the east between the Fifth and Fourth Creeks.

Stonyfell presents another isolated fragment of the thick quartzite, almost equalling the Black Hill in magnitude. The beds for the most part have a comparatively low angle of dip directed to the south-west, but the dip increases towards the western side, where the beds roll, and are intensely disturbed as they near the important fault which skirts the foot-hills. The fault-plane can be well seen in Dunstan's extensive quarries. The strike of the fault here is 35° east of north, and can be traced along the outcrop, both north and south. It is well seen in the Fourth Creek and between the Fourth and Fifth Creeks. The zone of fault-fracture in the quartzite at Stonyfell is about 50 yards wide, in which the rock is much brecciated, and penetrated by quartz veins. The quartzites are thrown against the slates, and the slates dip towards the fault-plane. At the fault their dip is 55° east, and in a short distance away, in a small quarry on the old road, the dip is 35° in the same direction. The quartzite comprises the high ground to the south of Stonyfell, which is intersected by Slape's Gully, and is limited, in the main, on that side by the Greenhill road. At Stonyfell, as in all cases with the thick quartzite, the stone is exclusively used for road metal.

Mount Lofty—Mount Lofty owes its prominence to the thick quartzite, which forms its summit, and is there nearly horizontal in position. The ridge which connects the Mount with Crafers forms a continuous outcrop of the same beds, and may be regarded as the crest of a wide anticlinal fold, nearly flat on top, with a low dip to the south-east on its eastern side; and a gradual slope with a dip to the south-west on its western side—the dip slope trending towards the Glen Osmond road. The summit of Mount Lofty, especially on its western face, is composed of crags of large size, which rise steeply from the road to a height of 150 feet. The east side of the ridge is steeper than the western, and cuts off the quartzite somewhat abruptly, the base of which is seen near the bottom of the escarpment, where it gives place to a compact slate, frequently coloured red. The line of junction between the quartzite and slate is marked by several springs, which yield strong runners of water.

The best exposure of the quartzite is seen in Hardy's quarry, on the east side of the ridge, near the road which connects Crafers and Piccadilly, and from which most of the road metal of the district is obtained. The top beds are soft, from the effects of weathering. The main body of the stone is siliceous, much jointed, and breaks with a free fracture. The bottom beds in the quarry contain a proportion of crystalline silicates, of a kind that alters the grain and makes the stone tenacious and tough, and difficult to break. This feature is mainly seen on the west side of the quarry, where the beds show the effects of thrust, directed from the east, which has raised the beds into a succession of small saddles, with a talcose film between the layers.

Stratigraphy of the Thick Quartzite.—The evidence seems to be conclusive that the prominent outcrops of Anstey's Hill, the Black Hill, the Fourth Creek Hill, Stonyfell, and Mount Lofty represent the same geological horizon. If so, they are examples of block-faulting on a large scale. A very thick series of beds has been tilted, broken into large fragments, and rendered discontinuous by a deformation of the earth's crust. This conclusion has been reached partly by the correspondence which these quartzite blocks show to each other in their lithology and great thickness, but more particularly from the peculiar occurrence of the "blue metal" limestone which accompanies them. This limestone appears to be in its normal position on the Glen Osmond road and at Beaumont, where, respectively, it is inferior in position to the Glen Osmond quartzites, and superior to those of Mount Lofty.

In the same way, along the foot-hills, the "blue metal" limestone at Beaumont, stands related to the Slape's Gully quartzites; the same beds at Stonyfell and the olive plantations are stratigraphically associated with the Stonyfell quartzites; the Magill and Fourth Creek exposure, to the Fourth Creek and Black Hill quartzites, and, in each case, the limestone, though stratigraphically superior to the quartzites, is thrown down to the west. At Anstey's Hill, however, where the quartzites are tipped to the east, the blue limestones are also thrown to the east. This stratigraphical association of the two sets of beds throughout the district (notwithstanding the disturbed condition of the field), establishes the order of succession and materially assists in fixing the main fault-planes.

VIII.—The Phyllites and Lower Limestone (River Torrens Limestone).

A *phyllite* is an argillaceous rock of a micro-crystalline structure. It differs from clay-slate mainly in its more schistose character. It is generally laminated and wavy, and the development of sericitic mica gives it a lustrous appearance.

There is no sharp line of distinction between the Glen Osmond slates, which are sometimes phyllitic (especially in their lower members), and the phyllites proper, which occupy a geological horizon beneath the thick quartzite described above. The development of the phyllitic structure appears to have been mainly determined by the measure of folding locally developed; the greater the crush the more distinctly are the phyllitic features manifest in the beds.

These beds outcrop on the north side of the Black Hill, are well seen in gullies facing the west; and also in the Torrens River, above the weir, where they have yielded a small amount of copper. The phyllites occur on the east side of Mount Lofty (rising from beneath the quartzite), and from their decomposition the productive garden soil of Piccadilly, situated in the valley, has been mainly derived. The Mount Lofty Park Mine (Section 840, Hundred of Onkaparinga) is in these beds. The ore is mainly sphalerite (zinc sulphide), with a little galena and iron pyrites. The phyllites at this place dip south-east at 30°, and the lode, which does not exceed 4 inches in width, has well-defined walls, and hades to the north at 80°. Not much quartz is present in these slates, a feature in which they show a strong contrast to the Pre-Cambrian slates of the district. The dip of the beds increases to the eastward, where they become vertical, or dip east at a very high angle.

The phyllites are often strongly chloritic, giving the stone a green colour, and along lines of great disturbance, accompanied by quartz veins, the mineral chlorite is often found in considerable quantities. The contemporaneity of the quartz and chlorite, in their origin, is proved by the inclusion of granular chlorite within the crystals of quartz.

Phyllites also occur extensively in the Onkaparinga River, about Clarendon; in the Little Para River, and the South and North Para Rivers.

Interbedded with the lower phyllites are quartzites and limestones. The latter are of great stratigraphical value in determining the geological horizon of the lower members of the Cambrian series.

The Lower (or River Torrens) Limestone.—Towards the lower part of the phyllite-quartzite series (which underlies the thick quartzite of the Black Hill, Mount Lofty, etc.), is an important development of limestone. The main bed varies from a blue or buff-coloured limestone to a white crystalline marble. It is frequently dolomitic, and in places becomes a true dolomite. The designation "lower limestone" distinguishes it from the Brighton and Reynella limestone, which occupies a much higher geological horizon; and as it is typically seen in the valley of the Torrens and its tributaries, it may be called the "Torrens limestone."

The limestone proper is associated with impure calcareous beds and quartzites, whilst the much faulted and broken condition of the beds makes it somewhat difficult to state their exact sequence, but the following appears to be the order in descent:—

(a) Overlying (rather thick) quartzite.

(b) Impure siliceous blue limestone.

(c) Calcareous quartzite. Weathers with quartz grains on surface of stone.

(d) Quartzite. About 50 feet thick.

(e) Slate. Calcareous near bottom. About 60 feet thick.

(f) Buff-coloured dolomitic limestone, or marble, with one or two earthy beds (not exceeding 2 feet), interbedded with the limestone. About 150 feet thick.

(g) Phyllites and quartzite.

Taking the limestone beds as a whole, for general description, the following localities have been noted:—It forms a rounded hill at Montacute, on the ridge behind the church. It crosses the new and old Corkscrew Roads, where it is apparently faulted with a throw to the west. In one direction (going east) it can be followed down to the Corkscrew Valley, and skirting the hillside (going east) it crosses a small creek at the back of Mr. Barnet's house; then, passing over the next ridge, it appears on the south side of the old Montacute mine, and is strongly developed in the Sixth Creek, on the same line of strike; and also in a tributary of the Sixth Creek, Section 5524.

Another line of strike of these beds, roughly parallel to the preceding, is met with on the ridge separating the Corkscrew Valley from Pinkerton Gully. In the latter the limestone becomes faulted, and is thrown down, on the east side of the gully, towards the bottom; then, passing over the east ridge, it again crosses the Sixth Creek, not far from the latter's confluence with the Torrens. From thence, with a strike east, slightly north, it passes over a steep hill, and is found in the grounds of Mr. Hersey and Mr. Batchelor, on the following rise. Maintaining the same general direction, the limestone follows the bed of the Torrens eastward, outcropping for half a mile before reaching the junction of Kangaroo Creek with the Torrens, and is continued beyond that point to the old drive, known as "Anstey's Mine," which was worked in this limestone, and is now beautifully coated with stalagmitic drapery.

Two other outcrops of this limestone occur in the bed of the Torrens, in each of which the strike is nearly at right angles to those just described. The more westerly of these outcrops occurs in the southerly bend of the river in Section 333. The stone is a dolomitic limestone of a buff colour, and is about 150 feet in thickness. On its southern side it is cut off by an east and west fault, accompanied by great masses of ironstone of metasomatic origin. The beds dip 20° west of south, at from 35° to 45°. The limestone follows the left bank of the river for about 200 yards from the angle of the bend, when it rises to the bank at an increased angle of dip. This outcrop is apparently an isolated fragment of no great extent, determined by fault planes.

On the east side of the same bend in the river, and nearly opposite the confluence of the Sixth Creek, another outcrop of this limestone can be seen in the bed of the Torrens. It is similar in character and thickness to the one last described, and has a like strike and dip, but on parallel lines. Locally it is known as the "Marble Bar."

This line of outcrop extends in a south-easterly direction for about a quarter of a mile, when, in the grounds of Mr. Hersey, it is cut by a strike fault and ends abruptly. Here also, as in the case of the faulting of the limestone on the west side of the river bend, the fault zone is marked by metasomatic deposits, and has been opened out in a small quarry for ironstone flux. In the opposite direction the limestone follows the gully in a northerly strike, passing through Sections Nos. 5604, 5607, 5546, and 5517. It outcrops in the vineyards of Highercombe, and can be traced up the side of the hill towards the house; but it disappears before reaching the latter. It is probably thrown down by a fault, as the limestone was penetrated when sinking a well in Highercombe House at a depth of 80 feet. On its western side the limestone is here bounded by quartzite; and on its eastern side the Pre-Cambrian beds, in a high and rocky ridge, form a continuous outcrop from the River Torrens to Houghton and beyond.

Other Localities for the Lower Limestone.—In the Onkaparinga, a little below Hack's Bridge, where the beds consist mainly of white marble, and are much obscured by the alluvial of the stream. This outcrop is at no great distance from the basal grits.

At Mount Bold, in the valley of the Onkaparinga, a blue siliceous limestone outcrops on the east side of the Mount, and a more extensive outcrop of limestone occupies the summit of a minor elevation (Section 295, Hundred of Noarlunga), about half a mile north-west of Mount Bold, and has been used to construct the ford of the river on the Clarendon Road. The stone apparently dips S.S.W. at 15°. I cannot definitely place this limestone, as it is a few years since I visited the locality, but it is probably the lower limestone.

On the South Para there is an outcrop of the same limestone series, which can be traced for a long distance on the north side of the river, and is closely associated with the basal beds, which rest on Pre-Cambrian gneiss.

Absence of these Limestones at Mount Lofty.—In the consecutive order of the lower Cambrian beds this important limestone series ought to outcrop on the east side of Mount Lofty, between that eminence and the Aldgate grits. No such outcrop, however, occurs. The absence of these beds must be referred to a strike fault of some magnitude, which has prevented the limestone from showing at the surface. This effect might be brought about in several ways. Two examples are shown on Plate xii., figs. 2 and 3.

In fig. 2 the beds are thrown down in two parallel trough faults, which obscure the limestone, and cause a repetition of some of the higher beds at the surface. The limestone is shown as faulted against the Pre-Cambrian beds at depth.

In fig. 3 a fault is shown which hades in the direction of the dip. This would have the effect of cutting off some beds and preventing their coming to the surface. I think the section shown in fig. 2 is the more likely occurrence of the two, and this is supported by some local features, which are best understood by applying to them the theory of a trough fault.

IX.—Basal Beds of the Cambrian Series (Basal Grits and Conglomerates).

For some time my attention has been directed to a series of outcrops which exhibit features no less interesting than difficult of interpretation. In general aspect they vary from fine-grained, white, felspathic sandstones and grits, through every gradation of coarseness to pebbly conglomerates. The lithological features were strongly suggestive of their being basal beds resting on an older and unconformable series. This first impression as to their origin has been gradually strengthened with more extended acquaintance, and there is little doubt, I think, that we have in the beds, now briefly described, the base of the Cambrian series of the Mount Lofty and associated ranges.

The general strike of the beds follows a north-by-east direction, through the Mount Lofty and Barossa ranges, and can be studied in the following localities:—*(a)* the Inman Valley; *(b)* in the ranges, a little east of Myponga; *(c)* on the Onkaparinga, a little below Hack's Bridge, at Mylor; *(d)* at Aldgate, Stirling, and Carey's Gully; *(e)* on the southern spurs of Forest Range, between Summerton and Balhannah; *(f)* on the River Torrens, near the confluence of Sixth Creek, and through Houghton; *(g)* on the South Para, near Menzies' Barossa Mine; *(h)* on a line, rather more to the east, forming escarpments of the Barossa Ranges, south-east of Williamstown; *(i)* and at Tanunda. There is also a conglomerate at Hog Bay,* Kangaroo Island, which is about on the same line of strike with the outcrops already referred to, and may represent the same horizon.

As illustrative of the general features of these beds a few of the outcrops will be briefly described.

Aldgate. — In this locality the basal beds are mostly gritty sandstones, with white felspathic cement, passing at times into coarse grits, with occasional pebbles. The stone is soft to friable. A special feature of the stone (as it is of most of the beds at this horizon) is the occurrence of ilmenite grains, which are laid down along current planes or diffused throughout the stone. Current bedding is common. Joints irregular. Much strain is exhibited by the texture of the stone, as well as by frequent small faultings of the body of the stone, which is only made apparent by the dislocation or faulting

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* Tate: Trans. Roy. Soc. South Aus., vol. vi. (1882-83), p. 122. Howchin: *Ibid.*, vol. xxvii. (1903), p. 82.

of the dark lines of ilmenite deposits. The stone can be got in very large blocks, but is of uncertain coherence.

These beds can be studied at Torode's Quarry, Stirling West, from which the stone for building the Conservatorium of Music and portions of the Adelaide Children's Hospital was obtained. The quarry exposes about 50 feet of stone face, with a south-east dip at 42°. The top layer of the quarry is a hard siliceous quartzite of the Mitcham type. This hard bed can be traced on the west side of the quarry, across the road, and on the railway line, where it is exposed in the first cutting above the Aldgate Station. The beds also skirt the hillside on the north side of the line, and have supplied a quarry near the entrance to Sewell's Nursery, showing a dip south-east at 21°. Opposite the railway gates (north side) the road is cut through these rocks, showing, in top beds, about 24 feet of soft laminated sandrock, underlain by hard Mitcham stone, with diffused ilmenite grains. Dip south-east at 20°. The hard rock is exposed for about 17 feet in thickness, under which is soft laminated felspathic beds. At a short distance up the road to Stirling the first of two quarries shows soft laminated rock on top, with hard Mitcham stone beneath, and a dip south-east at 16-25°. About 70 yards higher up the road the second quarry exposes hard white felspathic quartzite, in broad dip slopes, reading south-west at 10°. According to the dip, which shows a slight anticlinal curve across the strike, the main stone probably underlies the hard rock of the lower quarry, which is further indicated by the former being overlaid by hard siliceous quartzite, as in the case of the lower quarry.

Within 20 or 30 yards of the felspathic quartzite, granitic rocks appear in the road, and in the creek which runs by its side. The granitic belt has a width, at this spot, of 420 yards, with an outcrop trending in a north-easterly direction, showing at intervals through the ranges. It cannot be traced in the opposite direction, being apparently obscured by the felspathic sandstones and grits which rest upon it.

The question of the relationship which the grits bore to the granite was rendered difficult, inasmuch as the line of junction is obscured by soil and wash from the hills. It was observed, however, that the granite, which is mostly in the form of pegmatite and aplitic dikes, penetrates a set of beds which are of very distinct lithological character from the local grits, as well as divergent in dip. On the south side of the granitic belt aplitic veins penetrate what may be a much altered quartzite; whilst on the north side the granite is bounded by talcose and chloritic slates, which show a dip of 75°, with a face to the road of 77 yards long. At the northern limits of these slates the local sandstones are seen again, with a dip south-east at 45°. These beds, with granitic intrusions, I regard as a Pre-Cambrian inlier that has become exposed by the removal of the basal beds of the Cambrian series.

Another section of the beds in question can be seen on the back road leading from Aldgate Station to Stirling. It is almost due east of the one last described, and at no great distance from it. The outcrop is exposed in a small cutting on the road, and shows unconformity between the two series. The Pre-Cambrian slates, with pegmatite veins, show folia, with a dip south 10° west at 85°, and are overlain by hard quartzite of the Mitcham type, which dips 10° east of south at 35°.

A still more interesting exposure of the two unconformable series occurs about one and a half miles to the north-east of the one just described, on Sections 1203, 1133, and 1134, Hundred of Onkaparinga. On the district road, in front of Mr. Melrose's house, and on the creek to the east of the road, an excellent line of junction can be studied. Here very characteristic exposures of the Aldgate sandstone occur, which can be seen resting unconformably on aplitic and highly-foliated crystalline rocks, the former with a strike 120° east of north and dip 25° south-west, and the latter with foliated strike 10° east of north and dip 75° easterly. The grits are in places coarser than those which occur near the Aldgate township, and by following them down the creek they are seen to include rolled pebbles. In one instance, at least, a fragment of the older series was observed to be included in the upper beds near the line of junction, and also a rolled nodule of ilmenite. Lately I have had the privilege of being accompanied in a visit to the Aldgate section by my colleague, Mr. D. Mawson, B.Sc., Professor T. W. Edgeworth David, F.R.S., and Professor Skeats, D.Sc., who concurred in the interpretation that had been given to the beds.

The granite near Melrose's belongs to a much larger patch of the Pre-Cambrian beds than that which is exposed near Aldgate Station. It lies to the north-east of Stirling East, and can be seen on the main road going to Carey's Gully, about 200 yards from the Stirling East public school. It goes north-westerly to an unused north-and-south district road, and through Sir John Downer's and other properties to the district road between Piccadilly and Woodhouse, for three-quarters of a mile, beyond which it cannot be traced in that direction, in consequence of the ground falling suddenly away to low cultivated flats. On the main road to Woodhouse and the old sawmill it is clearly defined, but very rotten; and in a small quarry, near Cox's Creek, the junction of the granite with the slate rocks, and its intrusions into them, are clearly seen. The granite crosses the creek at the bridge, and outcrops on the rise of the hill on that side. A district road goes off from the Carey's Gully road, in a southerly direction, through Section 1203, along which the granite can be traced, making bold outcrops on Mr. A. H. Smith's grounds (Section 1133), and was proved in a well near the homestead at a shallow depth, yielding a moderate supply of water. It does not seem to pass behind Mr. Melrose's house (unless very near to it), as a quarry in Aldgate sandstone occurs in the grounds behind the house, with dip south-east at 30°. North-west of the house, quartz and ironstone outcrop; whilst on the low ground on the north side there is a large outcrop of granite, which is but slightly decomposed. Following the rise to the north-east, there are considerable outcrops of granite in a scrub, and these join on to those already described on the district road at Mr. Smith's, and in the section which shows the unconformity. This granitic patch may be regarded as about one and a half miles in length by about a mile in width. A special feature of the quartz veins, included in these Pre-Cambrian beds, is that they frequently contain ilmenite plates and nodules and grains, which is presumably the source of the detrital ilmenite abundantly present in the overlying grits and conglomerate.

The Grey Spur, Inman Valley.—The outcrop of the basal beds in the Inman Valley district is one of the most marked and instructive of those examined. It is approached by a district road, which crosses the Inman at the eighth milepost from Victor Harbour, passing over a ridge into a lateral valley. In this valley, near the homestead of Mr. J. J. Crossman, is the Dog Hill (Section 84, Hundred of Encounter Bay), exhibiting a very rocky face on its south-east side. This prominent ridge consists of a coarse conglomerate, and was named the Grey Spur by Mr. D. H. Cudmore, of Adare, Victor Harbour, who was the first to call attention to its remarkable features.

The matrix consists of a coarse arkose grit, the chief ingredients being quartz and felspar, mostly sharp or but slightly water-worn, and in places fragments of aplite. The pebbles are very numerous, strongly water-worn, and occur up to 10 inches in length. They consist mainly of a very hard siliceous quartzite, with rounded quartz, granitic, and other rocks. Layers and grains of ilmenite are distributed more or less throughout the bed. It is often laid down under current bedding, showing its derived origin, whilst some of the included quartz and other pebbles exhibit the same mineral of primary origin *in situ*.

At the base of the conglomerate, which is about 150 feet in thickness, is a layer of finer material a few feet thick, making an unconformable junction with the granitic and highly-altered schists and quartzites on which it rests.

The evidence of strain and shear, so generally present in the Mount Lofty Ranges, is strongly developed in the lower parts of the conglomerate. The line of junction with the older Pre-Cambrian beds appears to have shown itself a plane of weakness, and consequently of yielding along the line of least resistance. The basal portions of the beds have been greatly altered by shear, flattening out the particles, and drawing them out in the direction of the movement. The effect has been to convert the lower parts of the bed into a flattened, schistose structure. A similar effect has been produced on the included pebbles within the zone of shearing, flattening and drawing them out into long blade-like lenticles; whilst some of the quartzite pebbles have been converted into quartz-rock, making pseudo-quartz veins along the planes of bedding. The effect is most striking. In the upper parts of the conglomerate the included pebbles have suffered little or no distortion, but as they gradually approach the shear plane for some yards the deformation becomes increasingly evident. At one spot, near the bottom of the bed, differential movement could be detected in a line of fracture which passed through three adjacent pebbles, with the effect that the upper portions were carried forward 2 inches beyond those portions of the pebbles which were situated below the line of fracture.

No intrusive veins of quartz were observed passing up from the older beds into the Cambrian grits, although it is probable that the shearing took place at great depth, and was associated with some measure of hydro-thermic action, indicated by the development of quartz along the bedding planes, and which no doubt contributed to the plasticity of the pebbles under pressure and movement.

The conglomerate bed has been greatly fractured, exhibiting vertical smooth joints, the joint planes passing equally through matrix and pebbles, showing as clean and smooth faces as though cut by a knife.

The lower, or Pre-Cambrian, beds in this section consist chiefly of aplite in coarse crystals of quartz and felspar, sometimes passing into pegmatite or granite. The beds are much broken by quartz veins, which, together with the granite intrusions, have penetrated and greatly altered the sedimentary beds of this older series. The external appearance of these beds is very deceptive, for the molecular reconstruction has been so complete in many instances that what looks in general form like a sedimentary rock, shows, on fracture, complete crystalline structure. The beds contain much ilmenite, which is often sporadically developed, and generally in association with quartz. These granitoid beds are a leading feature in the Inman Valley exposures, and are of great extent.

The unconformity of the two series is determined upon the following considerations:—

A *The great discordance in structural features.*

(a) The underlying beds are to a large degree, crystalline, interpenetrating, and intrusive, inducing marked contact metamorphism in the sedimentary beds of the same series.

(b) The overlying grits and conglomerate are as clearly clastic in origin, and in no instance was it observed, in either the Aldgate or Grey Spur sections, that the aplitic veins pass over the line of junction and penetrate the upper series. In other localities, however, veins of pegmatite penetrate the Cambrian grits.

(c) The Pre-Cambrian beds are highly foliated, whilst the newer series, in the localities now more particularly referred to, gives no distinct evidence of foliation.

(d) The gritty particles forming the matrices of the upper beds give proof that they are derived, whilst the arkose character of these grits points to the disintegration of the underlying granitoid rocks as the source of the material.

(e) The occurrence of ilmenite in both series of beds is a characteristic feature: only, in the Pre-Cambrian it is a primary constituent, whilst in the Cambrian grits and conglomerates it is usually laid down on distinct planes of current deposition, showing its secondary origin. The quartz pebbles in the conglomerate, which have been derived from the older beds, frequently contain ilmenite crystals or plates.

B *The stratigraphical unconformity.*

(f) There is a distinct discordance shown along the plane of junction, the Pre-Cambrian having usually a much higher angle of dip (foliation) than the overlying beds.

Barossa.—At Williamstown, slates (probably the lower phyllites) outcrop in Victoria Creek, and are nearly vertical in their dip. Following the Mount Pleasant road, in a south-east direction, the basal grits, in a very decomposed condition, appear in the road cuttings. Thin veins of pegmatite are seen in the sections. About half a mile from the South Para River, on the same road, good sections are visible of these beds, with pegmatite veins, up to 22 inches or more, cutting obliquely across the bedding.

By following a district road, near Kangaroo Gully, these beds can be instructively studied, as they make very extensive outcrops on the ridge which runs south to the South Para River, including Sections 125, 126, 127, 136, and 222, Hundred of Barossa.

The beds are more highly metamorphosed than those of the Aldgate district, which can be explained from the fact that they are situated more easterly, and therefore more within the zone of metamorphism which becomes more and more marked in that direction. Instead of the felspathic cement, as in the Aldgate grits, mica is developed, and the stone often resembles a micaceous schist, whilst preserving the bedding-planes.

Ilmenite is present to an extraordinary degree, showing bedding-planes and cross-bedding in profusion. The presence of this mineral has had the effect of delineating in sharp lines the fitfulness of current action, furnishing some striking examples of this kind, and at the same time demonstrating the sedimentary origin of the beds. This is a feature which strongly differentiates the newer series from the older.

The presence of rounded pebbles in the grits accords with what is found in connection with these beds elsewhere. At the Grey Spur and at Forest Range the beds are characteristic conglomerates, whilst in other places the included pebbles are scattered irregularly through the matrix. This is the case with the Barossa beds. For a mile or more of outcrop these rounded stones are plentiful, but distributed singly rather than in layers or groups, and do not reveal the sorting action of water that is usual with clastic deposits. The stones are worn to a very high degree, being in nearly every case almost round, but there is no evidence of strong-current action in their transportation, as they are set in undisturbed finer material. The pebbles appear to consist of only two kinds: quartz, and a very fine-grained, siliceous quartzite, the sizes ranging up to ten inches or a foot; stones of 3 to 5 in. in diameter are very common. It is not easy to explain their occurrence under the conditions in which they are found. The beds give no evidence of ice action, as the bedding is undisturbed, and there is no indication of morainic material having been laid down, even by floating ice; whilst the limited variety of included pebbles is a further difficulty in assuming such an origin. To refer the beds to a crush conglomerate is equally out of the question, so that the difficulty must be left for a possible future solution.

The Pre-Cambrian beds are found underlying the basal grits near the southern extremity of the ridge, forming one of the south-western escarpments of the Barossa Ranges. The beds consist of a very coarse pegmatite, penetrating a true mica schist (mostly biotite), with accessories of beryls, tourmaline, and other minerals. The beds are highly foliated, showing a strike of 10° west of north, and a dip at 78° easterly. The exact junction between the Cambrian and the Pre-Cambrian beds cannot be seen at surface, as a narrow area of a few yards of grass separates the two, but the change is abrupt and strongly defined.

Other Localities.—Time has not permitted careful examination of other outcrops no less interesting than those just described. Of these the following may be mentioned:-

Forest Range.—This section (to which my attention was called by Mr. Robert Caldwell) occurs near the main road, five miles west of Balhannah. It presents a bold scarp to the east and south, about 200 feet in height. In lithological features it closely resembles the Inman Valley outcrop, in being a coarse conglomerate, with gritty matrix. Exposures of the conglomerate beds, much decomposed, can be recognized for most of the distance from Carey's Gully to the great outcrop of the Forest Range spur. The Pre-Cambrian slates, etc., follow the range on the east side of Carey's Gully.

River Torrens and Houghton.—A very interesting exposure of these beds can be studied in the Torrens, near the confluence of the Sixth Creek, and higher up the stream. The older series form a hill rising abruptly from the Torrens, to a height of seven or eight hundred feet. Its serrated and precipitous faces have suggested the local name of "the Devil's Staircase." The river has cut its way through its lower slopes and exposed fine sections. The beds are intensely altered slates, foliated, with felspar and quartz developed along the planes of foliation, giving the rock a gneissic character. Larger lenticles of a granitoid character are frequently present. On the western and southern sides of these older rocks the basal grits of the Cambrian series outcrop at a lower angle of dip. They closely resemble the ilmenite grits of Aldgate, with an occasional pebble included. The junction of the two series can be traced to Houghton, etc, in which direction the Pre-Cambrian beds are largely penetrated by granitic intrusions, some of which are of great width.

South Para.—The junction can be studied near Menzies' Barossa Mine, and in the South Para River, where very fine sections occur. The older rocks in this district develop a very characteristic augen-gneiss structure. They form the country rock at the Princess Alice Mine, and have been quarried to form the weir of the Barossa Reservoir.

Tanunda.—The felspathic grits are quarried near the township, and the older series is developed, under a great variety of lithological features, in the Tanunda Creek.

Yorke Peninsula.—The western limits of the Cambrian series are indicated on Yorke Peninsula by features closely analogous to those on the eastern side. At Ardrossan felspathic grits of Cambrian age rest unconformably on pegmatites and graphic granite. At Winulta Creek a coarse quartz conglomerate is seen to overlie similar granitic rocks. At Port Hughes, near Moonta, there is a coarse conglomerate and siliceous gritty quartzites outcropping on the beach. The included pebbles are nearly all quartz and rounded, similar to those of Winulta Creek. In certain zones the rock has been greatly cracked, and subsequently filled with quartz. These quartz veins run through matrix and pebbles quite indifferently. Dip, north, 20° west at 12°. No floor was visible, but granitic rocks outcrop at no great distance from the exposure.

X.—Pre-Cambrian Complex (Archæan).

The fundamental rocks which underlie the Cambrian series have been but slightly investigated. They occur as inliers of the Cambrian beds, sometimes several miles in extent. They are frequently in an advanced stage of decomposition, and in consequence have suffered extensive denudation and are reduced to low situations. Their study involves many difficult problems, but is of more than ordinary interest, as they will, no doubt, throw light on the early conditions of the Australian continent and the development of its orographic features.

The Pre-Cambrian rocks consist primarily of a sedimentary series, but these have been so altered under metamorphic action as frequently to obliterate their stratigraphical boundaries. They have been subjected to successive eruptive and intrusive conditions, which have profoundly modified both the texture and structure of the beds. In the central axes of the Mount Lofty and Barossa Ranges they include extensive areas of granitoid rocks, mostly under the forms of aplite and pegmatite. The batholiths and granitic dikes penetrated the sedimentaries, and were, in turn, penetrated by the later pegmatites and quartz veins, forming together an exceedingly complicated order of geological events.

One of the most attractive fields for investigation in relation to this subject is the pegmatization of the Pre-Cambrian sedimentaries, which is a special feature of their occurrence. In addition to the injection of thick dikes and veins of pegmatite, possessing a very coarse crystalline texture, the pegmatitic action has penetrated the schistose rocks over wide areas. In the slates the cleavage seems to have presented the planes of least resistance to the mineral solutions, with the result that the latter has, in many instances, completely penetrated the older slates, depositing, in parallel folia, strings, and lenticles, crystalline aggregates of felspar and quartz, giving the slates a granular or gneissic appearance. These lines of intrusive deposition may be almost microscopic in their fineness, or they may swell into lenticular aggregates of large size, causing the slaty laminæ to curve around them. As a rule, the pegmatitic material follows the cleavage planes, but at times it breaks across the cleavage and produces a tangential deposition. The gradual passage of these impregnated slates into a highly developed and characteristic augen-gneiss can be followed. At Aldgate and district we have examples of the former type, and at Barossa we have examples of the latter. No evidence could be clearer that gneiss, in some of its forms at least, can be developed under the conditions just described.

Van Hise, in his great work on metamorphism,* lucidly discusses the origin and phases of pegmatization. He concludes that pegmatites are formed in the latter stages of igneous intrusions, when the liquid rock becomes increasingly aqueous, and gradually passes into a hot-water solution. He states:—"From the water solutions true cementation takes place; from the rock solutions, true injection. Pegmatization comprises these and the intermediate processes. It is not to be expected that under great pressure and at high temperatures there is any sharp line of demarcation between the processes of aqueous cementation and igneous injection. At the surface it is usually easy to sharply separate aqueous from igneous action, but deeper within the earth even the strongest rocks are latently plastic. At great pressure heated waters must have power to absorb a quantity of material far beyond that at the

* A Treatise on Metamorphism, U.S. Geo. Sur. Monog. xlvii., p. 720.

surface of the earth. Truly liquid rock is highly impregnated with water. It, therefore, is probable that at considerable depths we have, on the one hand, material which all would call water solution, and on the other hand material which all would call liquid rock, with no sharp division-line between the two. If this be so, there are all stages of gradation between true igneous injection and aqueous cementation, and all the various phases of pegmatization may thus be fully explained."*

It is an interesting circumstance that Van Hise and others have observed in the United States a schistose impregnation which appears to be precisely similar to that which is exhibited in the Pre-Cambrian slates of South Australia. He says:—"This phase of pegmatization [the aqueo-igneous] is most extensive and best illustrated by rocks in which there is a gneissic or schistic structure, since cleavage furnishes planes of weakness which are readily taken advantage of by the igneous rocks. . . . Parallel to the folia are innumerable cementation-injection bands of lighter colour. These bands vary from those as thin as leaflets, being perhaps but a single row of crystals, to those of considerable width. There may be many such bands within the space of a centimetre, or a single one may be many metres across. Frequently parts of the injected material are in dike-like masses of varying size, which cut the schistosity at various angles. At numberless places the leaf-like bands of pegmatitic-looking material parallel to the schistosity are found to be connected directly with the dike-like masses cutting the schistosity."†

The final stage of this aqueo-igneous process is when the liquid residuum is distinctively a water solution, and is an agent of simple cementation, penetrating fissures and cavities caused by mechanical strain and porous beds, depositing quartz either diffused or in veins. No better illustration of this class of hydrothermal action could be had than occurs in the intimately reticulating veins of quartz, which penetrate the slates bordering the pegmatized areas of Aldgate. The weathering of the slate has freed the quartz from the matrix, strewing the ground with the scattered fragments, and in bare places giving the resemblance to a light cover of snow.

As accessory minerals in the pegmatized rock, the most prevalent are ilmenite and tourmaline. Both occur as inclusions of quartz. The ilmenite is in grains and plates, sometimes in considerable quantity. Tourmaline occurs, for the most part, as long acicular crystals of black colour. These

* A Treatise on Metamorphism, U.S. Geo. Sur. Monog. xlvii., p. 723.

† *Ibid.*, p. 725

are sometimes developed along certain planes in the slates. and still more commonly in vein quartz. If the vein is narrow, the rod-like prisms of tourmaline, mixed with quartz, cross the vein at right angles to the rock walls. When the vein reaches a thickness of a few inches the tourmaline becomes zonal, on either side of the quartz vein, exhibiting parallel dark bands, half an inch to an inch in thickness, which, when closely examined, is seen to consist of very fine bundles of tourmaline needles. Another mode of its occurrence is in larger prismatic crystals, in quartz, under an arrangement similar to that of graphic granite, the tourmaline taking the place of the felspar; whilst the strongly contrasted colours of the two minerals make a very striking effect when viewed in transverse section. Other accessories are beryls (yellow and blue), which are very common in the Mount Crawford district; garnets, chiastolite, etc.

XI.—General Considerations.

Information, at present, is too limited to attempt a full explanation of the great earth movements which built up the Mount Lofty and associated ranges. A few steps in advance, however, have been taken. The base of the Cambrian series has been determined, and the stratigraphical order of this very thick set of beds (so far as the central and western districts are concerned) is now fairly well understood. The eastern side of the ranges, with its highly metamorphosed rocks, presents greater difficulties, and these await solution. A few facts that will assist in reaching some generalizations may be mentioned.

It is clear that prior to the movement towards elevation the base of the Cambrians had become depressed to a great depth. This is made evident by the great thickness of the superincumbent beds and also by the metamorphosed condition of the beds, which must have sunk to such a depth. It has already been stated that pegmatite veins penetrate the Cambrian grits in the Barossa district. They are not so numerous or on so great a scale as those which intersect the Pre-Cambrian of the same and other districts, but their occurrence in the lower Cambrian beds is an important point of evidence. In the few examples of such intrusive dikes, noticed at Barossa, there was proof of inter-action between the rock mass and the intrusive dike. The latter, along either margin for the thickness of about an inch, showed a modification of crystalline structure as a selvage, approaching the comb-vein structure where the crystallization is developed at right angles to the retaining wall. From the difficulty in distinguishing arkose clastic material from thin intrusive veins, it is quite possible that the latter may exist in parts of the basal grits in a form almost indistinguishable to the eye. I was particularly struck with such a possibility when examining the coarse felspathic grits which rest immediately on the Pre-Cambrian beds near Melrose's, Aldgate. My friend and colleague, Mr. Mawson, B.Sc., discovered a pegmatite vein penetrating the Cambrian glacial till of Sturt Valley, which is at a considerably higher geological horizon than the basal grits.

There is thus sufficient evidence to show that there was, to a limited extent, contemporaneous pegmatization of both the Pre-Cambrian and the lower Cambrian, and was probably coincident with the maximum depression of the Cambrian series. If the Mount Lofty area received the full thickness of the Cambrian beds, as developed to the north of Adelaide, the depth to which they must have sunk during the period of their deposition must have equalled, if not exceeded, 20,000 feet, which would bring them well within the zone of metamorphic action.

The Mount Lofty Ranges, through a breadth of from 20 to 30 miles, exhibit anticlinoria on a large scale, but, through excessive denudation, the primitive foldings are truncated, and often obscure. The main axis of the uplift corresponds, roughly, with the centre of the highlands, although the Archæan core often occupies a less elevation than the superincumbent beds. From this ridge of elevation the beds, on the whole, dip away westwards and eastwards. A consideration of the causes which brought about the elevatory movement must be deferred until the eastern side of the ranges has been studied, and more particularly the great igneous belt which skirts the highlands of South Australia on their eastern and southern sides. It is, however, certain that the great earth-push came from the east, which determined the main north and south direction of the major folds—that is, the main folding has occurred at right angles to the folding forces, and has produced endless small overlaps and thrusts towards the west. There was also a nip between north and south, which contracted the area along the strike and diverted the main folds into a more or less tangential direction. This duplex system of crush has caused the beds, in many places, to roll in all directions, giving rise to a periclinal dip, producing either domes or saucer-shaped depressions. This feature is still more markedly developed in the Flinders Ranges. Small slips and overthrusts frequently occur on the line of strike, and are well seen on the beach between Brighton and Cape Jervis, where the sea has cut a floor of marine denudation.

The Mount Lofty ridge is in a condition of relatively rapid waste. The felspathic quartzites, of which it is largely composed, are greatly decomposed and but slightly cemented. When the mechanical action of running water is brought to bear on this material it is rapidly eroded. The clearing of scrub-lands and the cultivation of steep slopes are important contributory factors in producing this result. As the incoherent material is carried away by rain and rivers, the siliceous outcrops will become more prominent, and the valleys, following the direction of the more friable material, will become widened and deepened. In certain places this rapid denudation may have a disastrous effect on the productiveness of the gullies, and an economic foresight suggests that every effort should be exercised to conserve the soil in such situations where, by baring and loosening the ground under cultivation, it is liable to waste to an excessive degree.

EXPLANATION OF PLATE XII.

Fig. 1. Diagrammatic section of the Lower Cambrian beds from the River Torrens to the sea—about 15 miles.

Fig. 2. Diagrammatic section, from Mount Lofty to Aldgate, to illustrate how the Lower Limestone may be prevented from outcropping at the surface. Two parallel trough faults are shown in the section, by which the beds are thrown down to the east, and thereby cut off the limestone.

Fig. 3. Diagrammatic section, in which another explanation for the absence of the limestone at the surface is given, as alternative to the former. The section shows a normal fault, which hades in the direction of the dip of the beds. By this movement some beds slide down the fault-plane, and are thereby cut off from the surface.

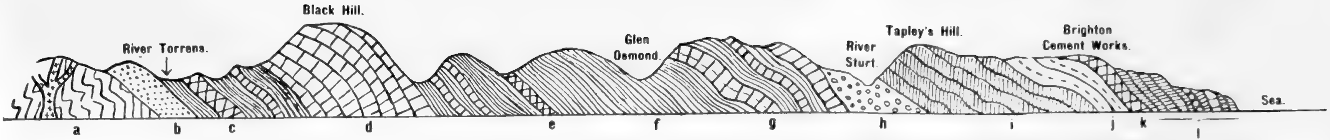

Fig. I.—DIAGRAMMATIC SECTION OF THE LOWER BEDS OF THE CAMBRIAN SERIES, FROM THE RIVER TORRENS TO THE SEA.

REFERENCES TO GEOLOGICAL HORIZONS.

a. Pre-Cambrian. b. Basal Grits and Conglomerates. c. The Lower (or River Torrens) Limestone. d. The Thick Quartzite. e. The "Blue-Metal" Limestone. f. The Thick (or Glen Osmond) Slate. g. The Glen Osmond and Mitcham Quartzite. h. Glacial Beds. i. Tapley's Hill Slates. j. Impure Siliceous Limestones. k. Brighton Limestone. l. Purple Slates, Quartzites, etc.

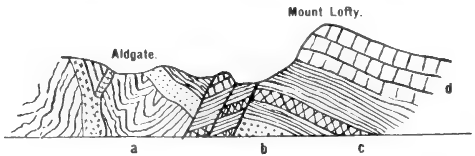

Fig. 2.

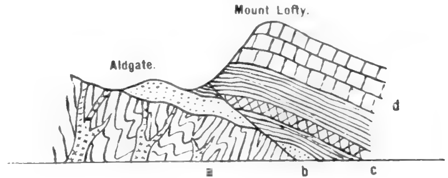

Fig. 3.

Hussey & Gillingham, Printers, Adelaide.

Further Notes on Australian Coleoptera, with Descriptions of New Genera and Species.

By the Rev. T. Blackburn, B.A.

[Read October 2, 1906.]

XXXVI.

LAMELLICORNES.

COPRIDES.

Onthophagus.

O. Macleayi, Blackb. I have received from Mr. R. C. L. Perkins a number of specimens from North Queensland, which I cannot venture definitely to pronounce specifically distinct from *O. Macleayi*, although they present some differences. They are of darker colour (dark piceous), with the apex and the hinder part of the lateral margins of the elytra red. This colouring points to the probability that the unique type of *O. Macleayi* is immature, its colour being dark red brown, with a traceable indication of still lighter colouring of the sides and apex of the elytra. The eyes are a little less distinctly granulate in the type (which again may result from immaturity), so that these recently acquired specimens do not fall so evidently as the type into the aggregate characterized in my tabulation (Tr.R.S.S.A., 1903, p. 270) as having the eyes "scarcely visibly facetted on their surface," although they certainly could not be referred to the other aggregate (of species having the eyes "conspicuously facetted"). On the whole, I believe them to be *O. Macleayi*. Among the Queensland specimens there is one male, all the rest (and also, contrary to my previous opinion, the type, assuming identity) being females. The male prothorax is much more massive than the female, with its front strongly and vertically declivous, the slight protuberances of the female notably exaggerated, and the puncturation of the dorsal surface finer and less close. The male clypeus is more elongated and narrowed in front, with its front almost evenly rounded. The sexual difference of the front tibiæ is almost nil. The Queensland specimens vary considerably in size (long., 3-4 l.), and in some of them the pronotum has a slight coppery gloss. The head of the male is unarmed.

O. bipustulatus, Fab. By some oversight I misplaced this species in tabulating the *Onthophagi* of Australia (Tr.R.S.S.A., 1903). I placed it among the species having the base of the pronotum without any raised or depressed margin, whereas it should stand among those having a fine raised margin along the base (Group V.), where its place will be beside, *Zietzi*, Blackb., and *nitidior*, Blackb. (page 271), from both of which it differs by the presence of a humeral red spot on each elytron. The punctures of its elytral interstices are notably stronger than those of *O. Zietzi*, and much less coarse than those of *O. nitidior*.

SERICIDES.

Diphucephala.

This extensive genus, no doubt on account of its species being for the most part of brilliant colourings, and many of them very abundant, contains numerous species whose so-called descriptions are scarcely worthy of being called descriptions at all. Consequently a really reliable monograph of its species is practically unattainable. On this ground, I have always hitherto omitted it when dealing with allied genera. As, however, the types are so scattered over the world that it is not likely one author can be in a much better position than another for solving the many enigmas of the genus, : only prospect of eventually reducing it to order seems to lie in someone making the best attempt he can at a revision of its contents, and so giving an opportunity for those who have access to individual types in isolated collections to confirm or correct with authority his identifications. It is with this idea that I offer the following notes on the genus, and I hope to be able at least to render it possible to identify the insects to which the specific names are applied in a memoir that, if in places needing correction, at any rate discusses all the existing names in a connected series. I have had the advantage of examining nearly all the types of Sir W. Macleay's species, and some of his identifications of species described in Europe, and therefore probably have at command as much profitable material for the work as anyone else could have.

The species of *Diphucephala* have been described under 56 names, the earliest description being, I think, that of *D. colaspidoides*, Schönh., published about the year 1806. The only treatises that I know dealing with the species collectively are those of Mr. G. R. Waterhouse (A.D. 1835), dealing with 16 species, and Sir W. Macleay (A.D. 1886) dealing with 43 species. The former of those treatises is, of course, obsolete, and the latter merely gives descriptions (many of them very insufficient) of the species known to the author, and which are divided into five groups, but not further classified. Burmeister, it is true, in 1855, included a synopsis of the genus in his "Handbuch der Entomologie," but it contained only a slight grouping of the species, and was little more than a repetition of Waterhouse, with the addition of three new species. Other authors only catalogued the species or described new ones. No *table* has been published to indicate the distinctive characters.

Of the 56 names referred to above, 11 are placed in Masters's Catalogue, which is, I believe, the latest catalogue of the Australian *Diphucephalæ*, as mere synonyms. The following of them I propose to assume to be correctly treated in that catalogue, although in most instances their determination (largely traditional) is very unlikely to be founded on examination of types, and, if that is the case, is little more than guesswork, owing to the insufficient nature of the descriptions. But since they have been assigned to certain species as synonyms, no end would be served by changing the assignment through a different guess. I propose, therefore, to let the following synonymy stand pending substantial reasons for changing it:—

D. foveolata, Boisd. = *aurulenta*, Kirby.
D. lineatocollis, Boisd. = *colaspidoides*, Macl. (? Gyll.).
D. splendens, W. S. Macl. = *colaspidoides*, Macl. (? Gyll.).
D. acanthopus, Boisd. = *furcata*, Guér.
D. pilistriata, Waterh. = *lineata*, Boisd.
D. ænea, Sturm = *rugosa*, Boisd.
D. viridis, Sturm = *sericea*, Kirby.
D. pusilla, Waterh. = *smaragdula*, Boisd.

The following synonymy of Masters' Catalogue must not be allowed to stand:—

D. pygmæa, Waterh. = *fulgida*, Boisd.

[Waterhouse's description applies to a very distinct and easily recognizable species. Boisduval's is quite worthless, founded on a specimen which had lost its legs, and is incapable of confident identification with any insect.]

D. Hopei, Waterh. = *furcata*, Guér.

[Waterhouse's description applies well to a very distinct species. Guérin's description (Voy. Coquille, vol. ii, 1830, p. 89), though very lengthy, cannot be definitely associated with the insect which Waterhouse described, because it omits reference to an important sexual character which Waterhouse correctly indicated in his species; it, however, applies very well to an insect closely allied to *Hopei*, and the only objection to regarding it as referring to that insect is its citing Port Jackson (instead of Western Australia) as the *habitat*. I take it that Guérin's *habitat* is erroneous, and I regard *Hopei* and *furcata* as two good species. It is to be noted that Waterhouse (Tr. Ent. Soc., I., 1836, p. 219) mentions a *D. furcata*, Guér., for which he gives the reference, "Griff. Cuv. Insecta,

I. p. 483," of which he gives a short diagnosis, adding his opinion that it is not a *Diphucephala.* I have not the work he refers to, but have no doubt Waterhouse's opinion is correct. The insect of which he furnishes the diagnosis is clearly, however, not that which Guérin described in Voy. Coquille.]

D. Spencei, Waterh.=*rugosa*, Boisd.

[Here again Waterhouse's description can be confidently identified with a familiar species; but Boisduval's *rugosa* might be any one of several *Diphucephalæ.* I think that I know *rugosa*, Boisd., from its being a common species near Sydney, and one of those that fit the description, and therefore I propose to retain the name and treat *Spencei* and *rugosa* as two good species. And here I may remark that Waterhouse himself seems to have confused the two species, since he states in a footnote to the description of *Spencei* that after writing it he had observed the female of that insect to differ from the male by the front angles of the prothorax not being produced. The female in question was no doubt a specimen of the insect that I take to be *rugosa*, Boisd. I have both sexes of both species before me, and do not find that there is any sexual difference in the front angles of the prothorax. This confusion of *Spencei* and *rugosa* no doubt is what accounts for Waterhouse's memoir not containing the description of so common a species as that which I have called *rugosa*, Boisd.]

Of species more recently described I find that *D. laticollis*, Lea (which I have received from its author), is evidently the species that Waterhouse described as *Spencei;* and an examination of the presumable type of *D. prasina*, Macl. (in the Macleay Museum), has satisfied me that it is the insect which I described as *D. Kershawi*, Macleay's being the older name.

I have now indicated as synonyms 10 of 56 names that have been used for *Diphucephalæ.* Of the remaining 46 I have been able to identify, with more or less confidence, and tabulate the characters of, 35 of the species that they represent, and I furnish below descriptions of 6 new species, bringing the total to 41 species. There are thus left 11 names to be accounted for, on which I make the following notes. To prepare these notes I have visited the Sydney Museums, and have there examined the specimens bearing the names that Macleay used for *Diphucephalæ*, but, unfortunately, with not very satisfactory results, as there is in very few instances any mark to indicate the actual type. In some cases specimens of more than one species bear the same name, and in one instance the presumable type differs widely in colouring from the description. I place the names now to be treated of in alphabetical order:—

D. azureipennis, Macl. The presumable type (in the Macleay Museum) does not seem to me to differ from *D. pulchella*, Waterh. It is a female.

D. cœrulea, Macl. Type presumably in the Brisbane Museum, which I have not visited. The description would fit several species.

D. cuprea, Macl. The presumable type (in the Macleay Museum) appears to me *D. rugosa*, Boisd., var.

D. fulgida, Boisd. The description cannot be identified with any particular species.

D. hirtipennis, Macl. Type presumably in the Brisbane Museum. The description does not enable me to place the species in my tabulation; but I think it is a good species which I have not seen.

D. humeralis, Macl. The presumable type (in the Macleay Museum) appears to me to be *D. rugosa*, Boisd., var.

D. latipennis, Macl. Type presumably in the Brisbane Museum. The description contains no definite information as to whether the longitudinal sulcus of the pronotum is divided in its basal part. If it be not divided, *latipennis* is probably near *Mastersi*, Macl.; if it is divided, the species will stand in my tabulation near *parvula*, Waterh.

D. lateralis, Macl. I can find no difference, except a little in colour, between the presumable type (in the Macleay Museum) and the species which stands in the same Museum (correctly, I have no doubt) as *D. pygmæa*, Waterh.

D. obscura, Macl. The presumable type in the Macleay Museum does not appear to differ, except in colour, from that of *D. nitidicollis*, Macl. The only definite distinction that the description indicates consists in the greater length of the lateral foveæ of the pronotum in *obscura;* but I do not find this a reliable character, except in a few instances of very peculiar lateral foveæ. The length of these foveæ varies somewhat within the limits of a species, and also appears different from different points of view.

D. pubiventris, Burm. The description of this species is very defective, and is founded on a female example. I am fairly confident, however, that the insect it represents is *D. rugosa*, Boisd. Macleay makes the name a synonym of *colaspidoides*, Macl. (? Gyll.), but, *inter alia multa*, the size that Burmeister assigns is much too small for that identification. According to Burmeister, *D. rugosa*, Boisd., is a synonym of *D. aurulenta*, Kirby; but the latter is one of the species that even the vague description of *D. rugosa* cannot be made to fit.

D. Waterhousei, Burm. Macleay says that he has never seen this species. Neither have I seen any species that fits the description. Burmeister says that the form of its front tibiæ is very remarkable, but the description of the tibiæ that follows does not specify any character that is not found in other species.

I now add notes on a few species which seem to call for special remark.

D. pulchella, Waterh. The female of this species is stated by Blanchard to have mucronate elytra. This is incorrect. Probably Blanchard had before him the female of the species which Macleay subsequently named *Barnardi*.

D. pusilla, Waterh. I have not been able to identify this species. Its author says that it is unique in the Macleay Museum, but I have failed to find it there. The description does not mention any very salient character by which the insect would be easily recognized. Waterhouse says that its allies are *D. parvula* and *D. Spencei*—two species that certainly are not closely allied, *inter se*, among the many *Diphucephalæ* now known.

D. smaragdula, Burm. It is possible (but only possible) that Macleay may be right in making *pusilla*, Waterh., a synonym of this species. It is most improbable that he had seen the type of *D. smaragdula*, and the description of that species would fit almost any *Diphucephala*. I have used Boisduval's name for a species which will, I think, be recognizable by the characters indicated in my tabulation, because that species, being one of the many that Boisduval's quasi-description fits, was taken at no great distance from Paramatta (the *habitat* cited for *smaragdula*), and under those circumstances it seems hardly safe to describe it as a new species.

The following tabulation shows the characters by which the *Diphucephalæ* known to me may be distinguished:—

A. Legs red.
  B. Longitudinal sulcus of pronotum even and narrow (in some species subobsolete).
    C. Puncturation of pronotum very fine and close (confluent).
      D. Size large (4 l. or more)... ... sericea, *Kirby*
      DD. Size small (less than 3 l.) ...
        E. Scutellum not punctured ... pubescens, *Macl.*
        EE. Scutellum punctured ... puberula, *Blackb.*
    CC. Puncturation of pronotum not as C.
      D. Base of elytra widely testaceous pulcherrima, *Blackb.*
      DD. Base of elytra not testaceous
        E. Lateral margins of elytra strongly dentate in the middle

EE. Lateral margins of elytra at most feebly angular in the middle ... ... ignota, *Macl.*

F. Sculpture of elytra obsolete around the apex ... nitens, *Macl.*

FF. Sculpture of elytra uniform, or nearly so ... ... rufipes, *Waterh.*

BB. Longitudinal sulcus of pronotum very wide and deep; lateral sulci large and approximating to each other.

C. Pubescence of elytra not running in conspicuous vittæ.

D. Size very large (5 l.) ... ... spreta, *Blackb.*

DD. Size much smaller (4l. or less) nitidicollis, *Macl.*

CC. Pubescence of elytra running in conspicuous vittæ.

D. Elytra very coarsely punctulate; red with greenish gloss ... richmondia, *Macl.*

DD. Elytra less coarsely punctulate, green ... ... lineata, *Boisd.*

BBB. Longitudinal sulcus of pronotum double at base ... ... minima, *Macl.*

AA. Legs metallic, and of dark colour.

B. Elytra red ... ... castanoptera, *Waterh.*

BB. Elytra metallic.

C. Longitudinal sulcus of pronotum not double in hind part.

D. Front tibiæ unarmed externally above apical process.

E. Inner margins of clypeal emargination parallel or subparallel in male. Elytral punctures deep and well-defined.

F. Pronotum somewhat strongly and less finely punctured beryllina, *Burm.*

FF. Pronotum very finely and feebly punctulate.

G. Pygidium of female with a large, deep impression Hopei, *Waterh.*

GG. Pygidium of female even furcata, *Guèr.*

EE. Inner margins of clypeal emargination strongly diverging in male. Elytral punctures feebler and less defined ... ... Mastersi, *Macl.*

DD. Front tibiæ with an external tooth above the apical process.

*E. Pronotum with longitudinal sulcus narrow, continuous, and even.

F. Inner apical spur of male hind tibia small, like that of intermediate tibia; female pygidium not having an elevated flat area.

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* *D. Carteri*, Blackb. (placed under EE), is somewhat intermediate between the two aggregates.

G. Inner margins of clypeal emargination of male quite parallel, or even approximating towards apex.

H. Elytral puncturation seriate, lightly impressed, and not very close ... ... Childreni, *Waterh*

HH. Elytral puncturation very close, strongly impresssed, and scarcely seriate ... ... affinis, *Waterh.*

GG. Inner margins of clypeal emargination evidently diverging in male ... Edwardsi, *Waterh.*

FF. Inner apical spur of male hind tibia very long; female pygidium bearing a flat elevated area ... ... colaspidoides, *Macl.* (*? Gyll.*)

EE. Dorsal sulcus of pronotum very different in front and hind parts, or very wide throughout.

F. Front angles of pronotum dentate, well separated from the head.

G. Scutellum not both very flat, and closely and finely asperate.

H. The lateral edging of the elytra does not quite reach the base. Size very large (more than 4 l.).

I. Middle of lateral margins of prothorax strongly dentiform elegans, *Blackb.*

II. Middle of lateral margins of prothorax feebly angular ... laticeps, *Macl.*

HH. Lateral edging of elytra normal.

I. Punctures of pronotum isolated and well-defined, for the most part including a single granule.

J. Lateral sulci of pronotum widely separated from longitudinal sulcus; female elytra mucronate ... Barnardi, *Macl.*

JJ. Lateral sulci of pronotum nearly or quite reach the longitudinal sulcus; female elytra normal.

K. Transversely impressed behind scutellum; apical part of pygidium nitid, with basal pilose area triangularly produced ... ... aurolimbata, *Blanch.*

KK. Not having elytra and pygidium as "K."

L. Hind part of scutellum bearing a deep, round fovea ... pulchella, *Waterh.*

LL. Pygidium normal ... ... smaragdula, *Boisd.?*

II. Punctures of pronotum feeble, ill-defined, and generally including several minute granules.

J. Sides of elytra (viewed from the side) quite straight rectipennis, *Blackb.*

JJ. Sides of elytra (viewed from the side) sinuate.

K. Elytral puncturation moderately strong and not exceptionally close.

L. Puncturation of pronotum (except fine close asperity) all but wanting... sordida, *Blackb.*

LL. Larger punctures of pronotum quite distinct.

M. Brilliantly nitid; longitudinal sulcus of pronotum forming a large subquadrate cavity in front of base ... quadratigera, *Blanch.*

MM. Much less nitid; longitudinal sulcus of pronotum smaller and not quadrate ... angusticeps, *Macl.*

KK. Elytral puncturation exceptionally fine and close ... ... crebra, *Blackb.*

GG. Scutellum very flat and even, closely and finely asperate.

H. Elytra normally (at most) costate.

I. Sculpture of head and pronotum strongly of subareolate character Spencei, *Waterh.*

II. No distinct areolæ, but only fine close asperity, forming sculpture of head and pronotum ... Carteri, *Blackb.*

HH. Elytra strongly costate ... ... prasina, *Macl.*

FF. Front angles of pronotum obtuse and not at all prominent ... ... rugosa, *Boisd.*

CC. Longitudinal sulcus of pronotum doubled in basal part.

D. Front tibiæ without any external tooth above the apical projection ... ... parvula, *Waterh.*

DD. An external tooth on front tibiæ above the apical projection.

E. Pronotum more or less nitid, its puncturation not very close and fine.

F. The two parts of the longitudinal sulcus of pronotum separated by a sharp strong ridge ... ... aurulenta, *Kirby*

FF. The two parts of the longitudinal sulcus of pronotum separated by a feebly-raised obtuse ridge.

G. Elytra more closely and less coarsely punctulate purpureitarsis, *Macl.*

GG. Elytra more coarsely and less closely punctulate ... ... obsoleta, *Macl.*

EE. Pronotum subopaque, owing to the very fine and close asperity of its surface ... ... pygmæa, *Waterh.*

D. puberula, sp. nov. Minus nitida; viridis, antennis clypeo pedibusque testaceo-rufis; supra pube sat densa brevi adpressa fulva vestita (hac in pygidio et in corpore subtus dilutiori magis densa); capite (ut pronotum) confertim subtiliter aspere punctulato; prothorace sat transverso, supra longitudinaliter anguste leviter canaliculato, sulcis lateralibus parvis (inter se remotis), antice fortiter angustato, lateribus minus arcuatis ad mediam partem dentato-angulatis pone medium leviter sinuatis, angulis posticis subrectis; scutello subtiliter punctulato; elytris confertim subtiliter aspere punctulatis, vix manifeste costulatis; tibiis anticis extus antice bidentatis.

Maris clypeo sat producto, quadrato, angulatim emarginato.

Feminæ clypeo minus fortiter minus angulatim emarginato; elytris ad apicem haud mucronatis. Long., $2\frac{1}{2}$ l.; lat. $1\frac{2}{5}$ l.

Closely allied to *D. pubescens*, Macl., but easily distinguishable by its smaller and punctulate scutellum, and by the non-mucronate apex of the elytra in the female. This species is confused in the Macleay collection with *D. pubescens*, Macl., but it is the one of the two that does not agree with Macleay's description of *pubescens*.

N. Queensland (Kuranda); taken by Mr. Dodd.

D. pulcherrima, sp. nov. Mas. Nitida, lætissime viridis, antennis (clava nigra exceptis) palpis pedibus (tarsis omnibus et tibiis posticis plus minusve infuscatis exceptis) et elytrorum parte tertia basali (sutura viridi excepta) clare testaecis; capite, pronoti lateribus, pygidio, et corpore subtus, setis minutis adpressis testaceo-griseis densissime vestitis; clypeo sat producto, quadrato, antice late leviter emarginato; capite crebre subaspere punctulato; prothorace leviter transverso, supra longitudinaliter anguste canaliculato, transversim prope marginem lateralem breviter sulcato, antice fortiter angustato, minus crebre (latera versus confertim subaspere) subfortiter punctulato (puncturis simplicibus), lateribus arcuatis vix sinuatis pone medium angulatis nec dentatis, angulis posticis subrectis (vix obtusis); elytris subseriatim subrugulose fortiter punctulatis, costis manifestis circiter 4 instructis; tibiis anticis extus antice bidentatis.

The remarkable colouring of this beautiful species separates it widely from all its described congeners. Long., $3\frac{1}{2}$ l.; lat., $1\frac{3}{5}$ l.

N. Queensland (Cairns). Sent by Mr. French.

D. rectipennis, sp. nov. Mas. Sat nitida; sat angusta; elongata; cœrula, purpureo-tincta, antennis nigris; supra parce subtus sat crebre albido-pubescens; capite crebre subtiliter ruguloso; clypeo lato, transversim quadrato, antice reflexo et sat profunde emarginato; prothorace minus transverso, supra obscure subareolato (areolis granula minuta nonnulla includentibus), sulco longitudinali simplici sat profundo ab apice ad basin gradatim latiori, sulcis lateralibus sat profundis supra haud plane conjunctis, lateribus in medio dentato-angulatis, angulis anticis leviter dentiformibus posticis obtuse rectis; scutello minus æquali vix perspicue punctulato; elytris modice [fere ut *D. colaspidoidis*, Macl. (? Gyll.)] sculpturatis, lateribus rectis; tibiis anticis extus antice modice (ut *D. Edwardsi*, Waterh.), bidentatis, intus haud productis. Long., 3 l.; lat., $1\frac{1}{2}$ l.

Remarkable for the straightness of the margin of the elytra, which is more straight even than that of *D. pulchella*. The present insect resembles *pulchella* in some respects, but its pronotum is very differently sculptured—the sculpture having an areolated appearance after the manner of that of *D. Spencei*, Waterh., and others—and the longitudinal sulcus of the pronotum is in the hind part very much wider than that of *pulchella*, and continues to widen quite to the actual hind margin of the segment. The colour seems to change from blue to green, according to the point of view from which the specimen is looked at. The bidentation of the front tibiæ is of the character of the same in *D. Edwardsi*, rather than in *D. colaspidoides*.

Australia; I do not know exact *habitat;* unique in my collection.

D. sordida, sp. nov. Sat nitida; obscure cuprea nonnihil viridimicans, vel ænea, antennis palpisque obscure ferrugineis; supra sat sparsim subtus magis crebre albidopubescens; capite crebre subtiliter punctulato, puncturis nonnullis majoribus vix impressis; prothorace sat transverso, supra sat obsolete subareolato (areolis granula minuta nonnulla includentibus), sulco longitudinali simplici sat profundo ab apice ad basin gradatim latiori, sulcis lateralibus sat profundis supra vix plane conjunctis, lateribus in medio angulatis vix dentatis, angulis anticis manifeste prominentibus vix dentiformibus posticis obtuse subrectis; scutello longitudinaliter canaliculato, postice nonnihil impresso, vix manifeste punctulato; elytris modice [fere ut *D. colaspidoides*, Macl. (? Gyll.)] sculpturatis, lateribus sinuatis; tibiis anticis extus antice modice (ut *D. Edwardsi*, Waterh.) bidentatis, intus haud productis.

Maris clypeo ut præcedentis (*D. rectipennis*, Blackb.); feminæ antice leviter sinuatim emarginato. Long., $2\frac{3}{4}$-$3\frac{1}{2}$ l.; lat., $1\frac{1}{2}$-$1\frac{3}{5}$ l.

This species stands unnamed in the Macleay Museum. It is of an obscure dingy-copper or bronzy colour, with dull greenish reflexions, the green somewhat more pronounced on the under-surface. It is especially characterized by the extreme faintness of the quasi-areolation of its pronotum. It does not seem very closely allied to any other species known to me. I have taken it in some numbers.

New South Wales; Blue Mountains.

D. crebra, sp. nov. Mas. Sat nitida; supra læte viridis, subtus cyanea, antennis (clava obscura excepta) ferrugineis; supra sat sparsim subtus magis crebre albido-pubescens; capite crebre subtilissime aspera; clypeo minus lato, modice producto, antice angulatim sat fortiter emarginato; prothorace sat transverso, supra obscure subareolato (areolis granula minuta nonnulla includentibus), sulco longitudinali ab apice ad basin gradatim latiori (parte postica fere subquadrata), sulcis lateralibus sat profundis supra (certo adspectu) conjunctis, lateribus in medio angulatis haud plane dentatis, angulis anticis subdentiformibus posticis sat rectis; scutello longitudinaliter canaliculato, subtiliter punctulato; elytris crebre minus fortiter [quam *D. colaspidoidis*, Macl. (? Gyll.), multo magis crebre minus fortiter] sculpturatis, lateribus leviter sinuatis: tibiis anticis antice extus leviter bidentatis, intus inermibus. Long., $2\frac{1}{5}$ l.; lat., $1\frac{1}{10}$ l.

The sculpture of the elytra of this species is not much different from that of *D. pygmæa*, Waterh. My specimen was sent to me by Mr. Lea, without indication of exact *habitat*, as *D. purpureitarsis*, Macl, which, however, has widely different sculpture of the pronotum.

Australia.

D. Carteri, sp. nov. Mas. Sat nitida; obscure viridis, plus minusve aureo-micans, antennis pedibusque picescentibus; supra sat sparsim subtus magis crebre albido-pubescens; capite cum pronoto confertim subtilissime aspero; clypeo lato, transversim quadrato, antice reflexo sat profunde emarginato; prothorace sat fortiter transverso, supra sulco longitudinali subobsoleto sed sat lato, sulcis lateralibus sat magnis vix profundis supra nullo modo conjunctis lateribus in medio angulatis (angulis subdentiformibus), angulis anticis subdentiformibus posticis subrectis; scutello sat plano sat æquali, confertim aspero; elytris crebre minus fortiter [quam *D. colaspidoidis*, Macl. (? Gyll.) multo magis crebre paullo minus fortiter] puctulatis, vix perspicue costulatis, lateribus sinuatis, tibiis, anticis antice extus bidentatis intus inermibus. Long., $2\frac{3}{4}$ l.; lat., $1\frac{1}{2}$ l.

Allied to *D. Spencei*, Waterh., but much less strongly sculptured, and of duller colouring. The longitudinal sulcus of the pronotum is remarkably faint, and does not increase in width hindward in any considerable degree. Such as it is, however, this sulcus is distinctly wide, but to a casual glance it does not appear very much different from that of some species with a faint but (when closely examined) much narrower sulcus.

New South Wales; Kosciusko.

SERICOIDES.

Automolus.

I furnished some preliminary notes on this genus in the preceding memoir of the present series (T.R.S.S.A., 1905), in the course of which I pointed out that its essential feature of distinction from Liparetrus is in my opinion the structure of its front tibiæ. Subsequent observation has shown that this same character distinguishes it from all the other known Australian genera of *Sericoid Melolonthides*, except *Caulobius* and the very widely separated genus *Mæchidius*. *Caulobius* was founded by Le Guillou (Rev. Zool., 1844, p. 224), for a species from Hobart which he named *villosus*,* and of which I have examples from the locality cited, agreeing perfectly with the descriptions, both generic and specific. Blanchard (Cat. Coll. Ent., 1850) states that that species is identical with *Silopa pubescens*, Er., and *Omaloplia villigera*, Hombr., and Jacq. (both described two years previously to Le Guillou's description). Blanchard's authority is not conclusive in respect of Erichson's species, and as the descriptions do not agree (*e.g.*, Erichson makes the claws of *pubescens* bifid) he is no doubt mistaken in respect of *pubescens*. But as he doubtless had the collection of Hombrot and Jacquinot before him, his authority ought, I think, to be accepted for the statement that *O. villigera* is a *Caulobius*, and, that being granted, there can be little doubt that he is right in identifying it with Le Guillou's insect, which must, therefore, stand as *Caulobius (Omaloplia) villiger*, Hombr. and Jacq. In a former memoir (Tr.R.S.S.A., 1898), I associated provisionally with *C. villiger* several new species that appeared to me (chiefly on account of different *facies*) not unlikely to be eventually regarded as generically distinct from it. I am still of the same opinion regarding these insects, but the unquestionably close structural alliance between *Automolus* and *Caulobius villiger* (in spite of great difference of facies) only recently observed by me, aggravates the generic difficulty. The species described as *Caulobii* (?) in my former memoir

* I may remark in passing that by a clerical error I called this species "*C. pubescens*, Le Guill.," instead of "*C. villosus*, Le Guill.," in Tr.R.S.S.A., 1898, p. 49. I hope that anyone having occasion to refer to the memoir in which this *lapsus calami* occurs will be good enough to correct it.

are in facies intermediate between *Automolus* and *Caulobius villiger*, in view of which I regard it as possible that the two may eventually have to be merged in one aggregate, the name *Automolus* being dropped as a synonym of *Caulobius*. As, however, it is easy to distinguish the *Automoli* from *C. villiger* and the species I have associated with it, by the elytra of the former leaving the greater part of the propygidium exposed, while those of the latter almost or quite cover the propygidium, it is convenient to maintain both names provisionally. The following tabulation will enable the student to distinguish the species I regard as *Automoli* and *Caulobii* from the rest of the genera that seem to me to form with them a natural group, and also from all other known Australian genera of *Sericoides*.

A. Claws simple.	
B. Prosternal sutures closed.	
C. Eyes small, not (or scarcely) prominent, and very conspicuously granulate.	
D. Body winged.	
E. Front tibiæ not as in EE.	
F. Elytral not striped with conspicuous wide pubescent vittæ.	
G. Elytra not regularly striate.	
H. Clypeus strongly margined in front ...	Liparetrus
HH. Clypeus not (or scarcely) margined in front	Comophorus
GG. Elytra regularly and strongly striate	Microthopus
FF. Elytra striped with conspicuous wide pubescent vittæ	Haplopsis
EE. Front tibiæ having externally a straight margin between two subapical and one basal tooth.	
F. Elytra leaving a large part of the propygidium exposed	Automolus
FF. Elytra almost or quite covering the propygidium	Caulobius
DD. Body apterous	Callabonica
CC. Eyes not as in the above genera	Colpochila & its allies
BB. Prosternal sutures open to receive the antennæ	Mæchidius
AA. Claws not simple	Heteronyx & its allies

I refer, then, to *Automolus* as distinguished from *Caulobius*, all the known Australian *Sericoides* having the tibial structure mentioned above, and having the greater part of their propygidium not covered by the elytra. This distinction is perhaps open to objection on the ground that accidental circumstances—such as distortion—may affect its reliability; but, nevertheless, it is found on examination that the principal part of the propygidium is, in the case of *Caulobius*, a surface, from its want of sculpture and vestiture, evidently designed to be a covered part of the body, while in *Automolus* the sculpture and vestiture are evidently those of an exposed segment, and are more or less uniform with those of the pygidium.

The antennæ of *Automolus* are not easy to examine, the joints between the 2nd and the club being very short, and their sutures difficult to distinguish. When paucity of specimens forbids the removal of an antenna I have been unable to arrive at certainty as to the number of joints of the antennæ in the species before me. I have not, therefore, been able to use this character in tabulating the *Automoli*, but I can say that the antennæ are by no means of uniform structure, there being in most of the species eight joints only, of which three form the club, while in at least one species there are certainly nine joints, of which three form the club, and in two species known to me the club (of at least one sex) consists of four joints.

The *Automoli* have a most remarkable sexual character in the elytra of the female, which appears to have been overlooked in the descriptions of all the hitherto described species. This consists in an elevated nitid space (varying in size and position with the species), which in some (*e.g.*, *poverus*, Blanch.) is extremely conspicuous; while in others it is small enough to be easily disregarded. Other sexual characters are found in the greater elongation of the antennal flabellum and peculiarities (very pronounced in some species) in the front tarsi of the male.

According to Burmeister (who uses the name "*Liparetridæ*" for the aggregate, which Lacordaire—and I in these memoirs—call "*Sericoides*") the genera *Automolus* and *Caulobius* belong to different sub-aggregates distinguished by the comparative length of the ventral segments—the 5th segment in the former being longer than, and in the latter equal to, the 4th. My observations show that there is an evident variation in this respect in closely-allied species, corresponding to the variation in the size and prominence of the propygidium on the dorsal surface—so that Burmeister's distinction between *Automolus* and *Caulobius* is in reality the same that I have indicated in the tabulation above. I cannot, however, regard it as of sufficient importance to be used in forming groups of genera—indeed, as already remarked, I doubt its being even generic.

It should be further noted that the elytra of the typical *Automoli* have a characteristic outline. Their lateral margin is more or less strongly sinuate, and they are narrowed behind in such fashion that outside a short apical portion of them the surface of the abdomen is to a greater or less extent visible on either side. In *Caulobius villiger*, and in the other species that I now attribute to *Caulobius*, the lateral margins of the elytra are straight, or almost straight, and the elytra are not narrowed hindward; but one which I attributed formerly to *Caulobius*, and which I now transfer to *Automolus* on account of its exposed propygidium [*A. (Caulobius) evanescens*], has elytra intermediate in form between those of a typical *Automolus* and of *Caulobius villiger*.

It appears to me quite possible that when both sexes are known of all the species which I now place in *Automolus* and *Caulobius* it may be found necessary to form, for species that do not appear quite at home in either of those genera, at least one new genus. Meanwhile, the tabulation given above will enable the student to assign without hesitation any of them to the genus in which I should place it.

Hitherto only the typical species (*angustulus*, Burm.) has been referred to *Automolus*, but 17 other names, which appear to me clearly referable to this genus, have been given to species that have been attributed by their authors to *Liparetrus* or *Caulobius*. Three of these names, however, I believe to be synonyms, viz., *Automolus (Liparetrus) basalis*, Macl. (nec. Blanch.) = *bicolor*; Blackb., *Automolus (Liparetrus) Cooki*; Macl. = *depressus*, Blanch., *Automolus (Liparetrus) unicolor*, Macl. = *humilis*, Blanch., female. I regard it as barely possible that also *Automolus (Liparetrus) alpicola*, Blackb. = *angustulus*, Burm. This synonymy will be found more fully discussed below. I therefore regard *Automolus* as consisting of 15 species, already described, and to these I have now to add 6 new species, bringing the number of Australian *Automoli* up to 21, all of which I believe that I know, except *angustulus*, Burm.

The following is a tabulation of the distinctive characters of the species that I place in the genus *Automolus*:—

A. Lateral part of elytra vertical, its limits defined both above and below. Antennal club four-jointed in both sexes, so far as known.
- B. Pilosity of elytra as long as of pronotum ... ... hispidus, *Macl.*
- BB. Pilosity of elytra much shorter ... aureus, *Blackb.*

AA. Lateral part of elytra not as in A. Antennal club, so far as known, only three-jointed in both sexes.

B. Head and pronotum with long dense, generally erect, pilosity.
  C. Pygidium clothed with fine hairs.
    D. Pilosity of pronotum dark, at least in middle part of disc.
      E. Elytra red, in some examples somewhat blackish along base.
        F. Pilosity of propygidium and pygidium long ... ... bicolor, *Blackb.*
        FF. Pilosity of propygidium and pygidium short ... Burmeisteri, *Macl.*
      EE. Elytra black.
        * F. Two rows of punctures in each of the elytral striæ... striatipennis, *Macl.*
        FF. Elytra not having striæ furnished with two rows of punctures ... ... funereus, *Blackb.*
    DD. Pilosity of pronotum entirely of pale colour.
      E. Nitid area on elytra of female is sublateral and extends from base to apex ... ... semitifer, *Blackb.*
      EE. Nitid area on elytra of female is sublateral and subapical (a sharply-limited, large, strong convexity) ... poverus, *Blanch.*
      EEE. Nitid area on elytra of female much smaller, at most not a sharply-limited strong convexity.
        F. Elytra red, or, at any rate, only blackish across base.
          G. Clypeus much produced in both sexes. Elytra not closely punctured. Male front tarsi very thick ... alpicola, *Blackb.*
          GG. Clypeus much less produced. Elytra closely punctured. Male front tarsi much less thickened.
            H. Pubescence of propygidium and pygidium close and entirely adpressed ... ... ordinatus, *Macl.*
            HH. Pubescence of propygidium erect, finer, and less close ... ... depressus, *Blanch.*
        FF. Elytra black, with an oblique red area on disc ... pictus, *Blackb.*
  CC. Pygidium clothed with coarse scale-like setæ ... ... valgoides, *Blanch.*
BB. Head and pronotum clothed with fine, erect, very short, and extremely dense pilosity ... ... irrasus, *Blackb.*

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* I accidentally omitted to examine the type of this insect in the Macleay Museum, and therefore have determined its place in this tabulation by a study of the description.

BBB. Head and pronotum with little pilosity, at most fine adpressed sparse hairs.
  C. Punctures of pronotum very coarse and by no means close ... ... pygmæus, *Macl.* (*?Burm.*)
  CC. Punctures of pronotum not as C.
    D. Propygidium of comparatively small size.
      E. Clypeus of male much narrowed forward and rounded at apex ... ... evanescens, *Blackb.*
      EE. Clypeus of male wider, shorter, and tridentate at apex ... ... opaculus, *Blackb.*
    DD. Propygidium enormous.
      E. Antennæ entirely testaceous... major, *Blackb.*
      EE. Club of antennæ black.
        F. The depressed part of pygidium bears a longitudinal sulcus ... ... granulatus, *Blackb.*
        FF. The depressed part of pygidium not longitudinally sulcate ... ... humilis, *Blanch.*

I shall now furnish notes on species already described, and add descriptions of new species.

A. (Liparetrus) hispidus, Macl. I have examined the presumable type of this species in the Macleay Museum. It is, I think, a male. Two specimens in my own collection are certainly male and female. The elytra of the female bear a strongly convex, highly nitid, glabrous elongate sublateral area, commencing at about the middle of the length and bent inward near the apex to join the subapical callus. It does not differ much from the male in other respects. In both sexes the antennal flabellum has four joints, which are a little shorter in the female than in the male.

A. (Liparetrus) aureus, Blackb. This species remains unique in the South Australian Museum. It is near to *A. hispidus*, Macl., but the pilosity of its elytra is so much shorter than in that insect that I have little doubt of its specific validity. The specimen is a male, and it is therefore, though probable, not certain that its female has antennæ with a four-jointed flabellum.

A. (Liparetrus) bicolor, Blackb. Identical with specimens named *L. basalis*, Blanch., in the Australian Museum. I have already (Tr. Roy. Soc., S.A., 1905, p. 312) stated my reasons for thinking that Macleay was mistaken in this determination. This insect is somewhat close to *A. (Liparetrus) depressus*, Blanch., but is readily distinguishable by the very much darker pilosity of its pronotum and the notably coarser sculpture of its elytra.

A. (Liparetrus) Burmeisteri, Macl. I have identified this species by comparison with the presumable type in the Macleay Museum.

A. (Liparetrus) alpicola, Blackb. I have already (Tr. Roy. Soc., 1905, p. 332) discussed the possibility of this being identical with *A. angustulus*, Burm. (the type of the genus).

A. (Liparetrus) ordinatus, Macl. This species is near to *A. (Liparetrus) depressus*, Blanch. Macleay distinguishes it by its pilosity being "decumbent." I believe this to be a satisfactory distinction when applied to specimens in their natural condition, but I find that the pilosity on *depressus* is easily made decumbent by artificial means (*e.g.*, passing a wet brush over it). The dense adpressed pilosity of the propygidium and pygidium of *ordinatus*, however, is essentially different from the finer, erect, and much less close pilosity of the corresponding segments in *depressus*.

A. (Liparetrus) depressus, Blanch. I have before me a long series of *Automoli* from almost all parts of New South Wales, Queensland, and Victoria, among which *depressus* is undoubtedly included. They vary considerably in size and somewhat in colour, but I cannot find characters in them to indicate more than one species. Some of them from North Queensland are of small size and evidently identical with the presumable type of *A. (Liparetrus) Cooki*, Macl., in the Macleay Museum, which Macleay distinguishes from *depressus* only by assigning a smaller size to it.

A. (Liparetrus) pygmæus, Macl. (? Burm.). The specimen before me of this insect is certainly identical with that which stands in the Australian Museum as *L. pygmæus*, Burm., and is, therefore, presumably that which Macleay described under that name in his Monograph of *Liparetrus*. In that case Macleay was mistaken in placing the species among those with only 8 antennal joints, as the stipes undoubtedly has a minute 4th joint, closely connected with the basal joint of the lamella. Whether Macleay's identification was correct, appears, however, doubtful in the extreme, not only because Burmeister, as the author of *Automolus*, would have been unlikely to place one of its species in *Liparetrus*, but also because Burmeister's description does not agree with Macleay's *pygmæus*, representing it as *inter alia* smaller, with less coarse punctures *(nadelstichpuncten)*, forming on the elytra regular (Macleay calls them "irregular") rows. Nevertheless, as among extensive collections from Western Australia that I have examined I have not seen any other species that could possibly be *pygmæus*, Burm., I think this one may reasonably be called provisionally "*pygmæus*, Macl. (? Burm.)."

A. (Liparetrus) humilis, Blanch. The species that I identify with this name is so identified in the Macleay Museum, and is doubtless that described as *humilis* in Macleay's Monograph. I have specimens from various localities (from Sydney to tropical Queensland) in eastern Australia.

A. (Liparetrus) unicolor, Masters. This was originally described by Macleay as *L. concolor (nom. præocc.)*. It is found in the same localities as *A. humilis*, from which I cannot distinguish it, except by colour and sexual characters, and of which I have no doubt it is the female.

A. funereus, sp. nov. Mas. Ovatus: subnitidus: niger, antennis (clava excepta) rufescentibus; pilis subtilibus erectis sat elongatis (in elytris brevioribus) vestitus (his in capite pronoto elytrisque nigris, in aliis partibus albidis); antennis 8-articulatis (?), clava quam articuli ceteri conjuncti haud breviori; clypeo antice subtruncato (vix sinuato) modice reflexo, crebre subgranulose ut frons (hac convexa) punctulato; prothorace fortiter transverso, supra æquali, ut frons punctulato, antice sat angustato, lateribus leviter arcuatis; elytris crebre minus subtiliter subseriatim punctulatis, vix manifeste bicostatis; propygidio crebre, pygidio sparsius (hoc æquali) fortiter punctulatis; tibiis anticis ad apicem bi- (ad basin uni-) dentatis; tarsis anticis sat fortiter elongatis, posticorum articulo. 2° quam basalis plus quam duplo longiori. Fem. latet. Long., 2 l.; lat., $1\frac{1}{5}$ l.

This species is readily distinguishable from its congeners by the characters cited in the tabulation. As it is unique in my collection I cannot bring myself to sacrifice an antenna for separate examination, but I am almost sure that there are only three joints in the very short stipes.

New South Wales.

A. semitifer, sp. nov. Fem. Ovatus: subnitidus: nigro-piceus, antennis palpis elytris (his circa scutellum infuscatis) et abdomine rufis, pedibus plus minusve rufescentibus; pilis elongatis erectis pallidis (his in pronoto medio vix, in elytrorum lateribus manifeste, infuscatis) vestitus; antennis 8-articulatis, clava quam articuli ceteri conjuncti parum breviori: clypeo antice late subtruncatim rotundato, parum reflexo, crebre sat grosse granulatim (ut frons pronotumque) punctulato: prothorace fortiter transverso, antice sat angustato, supra æquali, lateribus modice arcuatis: elytris subfortiter (versus suturam nec latera seriatim) punctulatis, sat perspicue bicostulatis, area glabra pernitida sat lata sublaterali totam longitudinem percurrenti: propygidio pygidioque (hoc æquali) ut pronotum punctulatis; tibiis anticis ut *A. funerei*, Blackb., dentatis; tarsis anticis brevibus, posticorum articulo 2° quam basalis vix duplo longiori. Long., $2\frac{1}{2}$ l.; lat., $1\frac{1}{4}$ l.

The pilosity of the pronotum of this species is of a somewhat darker tone of colour on the middle of the disc than elsewhere, though very different in colour from that of the preceding species. In that respect, however, the insect must be regarded as somewhat intermediate between the two aggregates which I have distinguished by the colour of the pilosity of the pronotum. The only sex known to me (the female) is, however, quite incapable of confusion with any other female *Automolus* that I have seen, on account of the presence of a wide, glabrous, and brilliantly nitid vitta near the lateral border, traversing the whole length of the elytra and dividing the otherwise uniformly pilose surface by a kind of lane which presents a very characteristic appearance if the insect be looked at obliquely from in front. I have not been able to identify the male of the species, but as I have seen four examples of the female I suspect that the other sex is among the *Automoli* before me, and is not distinguishable by any very noticeable character from the male of *A. depressus*, Blanch.

New South Wales (sent by Mr. Lea from Galston).

A. pictus, sp. nov. Mas. Ovatus; subnitidus; piceo-niger, antennis (clava excepta) palpis pedibus et in elytris macula magna discoidali ovali obliqua rufis; pilis erectis subtilibus pallidis sat elongatis vestitus; antennis 8-articulatis (?), clava quam articuli ceteri conjuncti haud breviori; clypeo antice late rotundato (vix subtruncato), sat late reflexo, crebre subgranulatim punctulato; fronte convexa, fortiter vix crebre vix rugulose punctulata; prothorace minus transverso, antice sat angustato, supra æquali, grosse minus crebre nec rugulose punctulato, lateribus parum arcuatis; elytris sat crebre sat fortiter subrugulose vix seriatim punctulatis, vix manifeste costulatis; propygidio pygidioque fere ut pronotum punctulatis; tibiis anticis ut *A. funerei*, Blackb., dentatis; tarsis anticis modice elongatis, posticorum articulo 2° quam basalis multo longiori Fem. latet. Long., 2 l.: lat., 1 l.

The markings on the elytra of this species (probably constant in the male) readily distinguish it. Other distinguishing characters are found in the red colour of its legs, the coarse puncturation of its pronotum, the almost complete absence of prominent lines on its elytra (of which there is no trace at all except faint indications of one near the suture).

As the species is unique in my collection I have not been able to examine the antennæ under a microscope, but I am almost sure that there are only three joints in the stipes.

North Queensland.

A. opaculus, sp. nov. Ovatus; sat opacus; piceo-niger, antennis (clava excepta) palpis et elytris (nonnullorum exemplorum) plus minusve rufescentibus; pilis subtilibus pallidis adpressis minus crebre vestitus; antennis 9-articulatis; clypeo antice breviter tridentato, cum fronte (hac minus convexa) subtiliter granulato; prothorace fortiter transverso, antice angustato, supra æquali, sparsim granulato-punctulato, lateribus arcuatis; elytris crebre subseriatim minus fortiter granulato-punctulatis, minus perspicue bicostulatis; propygidio sat crebre, pygidio minus crebre, squamoso-punctulatis; tibiis anticis ut *A. funerei*, Blackb., dentatis.

Maris quam feminæ antennarum clava magis elongata, tibiarum anticarum dentibus minoribus, tarsis anticis crassioribus, posticorum articulo 2° quam basalis minus quam duplo longiori.

Feminæ pygidio longitudinaliter impresso: tarsorum posticorum articulo 2° quam basalis duplo longiori. Long., $1\frac{3}{5}$-2 l; lat., $\frac{4}{5}$-1 l.

Its opaque dorsal surface distinguishes this species from all the preceding. It is near *A. (Caulobius) evanescens*, Blackb., from which the form of its clypeus readily separates it. The female has a small nitid sexual area on the subapical callus.

Western Australia (Perth).

A. irrasus, sp. nov. Ovatus; subnitidus; rufus, antennarum clava capite prothorace sternisque plus minusve infuscatis; pilis pallidis (his supra brevibus erectis confertim positis, subtus longioribus minus crebre positis) vestitus; antennis 8-articulatis; clypeo antice subtruncato (vix subemarginato), sat reflexo, cum fronte (hac convexa) pronotoque crebre minus subtiliter subrugulose punctulato; prothorace sat transverso, antice angustato, supra æquali, lateribus sat arcuatis; elytris obsoletissime striatis, confertim subseriatim nec profunde nec subtiliter punctulatis, haud costulatis; propygidio pygidioque fere ut pronotum (sed paullo minus crebre) punctulatis; tibiis anticis ut *A. funerei*, Blackb., dentatis; tarsis anticis brevibus.

Maris quam feminæ antennarum clava magis elongata, tarsis anticis paullo longioribus, posticorum articulo 2° quam basalis minus quam duplo longiori.

Feminæ tarsorum posticorum articulo 2° quam basalis duplo longiori. Long., $1\frac{3}{4}$-2 l.; lat., 1 l.

Remarkable for its almost uniform rusty-red colour, with the head, front part of pronotum, and the sterna infuscate, and by its short, erect, close, nap-like pubescence. Having only two specimens, I have not been willing to break off an antenna for examination, but I am confident that the stipes has only three joints. There is scarcely any trace of a sexual nitid space on the elytra of the female, and such as there is it can be discerned only on the subapical callus.

North Queensland.

A. major, sp. nov. Fem. Ovalis; sat opacus; castaneo-brunneus; pilis subtilibus adpressis sat brevibus minus crebre vestitus; antennis 8-articulatis, clava quam articuli ceteri conjuncti manifeste breviori; clypeo antice truncato, parum reflexo, subgrosse granulato; fronte sat convexa, cum pronoto crebre subtilius granulato-punctulata; prothorace leviter transverso, antice leviter angustato, supra æquali, lateribus sat arcuatis postice sinuatis; elytris confuse (a sutura latera versus gradatim magis grosse) rugulosis, vix perspicue costulatis, area nitida sat obsoleta in callo subapicali ornatis; propygidio (hoc quam elytra parum breviori) pygidioque (hoc æquali, fere a basi sub corpus reclinato) fortiter granulatis; tibiis anticis ut *A. funerei*, Blackb., dentatis; tarsis brevibus robustis, posticorum articulo 2° quam basalis duplo longiori. Mas latet. Long., $3\frac{3}{4}$ l.: lat., $1\frac{4}{5}$ l.

This species is of more oval form than typical *Automoli*, which are a little more dilated hindward. The extremely strong granulation of its dorsal surface and its large size render it a very distinct species. The testaceous colour of its antennal club is unusual in the genus.

North Queensland.

Comophorus.

This genus, founded by Blanchard, still contains only the one species (*testaceipennis*), which that author described. The genus is quite distinct from *Liparetrus*, though closely allied to it. There is no need to add here to what Blanchard (Cat. Coll. Ent., 1850, p. 106) has written about it.

Microthopus.

I have already discussed this genus (Tr.R.S.S.A., 1905), and as I, in doing so, had occasion to deal also, incidentally, with the three described species belonging to it, I need not add any remarks here.

Haplopsis.

Only five species attributable to this genus have been described, and I have no additions to make to them. They closely resemble each other superficially, and are not likely to be confused with any species of any other genus on account of their elytra being ornamented with wide, longitudinal stripes of whitish pilosity, the intervals between which are glabrous, or nearly so. I have selected this superficial character to distinguish the genus in the tabulation of genera *(vide Automolus)*, because I have not been able to discover any reliable structural character to separate *Haplopsis* from the extremely heterogeneous aggregate *Liparetrus*. Burmeister selects for this purpose the concealment of the propygidium under the elytra (or, rather, what I have pointed out above is the corresponding character on the ventral surface, viz., the shortening of the 5th ventral segment as compared with the 4th); but there is a distinct tendency in th females of *Haplopsis* to a lengthening and protrusion of the propygidium, and I have before me females of at least two species of *Haplopsis* in which the propygidium is as fully exposed as in many *Liparetri*, and the 5th ventral segment quite decidedly longer than the 4th. The most that can be made of this character, therefore, is that in *Liparetrus* the propygidium is exposed and the 5th ventral segment elongated, while in *Haplopsis* normally the propygidium is concealed, and the 5th ventral segment not longer than the 4th. The structure of the front tibiæ is intermediate between that of *Liparetrus* and *Automolus*, there being two adjacent external teeth close to the apex, and one (much smaller) about halfway between the intermediate tooth and the base of the tibia. These characters, together with the constant characteristic vestiture of the elytra, seem to indicate the generic validity of *Haplopsis*. I have already discussed the synonymy of the species described by the earlier authors *(vide* Tr.R.S.S.A., 1898, p. 48), and need not refer to it further. The following table shows the distinctive characters of the known species:—

A. Front of clypeus strongly, and decidedly angularly, emarginate in both sexes.
  B. Dorsal surface blackish, scarcely metallic; pronotum and pygidium deeply punctulate ... ... lineoligera, *Blanch.*
  BB. Dorsal surface quite bright-green; pronotum and pygidium very lightly punctulate ... ... viridis, *Blackb.*
AA. Front of clypeus not as A in either sex.

B. Clypeus of both sexes conspicuously reflexed in front.
C. Clypeus of male truncate in front. Elytra unicolorous ... ... Olliffi, *Blackb.*
CC. Clypeus of male distinctly and widely emarginate in front. Elytra red towards apex ... ... grisea, *Burm.*
BB. Clypeus in both sexes not reflected, only narrowly margined ... debilis, *Blackb.*

Caulobius.

I have already discussed the genus *(vide Automolus, supra)*, and will here merely repeat that I cannot see my way to a better treatment of the species than I attribute to it. I am afraid the genus as here regarded is little better than a receptacle for somewhat diverse species associated on the ground of their belonging to the *Liparetrus* group without being attributable to any other of its genera than this one. The first four species (in the following tabulation) are really very close to *Automolus*, but have their propygidium quite (or largely) covered by the elytra; the remaining four species (in the tabulation) differ much in *facies* from the first four, but I cannot find satisfactory structural differences for the creation of a new genus. As in *Liparetrus* and *Automolus*, the number of antennal joints varies in *Caulobius*. The first four species and the last in the tabulation (which follows and shows characters differentiating the species that I place in *Caulobius)* have 9-jointed antennæ, while there are only 8 joints in the antennæ of the other three species.

A. Less elongate species. Length of elytra exceeding width by about $\frac{1}{6}$ (or less) of the width.
B. The lateral margins of the clypeus strongly sinuate-emarginate.
C. The pronotum with very coarse sparse sculpture.
D. Elytra very coarsely sculptured. Tarsi robust ... ... discedens, *Blackb.*
DD. Elytra much less coarsely sculptured. Tarsi slender ... immitis, *Blackb.*
CC. Pronotum much more closely and less coarsely sculptured ... ... rotundus, *Blackb.*
BB. Lateral margins of clypeus not emarginate ... ... mæchidioides, *Macl.*
AA. More elongate species. Length of elytra exceeding width by about $\frac{1}{2}$ of the width.
B. Pronotum densely clothed with long, erect pilosity ... ... villiger, *Hombr. and Jacq.*
BB. Pronotum not as B.
C. Club of antennæ dark.
D. Elytra opaque ... ... rufescens. *Blanch. (?)*
DD. Elytra subnitid ... ... advena, *Blackb.*
CC. Antennæ entirely pale testaceous punctulatus, *Blackb.*

C. compactus, Blackb. I find that this species is identical with that which stands in the Macleay Museum as *Liparetrus mæchidioides*, Macl., and since one of the Museum specimens is presumably the type, my name must be dropped as a synonym.

C. rufescens, Blanch. This species is described by Blanchard as being that which was figured but not described in the "Voyage au Pôle Sud" (1842), under the name *Philochlænia rufescens*. Probably the identification is correct; but, whether or not, the name *Caulobius rufescens*, Blanch., will stand. I have a species before me from Tasmania (Blanchard's locality) which agrees with the description fairly satisfactorily, but the description is not detailed enough to allow of certainty. I have, therefore, called the species "*Caulobius rufescens*, Blanch (?)." According to Burmeister, *C. rufescens*, Hombr. and Jacq., is identical with *Caulobius (Sericesthis) cervinus*, Boisd. It, however, seems very clear that *C. rufescens*, Blanch., is not identical with *C. cervinus*, Burm. (? Boisd.), as a glance at the descriptions will show, the former being called "depressed," and the latter "strongly convex, almost cylindrical." Pending the improbable production of evidence to the contrary it seems clear, therefore, that there are two distinct species, which must be called *C. cervinus*, Burm. (? Boisd.), and *C. rufescens*, Blanch. I have not seen any insect that seems likely to be the former of these, which would be difficult of identification without inspection of Burmeister's specimen.

C. advena, Blackb. When I described this species I mentioned that I had failed to arrive at certainty as to the number of joints in its antennæ, but thought there were nine joints. I have now succeeded in counting them, and can state positively that there are only eight joints.

C. immitis, sp. nov. Ovatus; subnitidus; niger vel piceoniger, antennis (clava excepta) palpis pedibusque dilutioribus; setis brevibus fulvis vestitus, his in elytris seriatim dispositis; antennis 9-articulatis; clypeo reflexo, cum fronte granuloso, antice truncato; prothorace fortiter transverso, supra grosse rugulose punctulato, canaliculato, basi media sat lobata, lateribus sat arcuatis, angulis anticis sat acutis; elytris fortiter rugulose punctulatis et transversim nonnihil rugatis, interstitiis inæqualiter leviter subcostulatis; pygidio grosse punctulato; tibiis anticis ad apicem bi- (ad basin uni-) dentatis; tarsis anticis minus elongatis, posticorum articulo 2° quam basalis circiter duplo longiori.

Maris antennarum clava quam stipes paullo longiori; feminæ breviori. Long., $2\frac{1}{5}$ l.; lat., $1\frac{1}{5}$ l.

There are six specimens before me of this insect, and I do not find any very conspicuous sexual characters among them. In some, however, which I take to be males, the joints of the flabellum are slightly longer than the 4 joints together of the stipes, and the clypeus is a little more abruptly truncate than in others whose antennal flabellum is a little shorter. The species has a thick-set, coarsely sculptured appearance, suggestive of a lilliputian *Byrrhomorpha*, from which, however, its structural characters separate it widely, *e.g.*, its conspicuously granulate eyes with the hind angles of the clypeus projecting considerably beyond the outline of the eyes.

Western Australia; sent by Mr. Lea and others, from Perth.

C. rotundus, sp. nov. Ovatus; latissimus; minus nitidus; obscure rufus, capite prothorace metasternoque picescentibus; setis fulvis decumbentibus minus crebre vestitus; antennis 9-articulatis; clypeo reflexo cum fronte prothoraceque sat æqualiter sat crebre minus grosse granuloso-ruguloso, antice truncato; prothorace sat fortiter transverso, æquali, basi media vix lobata, lateribus minus arcuatis, angulis anticis acutis; elytris subtilius granuloso-rugulosis, interstitiis inter se inæqualibus (horum nonnullis leviter subcostulatis): pygidio leviter subtilius punctulato; tibiis anticis ad apicem bi- (ad basin uni-) dentatis; tarsorum posticorum articulo 2° quam basalis circiter duplo longiori. Long., $2\frac{2}{5}$ l.; lat., $1\frac{2}{5}$ l.

I have seen several specimens of this insect, which include both sexes. The antennal flabellum of the male is as long as the preceding joints together; that of the female a little shorter. The species seems out of place in being associated with the very much larger and more cylindrical *C. villiger*, Hombr. and Jacq., from which it differs also in the partial exposure of its propygidium. This latter character approximates it to *Automolus*, but in all the species that I attribute to *Automolus* there is much more of the propygidium exposed, and the elytra are of different shape, as indicated in the remarks (above) on the genus *Automolus*.

New South Wales. Taken by Messrs. Carter, Lea, and Taylor; also in the South Australian Museum.

Haplonycha.

I have already discussed the affinities of this genus in Proc. L.S.N.S.W., 1890, pp. 517, etc., and at the same time I furnished a tabulation of the species then known to me, and described some new species. Since that paper was published I have had opportunity of studying a large number of additional species, and have now before me a considerable number as yet undescribed. I am still of opinion that *Colpochila* cannot be maintained as distinct from *Haplonycha*, although I think that I was mistaken in selecting the former name for use, inasmuch as *Haplonycha* seems to have been used for Boisduval's *Melolontha obesa* in Dejean's catalogue, in 1837. *Colpochila* was proposed by Erichson (1843) without description. In 1850 Blanchard furnished characters for Erichson's name, and at the same time characterized under the name *Haplonycha* an aggregate which he regarded as forming a genus allied to but distinct from *Colpochila*. I, however, can find no character mentioned in his diagnoses which distinguishes either from the other, but in an appended note it is stated that in *Haplonycha* the galea of the maxillæ is not gibbous, the labium is less quadrate, and the antennal club and clypeus are distinct in shape (but without indication of the nature of the distinction, unless reference is intended to the word "productus," which in the diagnoses is used of the clypeus of *Colpochila*, but not of *Haplonycha*, and "oblonga," which is used of the antennal club of *Haplonycha*, but not of *Colpochila*). However, these characters are, I think, of no value, though, of course, one cannot be positive about the maxillæ without dissecting all the species, which I have not been able to do. Burmeister, in 1855, treated the two aggregates as identical. Lacordaire, in 1856 (in his tabulation of the *Heteronycid* genera of the world) distinguishes *Colpochila* from *Haplonycha* by the shape of its antennal club; certainly not, in my opinion, a character of generic value, nor constant in any considerable number of species. It is quite possible that the long and somewhat diverse series of species which I attribute to *Haplonycha* may sooner or later be regarded as yielding material for the formation of several new genera. At present I am able to break those species up into several groups, distinguished from each other by easily recognizable characters: but those characters are all such as appear to me, in the Australian *Sericoides* in general, merely specific, *i.e.*, not indicative of the nature of the other characters of the insects in which they appear.

It has seemed to me, therefore, that *Haplonycha* may be dealt with most satisfactorily by dividing it into subordinate aggregates under the name of groups, a method of treatment which I adopted recently in revising *Onthophagus* and *Liparetrus*. The species of *Haplonycha* known to me fall conveniently, I think, into eight groups, which may be distinguished as follows:—

A. Antennæ consisting of eight joints only ... ... Group I.
AA. Antennæ consisting of nine joints.
B. Lateral gutter of pronotum (especially round the hind angles) wide and filled with closely-packed setiferous rugulosity ... ... Group II.
BB. Lateral gutter of pronotum not as B.
C. Surface of apical joint of maxillary palpi, with a large impression bordered laterally by a raised edge ... ... Group III.
CC. Apical joint of maxillary palpi not as C.
* D. Penultimate joint of maxillary palpi longer than antepenultimate ... ... Group IV.
DD. Penultimate joint of maxillary palpi not (or scarcely) longer than antepenultimate.
E. Antennal club, with more than 3 joints in both sexes... ... Group V.
EE. Antennal club, with only 3 joints in both sexes.
F. Species not having the pronotum and pygidium black.
G. Perpendicular front face of clypeus, with plentiful, more or less rugulose punctures, more or less obscuring the transverse setiferous series ... ... Group VI.
GG. Perpendicular front face of clypeus nitid, smooth, and all but unpunctured, except the transverse series of very large setiferous punctures ... Group VII.
FF. Pronotum and pygidium black ... ... Group VIII.

The species which I associate together in each of the above groups are fairly homogeneous in facies, though considerably less so in respect of structural characters. More detailed remarks about the groups will be found below.

In subdividing *Haplonycha* into groups, the number of joints in the antennæ, though not, in my opinion, a character of much importance, enables two or three species with only eight antennal joints to be satisfactorily separated from the

* In the concluding species of this group the group-character is only feebly marked, but in these the dorsal surface of the body is pruinose and iridescent, which is not the case with any species known to me (of the following groups), having maxillary palpi of somewhat similar structure.

others as the first group. If the antennal characters were disregarded these species might very well be placed near *H. bella*, Blackb. The second group consists of large or very large species in which the marginal gutter of the pronotum presents the remarkable structure indicated in the tabulation, a character, however, that does not appear to be of much importance, since several species not possessing it are otherwise very close to some in the second group; it is, however, of great value for purposes of identification. The preceding two groups having been eliminated, I have arranged the remainder of the groups by means of the character that appears to me the most fundamental of those I have observed in the genus, inasmuch as well-marked differences in respect of it seem to be somewhat uniformly accompanied by other differences, such as in facies, colour, texture of elytra, etc. I refer to the structure of the maxillary palpi. Using this character I first separate as the third group a small aggregate of species having a remarkable impression on the apical joint of the maxillary palpi. The remainder of the genus I then divide into two sections ("D" and "DD" in the preceding tabulation) according as the penultimate joint of the maxillary palpi is or is not longer than the antepenultimate. It must be admitted, however, that there are a few intermediate forms in which there is little or no difference in length between these joints, but these forms will present no practical difficulty in identification, because if they be placed together it will be found that they naturally divide themselves into two aggregates, in one of which (while the penultimate joint is invariably, I think, at any rate a trifle longer than the antepenultimate) the facies is in general that of the species in which the antepenultimate joint of the palpi is *very* short, and the dorsal surface is invariably more or less brilliantly iridescent; and in the other aggregate the facies is very different (average size smaller, texture notably less fragile), and the dorsal surface is not, in any species known to me, iridescent. The aggregate "D" does not seem to lend itself to sectional division, and therefore I treat it as a single (the fourth) group. The aggregate "DD," however, is much less homogeneous, and contains a few isolated forms which I have separated as the seventh and eighth groups, the eighth consisting of three species not very much like each other, or very close to any other *Haplonycha*, but which happen to agree in presenting the unusual character of the head, pronotum, and pygidium being black; while the seventh group consists of a few species bearing a general resemblance to those of the third group, and differing from all those of the fifth, sixth, and eighth groups by the combination of a peculiar sculpture of the perpendicular front face of the clypeus, with antennal club of only three joints in both sexes. The remainder of the section "DD" consists of species closely resembling each other (with a few exceptions) in respect of facies, but conveniently divisible into two groups (the fifth and sixth), in one of which the sides of the prothorax are sinuate behind the middle and the antennal club has four joints (the first usually much shorter than the second in the females), while in the other the sides of the prothorax are not sinuate behind the middle and the antennal club has in both sexes only three joints.

I have not found any uniform external difference between the sexes in *Haplonycha*, except in the antennal club. The lamellæ of this are longer in the males than in the females, but not different in number, although in the species in which the club has more than three lamellæ the first of them is usually much abbreviated in the female, but very rarely (I think *H. bella*, Blackb., supplies the only instance), so much abbreviated that it is not very obviously a lamella of the club.

In dealing with the species of this genus it is necessary to begin by discussing those described by the earlier authors, inasmuch as their descriptions are for the most part extremely brief and devoid of any mention of the structural characters that are the most valuable for purposes of identification. The earliest species of those subsequently attributed to *Haplonycha* are *Melolontha obesa*, Boisd., *M. Astrolabei*, Boisd., and *M. ciliata*, Boisd. (described in 1835). Burmeister subsequently described as the first of these an insect which it seems probable was not Boisduval's type, but a *Haplonycha*, believed by Burmeister to be identical with the type, and in that identification I have little doubt he was mistaken. Assuming *M. obesa* to be a *Haplonycha* (which I fear is not certain), its description happens to mention two characters that in combination are very unusual in the genus, viz., "head and thorax black" and "prothorax rugulose-punctulate." Now, Burmeister says of what he calls "*obesa*, Boisd.," that it is entirely *(ueberall)* shining castaneous-brown, and makes no reference to its prothorax being rugulose. My own opinion is that *M. obesa*, Boisd., is the species of which Burmeister described a variety as *M. gagatina*. It is one of the very few species of the genus that seems subject to considerable variation in colour (its head and prothorax are always, so far as I have observed, black, while its elytra vary from dark ferruginous to black). It is found in New South Wales, the presumable *habitat* of *M. obesa*, Boisd., and the puncturation of the pronotum is more inclined to rugulosity than in most of its congeners. As, however, Boisduval gives no information about the antennæ of his insect, and does not mention its size, I do not propose to change the name of *H. gagatina*, Burm., but prefer to regard *M. obesa*, Boisd., as unrecognizable without a fresh description founded on the actual type (which very likely is not in existence), and accepting provisionally the bare possibility that Burmeister's statement of colour was an intentional correction of Boisduval, founded on inspection of the actual type, treat "*H. obesa*, Burm. (? Boisd.)" as the valid name of a good species. Burmeister cities *H. obesa*, Boisd. (Blanch.) as being the species which he called *obesa*, Boisd., but this was almost certainly without having seen the specimens so named by Blanchard. I believe, however, that the citation is correct, as, although Blanchard does not describe *H. obesa*, he compares other species with it in terms that are agreeable to its being *H. obesa*, Burm. *Melolontha Astrolabei*, Boisd., is, in Burmeister's opinion, probably a *Haplonycha*, from which genus I unhesitatingly exclude it, on the ground that its elytra are described as not geminate-striate. I believe it to be a *Systellopid*. *Melolontha ciliata*, Boisd., is attributed to *Haplonycha* by both Blanchard and Burmeister, the latter stating that he considers it incapable of identification. Blanchard mentions that its antennæ have only eight joints, and it is probable that that statement was founded on an inspection of the type, and therefore must not be passed over. I should say that it is very likely to be identical with *H. rugosa*, Burm., but as Boisduval implies that the insect has not geminate-striate elytra, I think it unlikely that either he or Burmeister was dealing with a true *Haplonycha*, but almost certainly with a *Frenchella*. It will be seen, then, that I reject all Boisduval's names from *Haplonycha*, believing that only one of them applied to a real *Haplonycha*, and that that *(obesa)* cannot be identified unless the type exists and can be studied. In 1842 Hope described as *Sericesthis Gouldi* an insect from Port Essington, which has been attributed to *Haplonycha (Colpochila)*, although there is little in Hope's description to indicate its generic characters. There is, however, in the South Australian Museum a *Haplonycha*, from the neighbourhood of Port Essington, which agrees so well with Hope's description that I have no hesitation in considering it Hope's species.

Hombre and Jacquinot, in 1842, figured, under the name *tasmanica* (Voy. Pôle Sud. Atl., t. 8, f. 8), a species which has been regarded as identical with *obesa*, Boisd. I regret that I have not been able to investigate the grounds of that determination, but may say that it seems to me unlikely to be correct. The species that I have called "*H. obesa*, Burm. (? Boisd.)" does not, so far as I know, occur in Tasmania, but that which I believe to be *pectoralis*, Blanch., is found there, and is likely to be identical with *tasmanica*, H. and J., which latter is the older name. But I have not before me sufficient evidence to decide this point.

The next author who described species of *Haplonycha* was Blanchard (Cat. Coll. Ent., 1850), who may be regarded as the founder of the genus, in which he placed seven species, three of which *(striatella, iridescens,* and *ciliata)* I exclude from the genus on account of their elytra not being geminate-striate. Another of his species *(obscuricornis)* is so vaguely described that the striation of its elytra can scarcely be inferred, but the implication is that it is not geminate, and I have not much doubt of the insect being a *Frenchella.* I take it, therefore, that Blanchard's *obesa*, *scutalis*, and *pectoralis* only can stand in *Haplonycha*. *H. obesa*, Blanch., I have already discussed above. *H. pectoralis*, Blanch., I identify without much doubt with a species common in New South Wales. *H. scutalis*, Blanch., is scarcely distinguished from *pectoralis* except by slight colour differences, and a scutellar character to which I attribute but little value. I think I know the insect, but doubt whether it is more than a variety of *pectoralis*. Besides the species which he called *Haplonycha*, Blanchard also described two as *Colpochilæ (crassiventris* and *punctulata)*, which must be placed in *Haplonycha* as including *Colpochila*. *Punctulata* is a well-known insect from New South Wales, but *crassiventris* is less easily identified. Burmeister says that it is probably identical with his *H. Roei* (in which case its name has priority), and in this I agree with him. The principal difficulty seems to be the much greater size quoted for *crassiventris*, but it almost disappears when it is remembered that in all Blanchard's measurements a millimetre requires to be taken as one-thirtieth of an inch. Bearing this in mind, and remembering also that the Swan River is the *habitat* quoted for both *crassiventris* and *Roei*, it seems fairly safe to treat the latter name as a synonym of the former.

The next author after Blanchard to describe species of *Haplonycha* was Burmeister (1855), who described ten species, three of which *(tasmanica*, Germ., *rugosa*, Burm., and *ciliata*, Boisd.), cannot remain in the genus, the first being a *Pachygastra*, and the other two probably identical with each other, and almost certainly belonging to *Frenchella*. I have identified five of the remaining seven with some confidence, and the other two with more doubt. I shall refer to them more particularly in the following pages. One of them, however (*Roei*), I have already discussed above.

After Burmeister there was a long interval, until in 1871 Macleay described a single species (*H. pinguis*). There are two specimens (one of them doubtless the type) bearing this name in the Australian Museum, and they are identical with the *Haplonycha* that I have discussed above as "*obesa*, Burm. (? Boisd.)". I may here remark that *obesa*, Boisd., is represented in the South Australian Museum by the species that I am convinced is *pectoralis*, Blanch.

In 1878 Mr. Tepper described a species of this genus under the name *destructor* (Tr.R.S.S.A.), which I have already discussed (Pr.L.S.N.S.W., 1890, p. 533).

In 1888 (Pr.L.S.N.S.W., p. 913) Sir W. Macleay described *H. testaceipennis*.

In 1890 I described a number of new species (l.c.) in a paper that I have already referred to in the present memoir, and I added other species in 1892 and 1895, all of which are treated in the following pages.

In 1891 *H. nitidicollis* was described (D.E.Z., p. 263) by Nonfried. As the description is so vague as not to mention even the number of joints in the antennæ, or, indeed, any other character that would enable me to place the insect in my tabulation, I am obliged to disregard it altogether.

I have now referred to all the names (to the best of my belief) that have been up to the present time proposed for species that are, in my opinion, or have been treated by their authors as members of this genus (including *Colpochila*). Of those (43 in number) I have indicated 7 as representing species that cannot remain in *Haplonycha*, 3 as synonyms, and 2 concerning which I have not sufficient data for forming any decided opinion. There consequently remain 31 names which I regard as representing valid species of *Haplonycha*. I have now to add the descriptions of 29 new species, bringing the total of this genus to the formidable number 60, the distinctive characters of which are displayed in the following tabulations:—

Group I.

[Antennæ consisting of only eight joints.]

A. Pronotum not having a fringe of long pilosity immediately within the basal and apical margins.
  B. Head very finely and closely (confluently) punctulate. Sides of prothorax not sinuate behind middle... ruficeps, *Burm.*

B. Head much less finely, and not nearly confluently, punctured. Sides of prothorax sinuate behind middle ... ... neglecta, *Blackb.*

AA. Pronotum having a fringe of long pilosity immediately within the basal and apical margins ... ... crinita, *Burm.*

GROUP II.

[Antennæ of nine joints. Lateral gutter of pronotum (especially round hind angles) filled with closely packed setiferous punctures or granules.]

A. Antennal club, with more than 3 lamellæ in both sexes.
  B. 3rd joint of antennæ longer than 2nd joint.
    C. Disc of pronotum and of pygidium non-pilose.
      D. Punctures of elytra much finer and more sparse than in the next two species ... ... antennalis, *Blackb.*
      DD. Punctures of elytra much stronger.
        E. Joint 3 of male antenna dentate near apex, joint 1 of female flabellum little shorter than 2 ... ... laminata, *Blackb.*
        EE. Joint 3 of male antenna simple; joint 1 of female flabellum scarcely more than half 2 ... ... dubia, *Blackb.*
    CC. Disc of pronotum and of pygidium pilose ... ... pilosa, *Blackb.*
  BB. 3rd joint of antennæ not longer than 2nd joint.
    C. Pygidium carinate, but little convex, and conspicuously punctulate ... ... carinata, *Blackb.*
    CC. Pygidium non-carinate, strongly convex, and scarcely punctulate.
      D. Pygidium very strongly gibbous; joint 1 of female flabellum about half-length of 3 ... ... campestris, *Blackb.*
      DD. Pygidium scarcely gibbous; joint 1 of female flabellum scarcely shorter than 3 ... ... fortis, *Blackb.*

AA. Antennal club in both sexes, with only 3 lamellæ.
  B. Base and apex of pronotum fringed with long hairs immediately within the marginal edging.
    C. Joint 4 of antennæ notably longer than joint 3... ... ... latebricola, *Blackb.*
    CC. Joint 4 of antennæ not longer than joint 3... ... ...
      D. Disc of pronotum glabrous and very sparsely punctulate ... trichopyga, *Blackb.*

DD. Disc of pronotum pilose, and, in parts, more closely punctulate ... ... crassiventris, *Blanch.*

BB. Base and apex of pronotum not fringed with long hairs within the marginal edging ... ... punctulata, *Blanch.*

GROUP III.

[Antennæ of nine joints. Lateral gutter of pronotum normal. Apical joint of maxillary palpi impressed with a conspicuous fovea (which is margined by a fine raised edging.]

A. Pronotum not fringed with long erect hairs immediately in front of its basal edging.

B. Lateral edging of elytra normal.

C. Pronotum lobed in middle of base (best seen from in front obliquely), and closely and strongly punctulate.

D. Pronotum strongly gibbous; elytral punctures isolated, on an even surface ... ... gibbosicollis, *Blackb.*

DD. Pronotum much less convex; elytral punctures run together and mixed with confused rugulosity ... ... setosa, *Blackb.*

CC. Pronotum not lobed at base, more finely and less closely punctulate spadix, *Blackb.*

BB. Lateral edging of elytra very strong and thick ... ... marginata, *Blackb.*

AA. Pronotum fringed with long, erect hairs immediately in front of its basal edging. longior, *Blackb.*

GROUP IV.

[Antennæ of nine joints. Lateral gutter of pronotum normal. Apical joint of maxillary palpi not foveate. Penultimate joint of maxillary palpi longer than antepenultimate, this character being doubtful only in some iridescent species.]

A. Hind angles of pronotum well defined, strongly dilated, and reflexed ... badia, *Burm. (?)*

AA. Hind angles of pronotum scarcely dilated.

B. Penultimate joint of maxillary palpi notably longer than apical joint ... solida, *Blackb.*

BB. Penultimate joint of maxillary palpi not longer than apical joint.

C. Penultimate joint of maxillary palpi much longer than antepenultimate joint.

D. Pronotum not continuously fringed with long, erect hairs immediately in front of its basal edging.

E. Dorsal surface of head not both strongly rugulose and clothed with long, erect hairs.
F. Perpendicular front face of clypeus, with plentiful punctures, more or less obscuring the transverse row of setiferous punctures.
G. Antennal club, with 4 joints in both sexes ... punctiventris, *Blackb.*
* GG. Antennal club, with only 3 joints, at any rate in the female.
H. Puncturation of elytra less close, similar to that of *bella*, Blackb., and *pectoralis*, Blanch.
I. Penultimate joint of maxillary palpi very little shorter than apical ... ... deceptor, *Blackb.*
II. Penultimate joint of maxillary palpi very much shorter than apical ... ... Sloanei, *Blackb.*
HH. Puncturation of elytra much more close.
I. Joints 3 and 4 of antennæ somewhat elongate (4, especially, much longer than wide) ... ... accepta, *Blackb.*
II. Joints 3 and 4 of antennæ very short, subtransverse ... punctatissima, *Blackb.*
FF. Perpendicular front face of clypeus nitid, with only very fine sparse punctures, except the very large transverse series (antennal club 4-jointed) ... ... paradoxa, *Blackb.*
EE. Dorsal surface of head strongly rugulose, and clothed with long, erect hairs.
F. Form very robust; pronotum strongly declivous at base (as in *H. solida*, Blackb.)... firma, *Blackb.*
FF. Form much less robust; pronotum normal (as in *H. bella*, Blackb.) ... ... clypealis, *Blackb.*
DD. Pronotum continuously fringed, with very long hairs immediately in front of its basal edging ... ... amabilis, *Blackb.*

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* I feel no doubt that this is the case also in respect of those males which are not known.

CC. Penultimate joint of maxillary palpi but little (or scarcely) longer than antepenultimate. [Iridescent species.]
D. Hind angles of prothorax entirely rounded off ... ... Gouldi, *Hope*
DD. Hind angles of prothorax well defined.
E. Species not having joints 3 and 4 of antennæ, both of them very short and subtransverse.
F. Joint 4 of antennæ longer than joint 3.
G. Size very large (about long. 14 l.) ... ... nobilis *Blackb.*
GG. Size much smaller (long. 9 l. or less). [Antennal club of male 4-jointed.] bella, *Blackb.*
FF. Joint 4 of antennæ slightly shorter than joint 3. [Antennal club of male with only 3 joints.] ... amœna, *Blackb.*
EE. Joints 3 and 4 of antennæ very short, subtransverse ... pulchella, *Blackb.*

Group V.

[Antennæ of nine joints. Lateral gutter of pronotum normal. Apical joint of maxillary palpi not foveate. Penultimate joint of maxillary palpi shorter than antepenultimate, or sub-equal to it. In the latter case the dorsal surface not iridescent. Antennal club composed of more than three joints in both sexes.*]

A. Large iridescent species. [Joint 3 of maxillary palpi much shorter than joint 2.]
B. Pygidium but little nitid, closely sculptured, especially near base ... gigantea, *Burm. (?)*
BB. Pygidium brilliantly nitid, its puncturation extremely sparse ... lucifera, *Blackb.*
AA. Non-iridescent species; almost invariably of much smaller size.
B. Puncturation of head sparse... ... gracilis, *Blackb.*
BB. Puncturation of head very close, more or less confluent.
C. Sides and base of pronotum (within the margin) and also base of elytra fringed with very long, erect hairs ... ... Mauricei, *Blackb.*

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* I am quite confident that this is the case in the species (of this aggregate), of which only one sex is known to me. See the remarks on this subject under the description of *H. lucifera*, Blackb.

CC. Pilosity not as in *H. Mauricei*.
D. Basal edging of pronotum fine, and equal all across base; hind angles not dilated.
E. Laminæ of antennal club very long (in male scarcely shorter than the head) ... ... egregia, *Blackb.*
EE. Laminæ of antennal club much shorter.
F. Base of pronotum strongly sinuate, middle part quite conspicuously lobate ... sinuaticollis, *Blackb.*
FF. Base of pronotum only feebly sinuate.
G. Pronotum strongly punctulate ... ... rustica, *Blackb.*
GG. Pronotum finely punctulate ... ... arvicola, *Blackb.*
DD. Basal edging of pronotum becomes notably more elevated laterally, with hind angles distinctly dilated.
E. Scutellum concolorous with elytra.
F. Antennal laminæ more elongate (especially in female); pronotum notably more strongly punctulate... electa, *Blackb.*
FF. Antennal laminæ shorter; pronotum notably more finely punctulate ... ... fraterna, *Blackb.*
EE. Scutellum black in contrast to the red-brown elytra ... sabulicola, *Blackb.*

Group VI.

[Antennæ of nine joints. Lateral gutter of pronotum normal. Apical joint of maxillary palpi not foveate. Penultimate joint of maxillary palpi shorter than antepenultimate, or sub-equal to it. In the latter case the dorsal surface not iridescent. Antennal club composed of only three joints. Pronotum not black. Perpendicular front face of clypeus with plentiful, more or less rugulose, punctures, more or less obscuring the transverse setiferous series.]

A. Pygidium somewhat densely clothed with long, soft; pallid hairs ... ... palpalis, **Blackb.**
AA. Pygidium not as in A.
B. The lateral gutter of the pronotum punctulate conspicuously and continuously to the hind angles.
C. Base of pronotum not fringed in front of its edging with erect hairs.
D. Apical 2 joints of maxillary palpi of equal length (at any rate in female). Size large (long. 12 l.) ... ... æqualiceps, **Blackb.**

DD. Apical joint of maxillary palpi distinctly longer than penultimate joint.

E. Lateral outline of prothorax straight or sinuate in front of middle.

F. Puncturation of elytra somewhat close (much like that of *H. fraterna*, Blackb., *obesa*, Burm. (?), etc. ... ... pectoralis, *Blanch. (?)*

FF. Puncturation of elytra much less close ... ... pygmæa, *Blackb.*

EE. Lateral outline of prothorax a continuous even curve ... thoracica, *Blackb.*

CC. Base of pronotum fringed in front of its edging with long erect hairs ... ... clara, *Blackb.*

BB. Lateral gutter of pronotum in its hinder part and round the basal angle smooth and more or less dilated.

C. Club of antennæ pallid in strong contrast to the preceding joints; clypeus very strongly reflexed ... destructor, *Tepper*

CC. Antennæ unicolorous; clypeus much less strongly reflexed ... obesa, *Burm.*

Group VII.

[Antennæ of nine joints. Lateral gutter of pronotum normal. Apical joint of maxillary palpi not foveate. Penultimate joint of maxillary palpi shorter than antepenultimate, or sub-equal to it. In the latter case the dorsal surface of the insect not iridescent. Antennal club of only three joints. Pronotum not black. Perpendicular front face of clypeus nitid, bearing only a few very fine punctures and a single series of very large setiferous punctures.]

A. Lateral outline of prothorax very strongly rounded.

B. Pronotum finely and closely punctulate ... ... testaceipennis, *Macl.*

BB. Pronotum strongly and considerably less closely punctulate ... ... faceta, *Blackb.*

AA. Lateral outline of prothorax feebly arched ... ... Jungi, *Blackb.*

Group VIII.

[Antennæ of nine joints. Lateral gutter of pronotum normal. Apical joint of maxillary palpi not foveate. Penultimate joint of maxillary palpi shorter than antepenultimate, or sub-equal to it. In the latter case the dorsal surface not iridescent. Antennal club of only three joints. Pronotum black.]

A. Pronotum opaque.
B. Elytra closely punctulate, piceous, or black ... ... gagatina, *Burm.*
BB. Elytra sparsely punctulate, pale testaceous, with a narrow black margin ... ... bicolor, *Blackb.*
AA. Pronotum nitid ... ... funerea, *Blackb.*

H. neglecta, sp. nov. Mas. Ovata; minus brevis; minus nitida; rufescens, elytris pallide testaceo-brunneis, iridescentibus; corpore subtus pedibusque longe fulvo-pilosis; palpis maxillariis testaceis, articulis 2° 3° que longitudine sat æqualibus (4° paullo longiori); antennis testaceis, 8-articulatis, clava 3-articulata sat elongata; clypeo modico, fortiter reflexo, cum fronte sat fortiter minus confertim punctulato; prothorace quam longiori duplo latiori antice sat fortiter angustato sparsim obsoletius minus subtiliter punctulato, lateribus rotundatis, anguste marginatis, ante basin leviter sinuatis, angulis posticis obtusis; elytris leviter geminato-striatis, sparsim minus subtiliter sat æqualiter punctulatis; pygidio nitido, crebre subtilius punctulato; tarsorum posticorum articulis basalibus 2 longitudine inter se sat æqualibus. Long., 8 l., lat., 4½ l.

Fem. latet.

Near *H. ruficeps,* Burm., but differing considerably from that species in puncturation—the head much more strongly and sparsely punctulate (in *ruficeps* the punctures are fine and confluent), and the pronotum much more closely. The prothorax is gently sinuate at the sides behind the middle, which it is not in *ruficeps.*

South Australia. In the South Australian Museum, from Wilmington (Burgess).

H. antennalis, sp. nov. Ovata; nitida; rufo-brunnea, nec iridescens; corpore subtus pedibus et prothoracis lateribus intra marginem fulvo-pilosis; palporum maxillarium articulo 3° quam 2^{us} et quam 4^{us} longiori; capite sat crebre vix fortiter sat rugulose, prothorace subtilius minus crebre subobsolete, elytris (his manifeste geminato-striatis) fere ut prothorax sed sat magis distincte, pygidio (hoc pernitido) haud perspicue, punctulatis; antennis 9-articulatis; prothorace quam longiori duplo latiori, postice retrorsum vix perspicue declivi, lateribus (et basis lateribus) sulco marginali (hoc granulis piliferis conferto) impressis, basi minus perspicue sinuata; elytris ad apicem suturalem haud vel vix acutis.

Maris antennarum flabello 6-articulato, quam articuli omnes præcedentes conjuncti sublongiori.

Feminæ antennarum flabello 6-articulato, quam maris multo breviori, articulo flabelli 1° quam 3^{us} circiter duplo breviori; pygidio gibbo nullo modo carinato. Long, 12-14 l.; lat., 6$\frac{1}{3}$-7 l.

An extremely distinct species, the only one known to me (of the genus) having a well-developed lateral sulcus on the prothorax, and the flabellum of the female antenna 6-jointed. The male has its antennal flabellum notably longer than in any other *Haplonycha* of the same group (known to me) except *pilosa*, Blackb., from which species it is easily separable, *inter alia*, by its pygidium, impunctulate, much more nitid, glabrous, somewhat tumid, and much more widely truncate (and not triangularly impressed) at the apex. The prothorax and elytra in both sexes are notably more nitid and finely and sparsely punctured than in the other species having a flabellum with more than three joints. The geminate striation of the elytra is very feeble, scarcely indicated except by the interstices between stria and stria of each pair being evidently convex and much narrower than the interstices between pair and pair.

Western Australia; Swan River, etc.

H. pilosa, sp. nov. Ovata, longior; subnitida; rufobrunnea, elytris subiridescentibus; corpore subtus pedibusque fulvo-pilosis, capite prothorace elytrorum basi pygidioque pilis elongatis erectis subtilibus vestitis; capite crebre rugulose, prothorace obsolete subcrebre, elytris (his geminato-striatis) sat crebre minus subtiliter, pygidio sparsim perspicue, punctulatis; antennis 9-articulatis; prothorace quam longiori duplo latiori, postice retrorsum sat late declivi, lateribus (et basis lateribus) sulco marginali (hoc granulis piliferis conferto) impressis, basi minus perspicue sinuata; elytris ad apicem suturalem sat fortiter dentiformibus.

Maris antennarum flabello 6-articulato, quam articuli omnes præcedentes conjuncti sat longiori, arcuato; pygidio minus convexo, ad apicem profunde triangulariter impresso.

Fem. latet. Long., 11$\frac{1}{2}$ l.; lat., 5$\frac{4}{5}$ l.

The antennal structure at once separates this species strongly from all its known allies except *H. antennalis*, from which it differs as indicated under the heading of that species. The flabellum of its antennæ is even longer than in the corresponding sex of *antennalis*. The sparse, erect, very fine, and inconspicuous hairs on its head disc of prothorax and base of elytra are a valuable specific character.

Australia. I am not certain of the exact locality, but believe it to be Eyre Peninsula.

H. trichopyga, sp. nov. Ovata; longior; sat nitida; rufo-brunnea, supra sat iridescens; corpore subtus pedibusque fulvo-pilosis, prothorace pilis erectis elongatis fimbriato, abdomine supra (pygidio incluso) pubescenti; capite crebre sat fortiter, prothorace sparsim subtiliter, elytris (his perspicue geminato-striatis) sat fortiter minus crebre (fere ut *C. punctulatæ*, Blanch., sed minus crebre), pygidio sparsim subtiliter (hujus puncturis cum granulis minutis setas sat breves erectas graciles ferentibus sparsim commixtis), punctulatis; antennis 9-articulatis, articulo 4° quam 3^{us} subbreviori; prothorace quam longiori plus quam duplo latiori, postice retrorsum sat late declivi, lateribus (et basis lateribus) sulco submarginali (hoc granulis piliferis conferto) impressis, basi modice sinuata, lateribus fortiter rotundato-ampliatis; elytris ad apicem suturalem inermibus.

Maris antennarum flabello 3-articulato, quam articuli 5 præcedentes conjuncti parum longiori; pygidio sat convexo, antice in medio longitudinaliter obsolete (vix perspicue) carinato.

Fem. latet. Long., 12 l.; lat., $5\frac{1}{5}$ l.

Among the species of *Haplonycha* having a well-defined lateral prothoracic sulcus and antennæ with a 3-jointed flabellum, this species is distinguished by its pilose pygidium in combination with the prothoracic disc non-pilose and its prothorax strongly declivous behind.

Western Australia; Coolgardie.

H. latebricola, sp. nov. Ovata; minus nitida, rufo-brunnea, vix iridescens; corpore subtus pedibusque fulvo-vel cinereo-pilosis, prothorace pilis erectis elongatis fimbriato; capite crebre rugulose, prothorace sparsim subtiliter, elytris (his geminato-striatis) crebre sat fortiter, pygidio (hoc sat nitido) crebre dupliciter (*i.e.*, subtiliter et minus subtiliter), punctulatis; antennis 9-articulatis; articulo 4° quam 3^{us}, sat longiori; prothorace quam longiori vix plus quam duplo latiori, postice retrorsum sat late declivi, lateribus (et basis lateribus) sulco submarginali (hoc granulis piliferis conferto) impressis, basi leviter sinuata, lateribus quam præcedentis (*C. trichopygæ*) minus fortiter rotundato-ampliatis; elytris ad apicem suturalem inermibus.

Maris antennarum flabello 3-articulato, quam articuli 5 præcedentes conjuncti parum longiori; pygidio modice convexo.

Feminæ antennarum flabello 3-articulato, quam articuli 5 præcedentes conjuncti sat breviori; pygidio quam maris magis convexo, antice in medio longitudinaliter obtuse sat perspicue carinato. Long., 11½-15 l.; lat., 6-7½ l.

Near the preceding (*H. trichopyga*), but differing from it by its glabrous and differently sculptured pygidium, its more closely punctured elytra, more convex pronotum, differently proportioned antennal joints, etc.

Western Australia. In my own collection; also from Mr. Lea (Champion Bay).

H. spadix, sp. nov. Fem.? Ovata, minus brevis; sat nitida; rufo-brunnea, elytris clare brunneis, antennis palpisque dilutioribus; corpore subtus femoribusque longe pilosis; palpis maxillaribus sat crassis, articulis 2° 3° que longitudine inter se sat æqualibus, 4° quam hi longiori fovea magna impresso; antennis 9-articulatis, articulis 3° 4° que longitudine inter se sat æqualibus, clava 4-articulata quam articuli 2-5 conjuncti vix breviori; clypeo sat brevi, antice sat reflexo, minus crebre sat fortiter punctulato; fronte confertim subtilius punctulata; prothorace quam longiori ut 17 ad 9 latiori, antice minus angustato, supra subtilius minus crebre punctulato, lateribus sat arcuatis sat anguste marginatis, basi vix sinuata, angulis posticis rotundato-obtusis; elytris leviter geminato-striatis, fortius sat crebre punctulatis; pygidio nitido, sparsim subtiliter punctulato; tarsorum posticorum articulis basalibus 2 inter se sat æqualibus. Long., 9½ l.; lat., 4⅘ l.

A more robust and dark-coloured species than its allies in the third group; easily distinguishable by the characters cited in the tabulation. Its sex is doubtful, but I think it a female, as the male is likely to have a longer antennal flabellum.

North-west Australia (Murchison district).

H. marginata, sp. nov. Fem.? Elongato-ovata; sat nitida; testacea, capite pedibusque rufescentibus; corpore subtus femoribusque longe pilosis; palpis maxillaribus ut præcedentis (*H. spadicis*); antennis fere ut præcedentis, sed articulo 3° quam 4^{us} manifeste longiori; capite fere ut præcedentis, sed clypeo minus elongato; prothorace fere ut præcedentis sed quam longiori duplo latiori, paullo magis subtiliter punctulato, basi paullo magis perspicue sinuata; elytris fere ut præcedentis sed (præsertim postice) magis subtiliter punctulatis, margine laterali fortiter incrassato; pygidio ad apicem subacuminato, minus nitido, subtiliter coriaceo et leviter sparsim punctulato; tarsis posticis ut præcedentis. Long., 8½ l.; lat., 4⅕ l.

Easily distinguishable from all the other species of its group by the very strongly thickened margin of its elytra. It is near *H. spadix*, but differs from it by numerous minor characters indicated in the diagnosis above, as well as by the remarkable lateral border of its elytra.

North Queensland (Mr. R. C. L. Perkins).

H. longior, sp. nov. Mas. Elongato-subovata; sat nitida; testacea, capite pedibusque rufescentibus; corpore subtus femoribusque longe pilosis; palporum maxillarium articulo 3° quam 2^{us} paullo (quam 4^{us} multo hoc fovea magna impresso) breviori; antennis 9-articulatis, articulis 3° 4° que inter se sat æqualibus, clava 4-articulata quam articuli 2-5 conjuncti sat longiori; clypeo minus lato, antice subtruncato, fortiter reflexo, sparsim punctulato; fronte confertim subtilius punctulata; prothorace quam longiori, ut 15 ad 9 latiori, antice sat angustato, supra subtilius vix crebre punctulato, lateribus minus arcuatis anguste marginatis, basi manifeste sinuata, pilis erectis fimbriata, angulis posticis obtusis; elytris fortius geminato-striatis, fortius vix crebre punctulatis; pygidio minus nitido, subtiliter subcoriaceo, sparsim subtiliter punctulato; tarsorum posticorum articulo basali quam 2^{us} multo breviori. Long., 8 l.; lat., 3$\frac{4}{5}$ l.

Narrower and less dilated hindward than its allies, its clypeus more sparsely punctulate, its pronotum fringed with erect hairs immediately in front of the basal edging, etc., etc.

North-west Australia; Roebuck Bay (Mr. F. Bishop).

H. Sloanei, sp. nov. Ovata, sat lata; minus nitida; rufobrunnea; iridescens; corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3° quam 2^{us} multo longiori quam 4^{us} multo breviori; antennis 9-articulatis, articulo 4° quam 3^{us} sat longiori, clava 3-articulata; clypeo sat brevi, modice reflexo, cum fronte crebre rugulose punctulato; prothorace quam longiori duplo latiori, antice sat angustato, supra crebrius nec profunde punctulato, lateribus sat fortiter rotundatis anguste marginatis, basi leviter sinuata, angulis posticis rotundato-obtusis; elytris leviter geminato-striatis, fortius minus crebre punctulatis; pygidio minus nitido, subtiliter subcoriaceo, leviter sat crebrè punctulato, setis perbrevibus erectis vestito; tarsorum posticorum articulo basali quam 2^{us} sat breviori.

Maris antennarum flabellis articulis 2-6 conjunctis longitudine sat æqualibus, feminæ paullo brevioribus. Long., 9 l.; lat., 4$\frac{4}{5}$ l.

This is the insect which I mentioned (Pr.L.S.N.S.W., 1890, p. 529), as very close to *deceptor*, Blackb., but probably distinct. I had not at that time noticed the great difference in the proportions of the apical two joints of the maxillary palpi, and this character in combination with those mentioned in the note cited above satisfies me that the two are valid species.

New South Wales; Mulwala (Mr. Sloane).

H. accepta, sp. nov. Fem.? Elongato-subovata; subnitida; rufo-brunnea, elytris rufis; iridescens; corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3° quam 2^{us} multo longiori, quam 4^{us} vix breviori; antennis 9-articulatis, articulo 4° quam 3^{us} sat longiori, clava 3-articulata articulis 3-6 conjunctis longitudine sat æquali; clypeo sat elongato, fortiter reflexo, crebre vix rugulose punctulato; fronte crebre rugulose punctulata; prothorace quam longiori duplo latiori, antice sat angustato, supra crebre fortius punctulato, lateribus sat fortiter rotundatis anguste marginatis, basi sinuata, angulis posticis rotundato-obtusis; elytris fortius geminato-striatis, crebre fortius (fere subrugulose) punctulatis; pygidio nitido, antice crebrius fortius punctulato in media parte longitudinaliter subgibbo, postice subcoriaceo sparsim punctulato; tarsorum posticorum articulo basali quam 2^{us} sat breviori. Long., 10 l.; lat., 5$\frac{1}{5}$ l.

Resembles *H. Sloanei*, Blackb., in colouring, but is redder and somewhat more nitid and iridescent. Longer and narrower than *Sloanei*, with the clypeus notably longer, the joints of the palpi differently proportioned, the stipes of the antennæ longer, the elytra and pygidium differently punctured. The pygidium of the unique type bears a few very short, erect setæ, which suggest the probability of its being abraded.

Western Australia: Coolgardie.

H. punctatissima, sp. nov. Fem.? Ovata; sat brevis; subnitida; rufo-brunnea; iridescens; corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3° quam 2^{us} multo longiori quam 4^{us} vix breviori; antennis 9-articulatis, articulis 3° 4° que brevibus inter se sat æqualibus, clava 3-articulata, quam articuli 2-6 conjuncti paullo breviori; clypeo minus elongato, modice reflexo, crebre fortiter punctulato; fronte confertim sat rugulose punctulata; prothorace quam longiori duplo latiori, antice sat angustato, supra crebre subtilius punctulato, lateribus fortiter rotundatis anguste marginatis, basi parum sinuata, angulis posticis late obtusis vix rotundatis; elytris minus fortiter geminato-striatis, crebre minus fortiter punctulatis; pygidio minus nitido crebre subtilius granulato-punctulato et setis perbrevibus erectis vestito; tarsorum posticorum articulo basali quam 2^us^ multo breviori. Long., 8 l.; lat., $4\frac{3}{5}$ l.

Resembles the preceding (*H. accepta*) in respect of its puncturation, but differs much by its antennal structure, as well as by its shorter clypeus, much more shortly ovate form, etc. Judging by the length of its antennal lamellæ I take the unique type to be a female. The length of those joints is about as in *accepta*, but owing to the shortness of the stipes the lamellæ are longer than the four joints preceding them.

North Queensland; given to me by Mr. French.

H. paradoxa, sp. nov. Mas. Ovata; modice elongata; nitida; rufa, elytris (his iridescentibus) palpis antennisque dilutioribus; sternis femoribusque longe fulvo pilosis, prothorace (exempli typici forsitan abrasi) haud pilis fimbriato; capite crebrius subfortiter (postice magis subtiliter), prothorace crebrius leviter, elytris (his geminato-striatis) sparsim minus fortiter, pygidio (hoc glabro coriaceo) subtiliter sat crebre, propygidio (hoc sparsim setoso) sparsim subfortiter, punctulatis; antennis 9-articulatis, flabello 4-articulato (hujus articulis quam præcedentes 5 conjuncti sat longioribus); palporum maxillarium articulo penultimo (hoc modice elongato plurisetoso ad apicem dilatato) quam antepenultimus (hoc sat robusto) multo longiori; prothorace quam longiori fere duplo latiori, antice minus angustato, transversim sat convexo, sat anguste marginato, angulis posticis obtusis, lateribus paullo pone medium leviter dilatato-rotundatis; scutello fere lævi; elytris ad apicem muticis; tarsorum posticorum articulo basali quam 2^us^ manifeste nec multo breviori. Long., 8 l.; lat., $4\frac{1}{4}$ l.

An isolated species, somewhat difficult to place in the genus. Its facies, colouring, and sculpture are suggestive of *testaceipennis*, Macl. and its allies, but its maxillary palpi resemble those of the preceding species, with the penultimate joint, however, less cylindric and with more numerous setæ; its antennal club seems to associate it with *gigantea* and allied species. I know no species really close to it structurally. When both sexes of all the species of *Haplonycha* are known it may well be that this insect may have to be treated as generically distinct from them.

Western Australia; I have no record of the exact locality, but probably it was taken by my son, near Coolgardie.

H. firma, sp. nov. Fem. Robusta; sat breviter ovata; sat nitida; obscure rufobrunnea; corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3° quam 2^{us} multo longiori quam 4^{us} parum breviori; antennis 9-articulatis, articulis 3° 2° que longitudine inter se sat æqualibus, clava 3-articulata (laminis articulis 2-6 conjunctis longitudine sat æqualibus); clypeo minus elongato, sat fortiter reflexo, crebre rugulose punctulato; fronte fortiter rugulosa, longe setosa; prothorace quam longiori ut 9 ad 5 latiori, antice fortiter angustato, supra sat crebre minus fortiter punctulato lateribus fortiter rotundatis sat anguste marginatis, basi sat fortiter sinuata ad latera ante marginem setosa, angulis posticis (superne visis) obtusis sat bene determinatis; elytris subfortiter geminato-striatis, fortiter crebrius punctulatis; pygidio nitido, leviter minus crebre punctulato; tarsorum posticorum articulo basali quam 2^{us} paullo breviori. Long., 9 l.; lat., 5 l.

Though falling, in the preceding tabulation, beside *H. clypealis*, Blackb., this species is not allied to it so closely as to *H. solida*, Blackb., being of much more robust form than *clypealis*, with its pronotum strongly declivous at the base, so as to appear (viewed from the side) strongly convex. From *solida* (besides its differently sculptured head) it differs by its smaller size, much more strongly punctulate elytra, and pronotum with a setose fringe (very widely interrupted in the middle) immediately in front of the basal edging.

Western Australia; sent to me by Mr. Jung.

H. clypealis, sp. nov. Mas. Ovata; modice elongata; sat nitida; rufa vel rufobrunnea, iridescens, tibiis tarsisque infuscatis, antennis palpisque dilutioribus; corpore subtus femoribusque longe fulvo-pilosis, capite pilis elongatis erectis sparsim vestito, prothoracis marginibus omnibus et elytrorum marginibus lateralibus pilis elongatis erectis fimbriatis; capite crebre ruguloso (clypeo minus ruguloso); prothorace elytrisque (his geminato-striatis) subfortiter minus crebre, pygidio (hoc minus nitido setis perbrevibus erectis vestito) minus crebre sat subtiliter, punctulatis; antennis 9-articulatis, flabello 3-articulato (hujus articulis quam præcedentes 5 conjuncti haud brevioribus); palporum maxillarium articulo penultimo (hoc elongato quam apicalis haud breviori) quam antepenultimus fere duplo longiori; prothorace quam longiori duplo latiori, antice sat angustato, transversim parum convexo, sat anguste marginato, angulis posticis obtusis, lateribus pone medium valde rotundato-ampliatis; scutello sparsim punctulato; elytris ad apicem sat muticis; propygidio opaco creberrime punctulato; tarsorum posticorum articulo basali quam 2^{us} multo breviori. Long., 9 l.; lat. 5 l.

A pretty species, with somewhat brilliant iridescence. I have a specimen from the same locality as the type which I believe to be its female; it is very much damaged and crushed, and differs from the male in the somewhat shorter flabellum of its antennæ, its pygidium gibbous near the base, and its puncturation in general somewhat closer and stronger. The most noticeable specific characters of this species seem to be its clypeus more elongate, and in front more narrowly rounded than in allied species, and the extremely strong, rounded dilatation of the sides of its prothorax behind the middle. It is rather close to *H. deceptor*, Blackb. (from Central and South Australia), but differs from that insect by, *inter alia*, its longer and anteriorly narrower clypeus, its prothorax less convex (transversely), and with sides much more strongly rotundate-ampliate, and the different proportions of its tarsal joints.

Western Australia; Coolgardie district.

H. amabilis, sp. nov. Mas. Modice elongata; nitida; rufa vel rufotestacea, iridescens; corpore subtus femoribusque longe fulvo-pilosis, prothoracis marginibus omnibus et elytrorum marginibus lateralibus pilis elongatis erectis fimbriatis; capite crebre subfortiter nec rugulose, prothorace subfortiter minus crebre, elytris (his geminato-striatis) minus crebre vix subfortiter, pygidio (hoc nitido setis elongatis erectis sparsim vestito) sparsius dupliciter (sc. puncturis sat magnis setiferis et alteris sat subtilibus), propygidio (hoc breviter setoso) sat crebre nec creberrime, punctulatis; antennis 9-articulatis, flabello 3-articulato (hujus articulis quam præcedentes 5 conjuncti haud brevioribus); palporum maxillarium articulo penultimo (hoc elongato quam apicalis sublongiori) quam antepenultimus (hoc sat gracili) multo longiori; prothorace quam longiori ut $1\frac{3}{5}$ ad 1 latiori, antice fortiter angustato, transversim parum convexo, sat anguste marginato, angulis posticis rotundatis, lateribus haud pone medium rotundato-ampliatis; scutello sparsim punctulato; elytris ad apicem sat muticis; tarsorum posticorum articulo basali quam 2^{us} multo breviori. Long., $9\frac{1}{2}$ l.; lat., 5 l.

Easily distinguishable from all its near allies by the sides of its prothorax not being rotundate-ampliate. This segment is very little convex (*i.e.*, not in any marked degree declivous hindward near the base). In colouring resembles *H. bella*, Blackb. I have not seen a female example.

Western Australia: taken by Mr. Lea near Bridgetown.

H. nobilis, sp. nov. Fem.? Ovata; sat elongata; subnitida; rufobrunnea; modice iridescens; corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3° quam 2^{us} fere longiori, quam 4^{us} parum breviori; antennis 9-articulatis, articulo 4° quam 3^{us} sat longiori, clava 4-articulata quam articuli 2-5 conjuncti vix breviori clavæ articulo basali valde abbreviato; clypeo modice elongato, fortiter reflexo, sat crebre punctulato; fronte crebre punctulata; prothorace quam longiori duplo latiori, antice sat angustato, supra sparsius subtilius punctulato, lateribus minus arcuatis sat anguste marginatis, basi parum sinuata, angulis posticis obtusis (bene definitis); elytris subfortiter geminato-striatis, sat crebre subfortiter punctulatis; pygidio nitido, obsolete sparsim punctulato; tarsorum posticorum articulo basali quam 2^{us} multo breviori. Long., 14 l.; lat., $7\frac{1}{5}$ l.

This remarkably fine species furnishes an instance of the difficulty that occurs, in almost all large genera, of tabulating the species through the existence of one here and there that does not seem to fit in anywhere satisfactorily. Its natural place is quite clearly among the species that form my fourth group, but its maxillary palpi certainly present a difficulty in so classifying it, as the 3rd joint is decidedly not longer than the 2nd. I am not justified in breaking off a palpus for measurement, but I suspect the 2nd joint would prove to be slightly longer than the 3rd. There is, however, in the fifth group not one species known to me which cannot be at once separated from the present insect by not presenting in combination an iridescent dorsal surface and palpi with joints 2 and 3 subequal in length. I have little doubt of the unique type being a female, or of the male having a much more elongate antennal club consisting of 4 subequal lamellæ.

Western Australia; in the South Australian Museum (Muir).

H. amœna, sp. nov. Mas. Elongata; leviter ovata; subnitida; rufa, elytris antennis palpisque testaceo-brunneis; iridescens; corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3° quam 2^{us} parum longiori, quam 4^{us} sat breviori; antennis 9-articulatis, articulo 4° quam 3^{us} subbreviori, clava 3-articulata quam articuli 2-6 conjuncti sat longiori; clypeo minus elongato, fortiter reflexo, cum fronte crebre fortius punctulato; prothorace quam longiori duplo latiori, antice modice angustato, supra sparsim leviter punctulato, lateribus sat fortiter rotundatis, anguste marginatis, pone medium sat fortiter sinuatis, basi subfortiter sinuata, angulis posticis bene definitis subdentiformibus; elytris fortius geminato-striatis, fortius sat crebre punctulatis; pygidio sat nitido crebrius dupliciter (subtiliter et minus subtiliter) leviter punctulatis; tarsorum posticorum articulo basali quam 2^us^ sat breviori. Long., $8\frac{1}{2}$ l.; lat., $4\frac{1}{5}$ l.

The strong sinuation of the sides of the prothorax behind the middle readily distinguishes this species from *H. Gouldi*, Hope, and *H. nobilis*, Blackb. Its antennal club with only three lamellæ separates it from *H. bella*, Blackb., and the very much longer stipes of its antennæ from *H. pulchella*, Blackb. I have no doubt the female differs from the male by the much shorter lamellæ of its antennæ.

Victoria; given to me by Mr. French.

H. lucifera, sp. nov. Fem.(?) Breviter ovata; minus nitida; rufa, antennis palpis elytrisque testaceo-brunneis; iridescens; corpore subtus femoribusque longe pilosis; palporum maxillarium articulo 3° quam 2^us^ multo (quam 4^us^ sat) breviori; antennis 9-articulatis, articulo 3° 2° longitudine subæquali, clava 4-articulata quam articuli 2-5 conjuncti vix breviori, clavæ articulo basali quam 2^us^ circiter dimidio breviori; clypeo modice elongato, fortiter reflexo, nitido, cum fronte sat crebre punctulato; prothorace quam longiori duplo latiori, antice fortiter angustato, supra sparsim subtilissime punctulato, lateribus sat arcuatis sat anguste marginatis, basi sat fortiter sinuata, angulis posticis rotundatis; elytris modice geminato-striatis, leviter dupliciter (subtiliter et minus subtiliter) sat crebre punctulatis; pygidio pernitido, puncturis subtilissimis sparsissimis setiferis impresso; tarsorum posticorum articulo basali quam 2^us^ multo breviori. Long., 11 l.; lat., $6\frac{3}{5}$ l.

A species of very widely ovate form, very close to the insect that I take to be *H. gigantea*, Burm., but differing from it strongly by the structure of its antennæ and the sculpture of its pygidium. I do not think I can be mistaken in my identification of *gigantea* with a species (of which there is a male in my collection and a female in Mr. Lea's), from Perth, W.A., agreeing well with the description except in respect of the antennæ. Burmeister says that the antennal flabellum of the female is 3-jointed, and that of the male 4-jointed, while I regard the flabellum as 4-jointed in both sexes. As a fact, I do not think that there is any *Haplonycha* in which it is correct to regard the number of joints in the flabellum as different in the sexes; and that, in spite of my having myself attributed that difference to a species (*H. bella*), which I described in 1890, and before I had had the opportunity of observing any large proportion of the species now before me. It seems to be invariably the case that if there are 4 laminæ in the antennæ of the male the 6th joint of the antennæ of the female is produced into a lamella representing (not the last joint of the male stipes, but) the basal joint of the male flabellum. In most of these species the 6th joint is so lamelliform in the female that there is no doubt whatever of its being part of the flabellum, but in a few species it is only feebly produced. In the species that I take to be *gigantea* it is scarcely one-third of the 7th joint in length, and in *bella* it is still shorter (scarcely one-fifth); but the males of the species in which it is not produced at all in the female I invariably find to have only 3 laminæ. Under these circumstances I feel justified in thinking that Burmeister was not strictly correct in his statement that the flabellum has a different number of joints in the two sexes of *H. gigantea*. I am doubtful as to the sex of the unique type of *H. lucifera*. The laminæ of its flabellum are notably shorter than in the male, and slightly longer than in the female of the species I regard as *gigantea*, the basal lamella (the 6th joint of the antennæ) being a little more than half the next joint in length. The probability, however, is strongly in favour of its being a female.

Western Australia: Swan River: in the collection of Mr. Lea.

H. Mauricei, sp. nov. Mas. Subovata; minus lata; subnitida; rufa, antennis dilutioribus; corpore subtus pedibusque dense longissime pilosis; palporum maxillarium articulo 3° 2° sat æquali, quam 4^{us} sat breviori; antennis 9-articulatis, articulis 2° 3° que sat brevibus inter se sat æqualibus, clava 5-articulata, hujus lamina basali perbrevi quam 2^{a} tribus partibus breviori (laminis 2-5 valde elongatis quam antennarum articuli 1-4 conjuncti multo longioribus, quam caput vix brevioribus); oculis manifeste granulatis; clypeo sat elongato, ad basin manifeste angustato, sat crebre punctulato, antice fortiter reflexo; fronte confertim punctulata; prothorace quam longiori ut 13 ad 7 latiori, antice fortiter angustato, supra sparsius subfortiter punctulato, lateribus sat arcuatis sat anguste marginatis (his cum basi pilis elongatis fimbriatis), basi sat fortiter sinuata, angulis posticis rotundato-obtusis; elytris ad basin longe pilosis, sat fortiter geminato-striatis, fortiter minus crebre punctulatis; pygidio puncturis sparsis (his longe piliferis) impresso; tarsorum posticorum articulo basali quam 2^us^ sat breviori. Long., $6\frac{1}{2}$ l.; lat., $3\frac{2}{5}$ l.

A very remarkable species; the extremely long laminæ of its antennæ and the basal narrowing of its clypeus suggest a doubt whether it ought not to be treated as the type of a new genus. The antennal character, however, is reproduced in another species (*H. egregia*, Backb.), which has a normal clypeus, and so connects it with *Haplonycha*. The long pilosity of the sides and base of its pronotum is suggestive of the species of my second group, but its pronotum has not the wide lateral gutter of those species. The granulation of the eyes is more distinct in this species than in most of its congeners. It may be noted that in this species and all the others of the Group V., in which I have indicated the antennal club as having more than three joints, the club might almost be called 5-jointed, as the 5th joint is slightly lamelliform on its inner side, but so slightly that it seems more convenient to regard it as appertaining to the stipes.

Ouldea; Central Australia; taken by Mr. Maurice.

H. egregia, sp. nov. Sat ovata; minus elongata; sat nitida; rufo-brunnea, antennis dilutioribus; corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3° 2° sat æquali, quam 4^{us} sat breviori; antennis 9-articulatis, articulis 3° 4° que brevioribus inter se sat æqualibus, clava 5-articulata (maris fere ut præcedentis, *H. Mauricei*, sed articulo basali paullo longiori; feminæ articulo basali vix laminato, 2° quam 3^{us} paullo minus longe laminato, laminis 3-5 quam antennarum articuli 1-4 conjuncti vix brevioribus); clypeo sat elongato, cum fronte crebre subrugulose punctulato; prothorace quam longiori vix duplo latiori, antice minus angustato, supra sat crebre subleviter punctulato, lateribus modice rotundatis sat anguste marginatis pone medium manifeste sinuatis, basi manifeste sinuatis subtiliter æqualiter marginata, angulis posticis obtusis haud dilatatis; elytris perspicue geminato-striatis, crebre sat fortiter punctulatis; pygidio nitido, sparsius leviter punctulato; tarsorum posticorum articulo basali quam 2^{us} manifeste breviori. Long., $6\frac{1}{2}$ l.; lat., $3\frac{4}{5}$ l.

Agrees with *H. Mauricei*, Blackb., in the extremely long laminæ of its antennal club, but otherwise more resembling *H. sinuaticollis*, Blackb., from which it differs by its much smaller size, prothorax less strongly sinuate at the base, etc.

South Australia; Troubridge, etc.

H. rustica, sp. nov. Fem. Elongato-ovata; sat nitida; rufo-brunnea, capite pronoto pygidioque nigris, antennis palpisque dilutioribus; corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3° quam 2^{us} vix (quam 4^{us} sat multo) breviori; antennis 9-articulatis, articulo 4° quam 3^{us} paullo longiori (ambobus brevibus), clava 4-articulata (hujus lamina basali quam 2^{a} fere dimidia parte breviori, ceteris quam antennarum articuli 2-5 conjuncti sat longioribus); clypeo sat elongato, modice reflexo, cum fronte crebre rugulose nec grosse punctulato; prothorace quam longiori fere duplo latiori, antice modice angustato supra crebre sat fortiter punctulato, lateribus modice rotundatis sat anguste marginatis pone medium subfortiter sinuatis, basi modice sinuata subtiliter æqualiter marginata, angulis posticis haud dilatatis fere rectis subprominulis (superne visis); elytris leviter geminato-striatis, crebre subfortiter punctulatis; pygidio sat nitido, leviter punctulato, brevissime setoso; tarsorum posticorum articulo basali quam 2^{us} sat breviori.

Maris antennarum laminis quam feminæ longioribus; pygidio magis nitido, glabro, magis fortiter punctulato. Long., 8 l.; lat., $4\frac{1}{5}$ l.

Easily recognized among its immediate congeners by its black head, pronotum, and pygidium, also from *Mauricei* and *egregia* by the very much shorter laminæ of its antennæ, and from *sinuaticollis* by, *inter alia*, the much less strongly sinuate base of its prothorax, and the considerably closer puncturation of its elytra. I have founded the description on one of two female examples in the South Australian Museum rather than on the unique specimen (male), in my own collection, because the latter is a broken specimen, with only the basal lamella remaining of its antennal flabella, and therefore I cannot describe its antennæ satisfactorily. There is a difference between the two females in the Museum in respect of the pygidium, the surface in one of them being somewhat dull and coriaceous, but I regard this as a mere accidental variation.

South Australia; Murray Bridge.

H. arvicola, sp. nov. Fem. Elongato-ovata; sat nitida: rufo-brunnea, antennis dilutioribus, capite nonnihil obscuro; corpore subtus pedibusque longe pilosis; capite (antennis palpisque inclusis) fere ut præcedentis *(H. rusticæ)* sed fronte minus crebre punctulato; prothorace fere ut præcedentis, sed supra multo magis subtiliter punctulato, ad basin parum sinuato; elytris quam præcedentis minus fortiter minus crebre punctulatis; pygidio sat nitido quam præcedentis minus leviter punctulato; tarsorum posticorum articulo basali quam 2^us parum breviori. Long., $8\frac{1}{4}$ l.; lat., $4\frac{1}{5}$ l.

Somewhat close to *H. rustica*, but very differently coloured, with the pronotum very much more finely punctulate, etc. It is unlikely that the male differs much from the female except by the longer laminæ of its antennæ. As the unique type of this insect has already lost one of its maxillary palpi, I have not been able to risk a satisfactory examination of a palpus; but I can see (without unsafe manipulation) that, although the second joint is partially concealed, there is at least not *much* difference from the palpi of *H. rustica*.

South Australia; Gawler (taken by the late Mr. Rothe).

H. electa, sp. nov. Sat late ovata; sat nitida; rufo-brunnea, antennis palpisque dilutioribus; corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3° quam 2^us vix (quam 4^us multo) breviori; antennis 9-articulatis articulo 4° quam 3^us longiori (ambobus sat brevibus), clava 4-articulata (hujus lamina basali quam 2^a maris quinta parte, femina septem partibus, breviori); clypeo sat elongato, sat fortiter reflexo, confertim rugulose punctulato; fronte magis subtiliter vix confertim punctulata; prothorace quam longiori fere duplo latiori, antice modice angustato, supra minus subtiliter punctulato, lateribus modice rotundatis sat anguste (parte postica minus anguste) marginatis pone medium subfortiter sinuatis, basi subfortiter sinuata, margine basali latera versus magis elevato, angulis posticis manifeste dilatatis fere rectis subprominulis (superne visis); elytris sat fortiter geminato-striatis, crebre sat fortiter punctulatis; pygidio nitido subtilius sparsissime punctulato; tarsorum posticorum articulo basali quam 2^us manifeste breviori. Long., $9\frac{1}{2}$ l.; lat., $4\frac{4}{5}$ l.

Very close to *H. fraterna*, Blackb., and differing chiefly by sexual characters. In the male the antennal laminæ are scarcely shorter than the clypeus (in *fraterna* notably shorter). In the female the antennal laminæ are very little shorter than in male *fraterna*, but the basal lamina (*i.e.*, that of the 6th antennal joint) equals only about one-seventh of the 2nd lamina in length (in *fraterna* the longer laminæ are notably shorter than in *electa*, but the basal one equals in length nearly half the 2nd). In *electa* the male pronotum is less strongly punctured than the female, but in *fraterna* the pronotum of both sexes is punctured like that of male *electa*.

Western Australia.

H. sabulicola, sp. nov. Mas. Sat late ovata; sat nitida: rufo-brunnea, capite pronoto scutello pygidio et segmento ventrali apicali nigris; corpore subtus et pedibus longe pilosis; palporum maxillarium articulo 3° quam 2^{us} vix (quam 4^{us} multo) breviori; antennis 9-articulatis, articulis 3° 4° que sat æqualibus, clava 4-articulata (vel quasi 5-articulata, articulo antennarum 5° breviter sed manifeste lamelliformi); clypeo modice elongato, sat crebre punctulato; fronte crebre punctulata; prothorace quam longiori ut 7 ad 4 latiori, antice sat angustato, supra sparsius subtilius punctulato, lateribus modice arcuatis sat anguste (parte postica minus anguste) marginatis pone medium subfortiter sinuatis, basi sat fortiter sinuata (parte mediana subfortiter lobata), margine basali latera versus magis elevato, angulis posticis manifeste dilatatis fere rectis subprominulis (superne visis); elytris leviter geminato-striatis, crebrius sat fortiter punctulatis; pygidio nitido sparsim leviter punctulato; tarsorum posticorum articulo basali quam 2^{us} paullo breviori. Long., 8 l.; lat., 4¼ l.

Easily distinguishable, by its colouring, from its nearest allies, also by the finer and less close puncturation of its pronotum. The lamellæ of its antennæ are not much different from those of the male of *H. electa*, Blackb., but that of the 5th antennal joint is very evidently more developed. I have seen nine specimens of this insect, all from the sandy regions about Eucla, and other parts of south-west Australia (some of them taken by Mr. Graham), and find only very feebly indicated sexual character. The examples which I take to be females are a little smaller than the described type, with the antennal laminæ a little shorter, the 5th antennal joint scarcely lamelliform, and the puncturation of the frons and the pronotum a little finer and less close. It is just possible that these specimens are feebly developed males, and that I have not seen the female.

South-west Australia (Eucla, etc.).

H. æqualiceps, sp. nov. Fem. Robusta; ovata; minus lata; sat nitida; obscure rufo-brunnea; corpore subtus pedibusque longe pilosis; palporum maxillarium articulis 2-4 inter se longitudine sat æqualibus; antennis 9-articulatis, articulo 4° quam 3^{us} nonnihil longiori, clava 3-articulata (laminis quam antennarum articuli 2-6 conjuncti sat brevioribus); clypeo modice elongato, sat fortiter reflexo, cum fronte confertim sat rugulose punctulato; prothorace quam longiori fere duplo latiori, antice sat angustato, supra crebre subfortiter punctulato, lateribus minus fortiter rotundatis sat anguste marginatis, sulco laterali æqualiter ut discus punctulato, basi sat fortiter sinuata, angulis posticis rotundatis; elytris sat fortiter geminato-striatis, crebrius sat fortiter punctulatis; pygidio sat nitido minus crebre subfortiter punctulato, parte mediana sublævi; tarsorum posticorum articulo basali quam 2^{us} multo breviori. Long., 12 l.; lat., $6\frac{1}{4}$ l.

Its large size is sufficient to distinguish this species from all its immediate allies. It bears much general resemblance to the species which I take to be *H. badia*, Burm., but differs from it widely by the structure of its maxillary palpi, also by the very much closer puncturation of its pronotum, and by the hind angles of that segment being rounded off and not dilated.

Australia (exact *habitat* uncertain; probably Western Australia).

H. thoracica, sp. nov. Fem. Sat late ovata; sat nitida; rufo-brunnea, antennis palpisque dilutioribus; corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3^o quam 2^{us} vix (quam 4^{us} manifeste) breviori; antennis 9-articulatis, articulo 4^o quam 3^{us} sublongiori, clava 3-articulata (laminis quam articuli 3-6 conjuncti vix longioribus); clypeo minus elongato, fortiter reflexo, confertim rugulose punctulato; fronte crebre punctulata; prothorace quam longiori ut 17 ad 8 latiori, antice sat angustato, supra fortius minus crebre punctulato lateribus æqualiter sat fortiter arcuatis sat anguste marginatis, sulco laterali sat æqualiter ut discus punctulato, basi minus fortiter sinuata, angulis posticis (superne visis) obtusis sat bene determinatis; elytris sat fortiter geminato-striatis, sat crebre sat fortiter punctulatis; pygidio sub-nitido, leviter sat crebre punctulato; tarsorum posticorum articulo basali quam 2^{us} paullo breviori. Long., $8\frac{1}{5}$ l.; lat., $4\frac{1}{4}$ l.

Somewhat closely allied to the species that I take to be *H. pectoralis*, Blanch., but very distinct on account of its pronotum less closely punctulate and with its lateral outline forming an even curve, the greatest width being very little behind the middle.

New South Wales.

C. clara, sp. nov. Mas.(?) Ovata; modice elongata; sat nitida; rufo-brunnea, sternis infuscatis; corpore subtus pedibusque cinereo-pilosis, prothoracis marginibus pilis elongatis erectis fimbriatis; capite crebre rugulose, prothorace minus crebre minus fortiter, elytris (his geminato - striatis) sat crebre minus subtiliter, pygidio sparsius subtilius sat æqualiter, punctulatis; antennis 9-articulatis, flabello 3-articulato (hujus articulis quam præcedentes 5-conjuncti vix brevioribus); palporum maxillarium articulo penultimo (hoc subcylindrico ad apicem setis brevibus minus perspicuis instructo) quam antepenultimus vix longiori; prothorace quam longiori duplo latiori, antice sat angustato, postice retrorsum sat late declivi, sat anguste marginato, angulis posticis rotundato-obtusis, basi modice sinuata; scutello acervatim punctulato; elytris ad apicem muticis; propygidio apicem versus crebre aspere minus subtiliter punctulato; tarsorum posticorum articulo basali quam 2^{us} vix breviori. Long., 9 l.; lat., $3\frac{1}{5}$ l.

From the comparatively long lamellæ of the antennal flabellum and the feebly and evenly convex pygidium I take my unique example of this insect to be a male. It is very distinct from most of the species that resemble it superficially, by the structure of its maxillary palpi.

South-west Australia.

H. faceta, sp. nov. **Fem.**(?) Ovata; minus brevis; nitida; rufo-brunnea, antennis palpis elytrisque dilutioribus (his exempli typici anguste fusco-marginatis); corpore subtus pedibusque longe pilosis; palporum maxillarium articulo 3° quam 2^{us} parum (quam 4^{us} paullo) breviori; antennis 9-articulatis, articulo 3° quam 4^{us} vix longiori, 6° introrsum acuto; clava 3-articulata (laminis articulis 2-6 conjunctis longitudine vix æqualibus); clypeo brevi, sat fortiter reflexo, cum fronte sat grosse vix crebre punctulato, parte antica perpendiculari pernitida vix punctulata (serie puncturarum magnarum setiferarum excepta); prothorace quam longiori fere duplo latiori, antice sat angustato, supra inæqualiter sat fortiter punctulato, lateribus fortiter rotundatis sat anguste marginatis, basi sat fortiter sinuata, angulis posticis obtusis sat bene determinatis nonnihil dilatatis; elytris leviter geminato-striatis, minus fortiter sat crebre punctulatis; pygidio nitido, inæqualiter subgrosse punctulato, longitudinaliter obtuse carinato; tarsorum posticorum articulo basali quam 2^{us} paullo breviori. Long., 8 l.; lat., 4 l.

A nitid species, of clear bright colour, the fuscous edging of the elytra probably not constant, as it is more conspicuous in some parts than in others. I think the type a female, but probably there is very little external difference between the sexes, as in the allied *H. testaceipennis*, Macl. The antennal laminæ, although rather elongate for a female, would be unusually short if the type were a male.

Western Australia (exact locality uncertain).

H. Jungi, sp. nov. Mas.(?) Ovata; sat elongata; nitida; rufo-brunnea, capite obscuriori, antennis palpisque testaceis: corpore subtus pedibusque sat longe pilosis; palporum maxillarium articulo 3° quam 2^{us} vix (quam 4^{us} perspicue) breviori: antennis 9-articulatis, articulis 3° 4° que inter se longitudine sat æqualibus, 5° 6° que introrsum acutis: clava 3-articulata (laminis articulis 2-6 conjunctis longitudine æqualibus): clypeo sat brevi, fortiter reflexo, crebre minus fortiter punctulato, parte antica perpendiculari pernitida vix punctulata (serie puncturarum magnarum setiferarum excepta): fronte sparsius subtilius punctulata: prothorace quam longiori duplo latiori, antice minus fortiter angustato, supra sparsim subtilissime punctulato, lateribus minus fortiter arcuatis sat anguste marginatis, basi modice sinuata, angulis posticis fere rectis nonnihil dilatatis; elytris sat leviter geminato-striatis, fortius minus crebre punctulatis: pygidio sat nitido, sparsissime subtilissime punctulato: tarsorum posticorum articulo basali quam 2^{us} multo breviori. Long., 7 l.: lat, $3\frac{2}{5}$ l.

The sexual differences in the species of this group (the 7th) appear to be very slight: but from its antennal laminæ being slightly longer than in *H. faceta*, Blackb., and the 5th antennal joint, as well as the 6th, being angular on the inner side I judge the type of *H. Jungi* to be probably a male. It is specifically extremely distinct from *H. faceta* by the very different puncturation of all its dorsal segments and from both that species and *testaceipennis*, Macl., by the shape of its prothorax.

Western Australia: given to me by Mr. Jung.

CLERIDÆ.

Natalis.

N. Leai, Blackb. This species has a somewhat involved history. I described it in Tr.R.S.S.A., 1899, and pointed out that it must be superficially extremely like *Opilo floccosus*, Schenk. (described in Deutsch. Ent. Zeit., of the preceding year). In 1903 Schenkling stated *(l.c.)* that he had found his species to be a *Natalis*, and that it was identical with *N. Leai*, Blackb. In the same year, Tr.R.S.S.A., p. 308, I reported Schenkling's announcement, and assented to it. Subsequently Herr Schenkling has been so good as to send me a specimen of his *floccosus*, with the result that on a recent re-examination of the specimens of *Natalis* in my collection, I find that after all the two names appear to represent two distinct, though closely allied, species, which can be readily distinguished from each other by the puncturation of the sterna (especially the metasternum), which in *floccosus* is very close and asperate; while in *Leai* it is entirely different, the prosternum and mesosternum being almost punctureless, and the metasternum being along the median part strongly transversely rugate and elsewhere extremely sparsely punctulate. On the dorsal surface there are also evident differences, the pronotum of *floccosus* being notably more punctulate, and the white hairs on the elytra of *Leai* being disposed in perfectly well-defined fascicles. Of *floccosus* I have two examples (one of which is from Sydney, the exact locality of the other uncertain). Of *Leai* there are three examples in my collection, one of which is from Richmond River, and two from North Queensland (Mr. R. C. T. Perkins).

CURCULIONIDÆ.

TITINIA.

T. læta, Blackb. Mr. Lea (Tr.R.S.S.A., 1905, p. 219) makes this name synonymous with *T. ignaria*, Pasc. *(sic.)*. He is, however, mistaken in this opinion. In the unique type (in my collection) of *læta*, *inter alia*, the rostrum is very much narrower between the insertions of the antennæ than in *T. ignaria*, Pasc.

LONGICORNES.

PAPHORA.

The following two species must be referred to this genus, though both very much larger than the type of this genus, very different in colouring, and of much more robust appearance. I cannot, however, find any structural character in them on which to found a new genus.

P. pulchra, sp. nov. Robusta; ferruginea, capite postice elytrorum basi et in his fascia postmediana lata chalybeo-nigris; breviter sparsius pubescens; antennis elytrorum apicem haud vel vix attingentibus, articulo 3° quam basalis vix (4° manifeste) brevioribus, articulis 5°-9° gradatim longioribus, 10° 11° que parum brevioribus; capite longitudinaliter leviter concavo, crebre rugulose punctulato; prothorace ut caput punctulato, linea brevi longitudinali postmediana nitida minus perspicue instructo, longitudine latitudini æquali, lateribus leviter rotundatis; elytris minus crebre (a basi retrorsum gradatim minus fortiter) vix rugulose punctulatis, ad apicem late rotundatis.

Probably the smaller of the two examples before me is a male. Apart from size, it differs little from the other specimen, but its antennæ are a trifle longer and less robust, with their apical two joints hardly perceptibly shorter than the 9th joint. Long., $6\frac{1}{2}$-8 l.; lat, 2-$2\frac{3}{5}$ l.

Western Australia (Murchison); sent by Mr. C. French.

P. miles, sp. nov. Robusta; piceo-nigra, palpis antennis pedibusque obscure ferrugineis; breviter sparsius pubescens; antennis elytrorum apicem vix attingentibus, articulo 3° quam basalis sat longiori (quam 4^{us} sublongiori), articulis 5°-11° quam 4^{us} sat longioribus (inter se gradatim vix longioribus); capite longitudinaliter leviter concavo, crebre rugulose punctulato; prothorace supra crebre rugulose fere subgrosse punctulato, longitudine latitudini æquali, lateribus sat fortiter rotundatis; elytris ad apicem oblique truncatis, ad basin ut pronotum (hinc retrorsum gradatim minus fortiter, in parte apicali leviter sat sparsim) punctulatis. Long., $6\frac{1}{2}$ l.; lat., 2 l.

Of its previously described congeners, *P. robustior*, Blackb., is the nearest to the present species, but differs from it by its more parallel form, puncturation much less coarse and rugulose, basal joint of antennæ shorter in proportion to 3rd joint, elytra rounded at apex, prothorax much less rounded laterally, etc.

Central Australia (Oodnadatta).

The following table shows the distinctive characters of the four species that have now been attributed to this genus:—

A. Elytra unicolorous.	
B. Puncturation of elytra not (or scarcely) rugulose.	
C. Apex of elytra narrowly rounded	modesta, *Pasc.*
CC. Apex of elytra very widely rounded	robustior, *Blackb.*
BB. Elytra very strongly rugulose in their front half	miles, *Blackb.*
AA. Elytra bicolorous	pulchra, *Blackb.*

A Note on Some Modifications in the Morphological Structure of the Mammalian Vertebræ.

By A. Zietz, F.L.S., C.M.Z.S.

[Read September 4, 1906.]

The morphological changes which the vertebræ present when we compare certain modifications in the apophyses, right through the whole of the mammalian series, appear almost as a blank, even in more recent publications. I selected for comparison of these transformations the vertebræ of the lumbar series, for the reason of their simplicity in structure, in preference to the dorsal series, which are subject to many complications.

In human anatomy the lumbars show the usual forms of apophyses, with the exception of one of these, which is only indicated and known as the tubercle; this is the anapophysis.

A step further downwards in the mammalian order shows that the tubercle becomes more or less pronounced, till we arrive at the marsupialia, where in some instances they appear as a rather conspicuous element. So far, these changes do not seem to affect the diapophyses, except in one instance, recorded by Professor Owen. This is in *Osphranter rufus*,* in which they are marked by the reduction to a small rudiment, but only in the first lumbar. As we step still further back to the apparently ancient type, the Diprotodon of Owen, the lumbars at a first glance strikingly resemble the lumbars of man, except in one point; this is the entire absence of the tubercle. A more detailed investigation, however, reveals the fact that what at a first glance appeared to be the diapophyses are in reality the anapophyses, which in this case are transformed into the long, flat, lateral expansions which in other mammalia characterize the diapophyses, but the latter are either absent or occur as a rudiment connected with the anapophyses, which would be just the reverse to what happened in the lumbars of man.

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* Professor Owen: On the Osteology of the Marsupialia. Trans. Zool. Soc. L., vol. ix., part viii., page 429, pl. lxxv., fig. 11.

ABSTRACT OF PROCEEDINGS

OF THE

Royal Society of South Australia

(Incorporated)

FOR 1905-6.

ORDINARY MEETING, NOVEMBER 7, 1905.

THE PRESIDENT (J. C. Verco, M.D., F.R.C.S.) in the chair.

EXHIBITS.—J. G. O. TEPPER, F.L.S., a piece of rock from near Paratoo, said to be a phosphate and nitrate of potassium and iron.

THE PRESIDENT read a paper on the trapdoor spider of the Adelaide Plains, of which the following is an abstract:—Interested in this remarkable animal from boyhood, Dr. Verco had at various times taken pains to discover its habits. "The burrow or nest of the female spider is a circular and nearly vertical hole, lined for a short distance from the entrance with silk webbing. The entrance is closed with a door consisting of layers of webbing and earth, lined on the edges and lower surface with silk webbing. In plan the door is semicircular, and lightly bevelled on the lower side to fit exactly the aperture, which is funnel-shaped. The hinge is formed of webbing along the straight side, curved inwards a little towards the ends, so preventing the door opening widely. This modification of the hinge, together with the weight of the door—the centre of gravity of which is always over the opening—causes it to close automatically. Such a door must afford considerable security against enemies:—(1) Is not readily seen, being flush with the surrounding ground; (2) is not easily opened; (3) is well supported against outside pressure." The President, having described the occupant, as far as necessary for a clear conception of how it secures its nest against an intruder, proceeded:—"If the wall of our spider's tube be carefully examined under a lens, a small area will be found just below the bevelled edge, opposite the hinge, which is studded with pin-pricks, slightly elongated vertically. These are made by the spines of the falces. The spider when alarmed rushes to the door, fixes the two fangs into the door, and pushes the dorsal surface of its falces against the wall of the tube, immediately below, thrusting the foremost spines into the silken lining, and so effectually locks the door. Again, as to the disposition of the legs and claws. There are two punctate areas, one on each side of the tube, a little behind the transverse diameter. The areas show the pin-pricks, which indicate the holding-ground of the creature's claws. By this means the strain on the tube is distributed at three equidistant points, manifestly with advantage and safety to the spider."

Mr. A. H. C. Zietz, F.L.S., mentioned that the spider with wafer operculum was found in the sandhills at Henley Beach and elsewhere.

Mr. Griffiths showed a very interesting specimen from Western Australia, with a window of silk webbing in the middle of the door.

Mr. W. Howchin, F.G.S., exhibited examples of the mineral wavellite, a hydrous phosphate of alumina, in two forms. One of these, in the form of small spheres with a radial structure, from the phosphate claims at Pekina. The phosphate mineral occurred in belts and pockets in a decomposing slate. The other form of the mineral was in mammillary nodules, up to six inches in diameter, obtained at Angaston. These specimens are interesting from a mineralogical standpoint, but as they are difficult to treat for extraction of phosphoric acid they are not of much commercial value. In Mr. H. Y. L. Brown's printed list of South Australian minerals the only locality for wavellite noted is Gawler River, in gneiss. Mr. Howchin also exhibited rock specimens and microscopic sections of an interesting nullipore limestone which occurred over many square miles on Yorke Peninsula, in the neighbourhood of Wallaroo Bay, Alford, Boors Plains, and Tickera. The rock for a thickness of 15 ft. is almost entirely composed of calcareous algæ, belonging to the genus *Lithothamnium*, a genus, specimens of which can often be picked up on the beach on South Australian shores.

Ordinary Meeting, April 3, 1906.

The President (J. C. Verco, M.D., F.R.C.S.) in the chair.

Exhibits.—Mr. W. Howchin, F.G.S., placed before the meeting a Monograph of the Foraminifera of the Permo-Carboniferous limestones of New South Wales, recently published by the New South Wales Department of Mines and Agriculture, and of which Mr. F. Chapman, of Melbourne University, and he (Mr. Howchin) were the joint authors. Mr.

Howchin passed under review the history of the discovery of foraminifera in the rocks of the Permo-Carboniferous age in Australia, and then described the results recorded in the monograph submitted to the meeting. In this work 35 species were described and figured, 9 of which were new to science. Several species that occurred in rocks of a similar age in Europe and America were found in the New South Wales material. The localities which yielded the foraminiferal forms were Wollong and Pokolbin, the former in the Upper Marine series, and the latter in the Lower Marine series, separated by 4,000 ft. of strata. The material was supplied by Professor David and Mr. Dun of the Mines Department.

Mr. A. H. C. Zietz, F.L.S., Assistant Director of the Museum, informed the meeting that he had successfully finished the restoration of the skeleton of the Diprotodon. Mr. Zietz also exhibited portions of two algæ, one *Macracystis pyrifera*, remarkable for its size, which, according to Harvey, grows to 500 and 1,500 ft. in deep water. This alga is common in the South-East, at Beachport, and elsewhere.

The other alga, *D'urvillaea potatorum*, when fully grown, is from 12 to 24 ft. long, and nearly ¼ in. thick. The segments, strap-shaped, of great length, and 6 to 12 inches broad. This alga is also found at Beachport.

Another exhibit by Mr. Zietz was a piece of tertiary rock containing fossil shells, obtained at a depth of 60 ft. below the surface, from a well at Klemzig, on the River Torrens; and glauconite, from the same locality; also specimens of black flint, obtained from a large deposit of this mineral on the sea beach, Port MacDonnell, in the South-East.

Mr. Edwin Ashby, bird-skins from the bush, Queensland, which, with those previously shown, completed the series. Among these were the rifle bird *(Craspedophora magnifica)*, male and female, from New Guinea; *C. alberti*, male, from Cape York; *Ptilorhis victoriæ*, male and female, from Cardwell; *Prionodura newtoniana*, male and female, from Herberton; *Sericulus melinus*, Regent bird, male, from Blackall; *Scenopœus dentirostris*, male, from Cardwell.

Mr. J. G. O. Tepper, F.LS., a *Chione* from Kangaroo Island, and a specimen of chiastolite, from Bimbowrie. Mr. Tepper also showed some flower-like galls on the leaf of a stringybark-tree.

The British Science Guild.—It was proposed and carried that the Society should become a life member of this Guild.

Papers.—"On the Ionisation of Various Gases by the

Alpha Particles of Radium," and the "Alpha Rays of Uranium and Thorium," by Professor W. H. Bragg, M.A.

"Descriptions of Australian Tineina," by Ed. Meyrick, B.A., F.R.S.

Ordinary Meeting, May 1, 1906.

The President (J. C. Verco, M.D., F.R.C.S.) in the chair.

Ballot.—Harry Taylor, sharebroker, Adelaide, was elected a Fellow.

Mr. Howchin then proposed:—"That the Royal Society of South Australia respectfully call the attention of the Government to the desirability of erecting a seismograph at the Adelaide Observatory, by which scientific data of very great interest and of practical importance may be obtained." Carried. It was agreed that the Secretary should forward a copy of the above resolution to the Astronomical Society, at the same time asking if any of the members would join a deputation from the Royal Society and wait on the Premier, to urge the necessity there exists for having some form of seismographical instrument set up in Adelaide. The meeting further empowered the Council of this Society to bring the matter before the Government.

Exhibits.—Mr. W. B. Poole read a paper describing a new Hydroid, found in the Patawalonga Creek, and Mr. E. J. Bradley described the various phases through which the animal passed while under observation, illustrating these on the blackboard.

The President (Dr. Verco) showed an alga from Beachport, which had been brought under his notice by Mr. Zietz. Mr. McAlpine, to whom it had been shown, pronounced it an alga new to science. The specimen on view at the larger end was flattened, and about 7 in. in circumference, with no root or base. The thallus, or stem, grows dichotomously, at certain points dividing into two equal arms, and these again dividing into two, but not always regularly. When dry the colour is brown, but when moist olive green and glutinous to the touch. Examined closely, the surface has a honeycomb-like appearance. In section it is cellular, with a thin outer cuticle.

Mr. A. H. C. Zietz, a small, green pebble, dredged up from 150 fathoms, supposed to be olivine.

Papers.—"Notes on Marine Mollusca of South Australia," by J. C. Verco, M.D. "Remarks on the Occurrence of Cambrian Glacial Till Beds in the Willouran Ranges, East of Hergott," by W. Howchin, F.G.S. "Mineralogical Notes

—*(a)* Fetid Felspar *(Necronite)* and Quartz, from Umberatana; *(b) Atacamite*, from Bimbowrie," by Douglas Mawson, B.E., B.Sc. Mr. Howchin, F.G.S., gave a short description of a visit he had recently made to Hergott during which he had discovered the existence of Cambrian glacial till beds in the Willouran Ranges, similar in all respects to those which occur in the Sturt Valley, near Adelaide. Geological sections were drawn on the blackboard to show the similar stratigraphical features in each case. One observation made was of special interest as offering an explanation of the occurrence of erratics scattered over some of the plains of the Lake Eyre basin. Mr. Howchin had noted these at Stuart Creek Station, and the Government Geologist had referred to them in a recent report on that district. About six miles from Hergott, eastward, there was a gradual rise to the Willouran Ranges, at the base of which the till beds, with erratics, outcrop. These erratics were found all along the low slope, for at least a mile in breadth, resting on the clay of the plains, and far removed from their source. These may either have directly weathered out of the till beds which occupy the low rises; or, possibly, dispersed by denudation of the desert sandstone, in which they have been included as derived material. Mr. Howchin exhibited erratics from the hardened till and glaciated stones from the same locality.

Ordinary Meeting, June 5, 1906.

The President (J. C. Verco, M.D., F.R.C.S.), in the chair.

Ballot.—F. H. Snow, merchant, Adelaide, was elected a Fellow.

Exhibits.—Mr. A. H. C. Zietz, F.L.S., a Gecko, a fine specimen, from Umberatana *(Gymnodactylus milensii)*, has sucking discs at extremities of its five toes and claws. This reptile is found in New South Wales and Victoria. Named from the sound it emits.

Mr. Zietz also exhibited a Batrachian *(Heleiporus pictus)*, found by Mr. F. R. Zietz, on September 1, 1891, at Henley Beach, in the sand at a depth of 3 ft. When found, the animal was very much distended with water and of a pale colour. In this state it had a close resemblance to specimens of frogs dug out of the sandy bed of Callabonna Creek by Mr. Zietz, locally known as water-frogs, on account of the water they contain. A mass of olivine, or *chrysolite*, from Mount Gambier. A specimen of *carnotite*, from Olary, South Australia. Mr. Edwin Ashby exhibited male and female megapode skins *(Megapodius duperreyi)*, and skins of two young birds and eggs of the same sub-order, from Port Keats, Northern Territory. The megapodes, called also scrub and jungle fowl, form nests of huge size by scratching up sand and leaves. The eggs are deposited in the mass of decaying leaves, in holes, some 2 or 3 ft. deep. The fledglings, of which skins were exhibited, taken out from a depth of 2 ft., were able to fly when taken. The nest was about 40 yards in circumference. Mr. Zietz, a brush turkey *(Talegallus lathami)*, Gould.

Paper.—"Notes on South Australian Decapod Crustacea," Part iv., by W. H. Baker.

Ordinary Meeting, July 10, 1906.

The President (J. C. Verco, M.D., F.R.C.S.) in the chair.

Exhibits.—Mr. A. H. C. Zietz, F.L.S., Assistant Director of the Museum, a toad *(Pseudophryne bibroni)*, found by Mr. Ashby under a stone on sloping ground at Blackwood. The ova are large, and are not enclosed in a jelly-like mass like those of the common frog. Two petrels: one *(Prion vittatus)* found at Plympton and Glenelg, is a pelagic species, rarely seen near land; and the other *(Prion turtur* or *desolatus)* the dove-like petrel. This bird frequents the shore, and breeds in Bass Straits. Mr. W. H. Baker, a case of crabs from New South Wales and Queensland, which are to be presented to the Museum.

Papers.—"Geology of the Mount Lofty Ranges," Part ii., by W. Howchin, F.G.S. "New Australian Lepidoptera, with Synonomic and Other Notes," by A. Jefferis Turner, M.D., F.E.S. Mr. Howchin gave a very interesting résumé of his paper on the "Geology of the Mount Lofty Ranges," in which he dealt with the lower members of the Cambrian series, from the Cambrian glacial till to the basal grits and conglomerates.

Ordinary Meeting, August 7, 1906.

The President (J. C. Verco, M.D., F.R.C.S.) in the chair.

Exhibits.—Mr. W. Howchin, F.G.S., exhibited some very striking examples of pressure in slate rocks from Mundallio Creek, Flinders Range, near Port Augusta. Lateral pressure had forced the slate into parallel fractures, which were then forced forward, forming a series of openings, bridged by thin bands of slate nearly at right angles to the direction of pressure. The spaces thus created had been subsequently filled with fibrous calcite, in a series of lenticles, the white calcite showing up on the background of the dark slate, making a very effective contrast. The slates in which the specimens occur belong to the Mitcham slates horizon. Dr. Verco exhibited shells dredged in Investigator Straits, from 10 to 18 fathoms, closely resembling *Lippistes separatista*, Dillwyn, but having polygonal whorls. The type specimens, as shown to Dr. Verco by Mr. Smith, of the British Museum, have polygonal whorls. Mr. Gatliff has dredged live *Lippistes blainvilleames*, Petit, from 5 fathoms, on the Victorian coast, from which Dr. Verco extracted the radula, which was found to be identical with that of *Trichotropis borealis*, found in Behring Straits, and within the Arctic Circle. The President also showed limpets (*Patella aculeata* and *P. ustulata*) from Beachport and Port MacDonnell; the latter shell is found also in Tasmania and Western Australia. Dr. Verco exhibited the radula of *Trichotropis*, under the microscope. Mr. Douglas Mawson, B.Sc., exhibited a collection of radio-active minerals: *carnotite*, from Radium Hill, Olary; a bituminous mineral from Taylor's Shaft, Moonta; *monozite*, from Emmaville, New South Wales; Cairns, Queensland; and Pilbarra, Western Australia; radio-active sulphide of copper from Treuer's Shaft, Moonta; *uranite*, from Carcoar; *pitchblende*, from Tamworth, New South Wales; and *euxenite*, from the Barrier Ranges.

Papers.—"A Note on Some Modifications in the Morphological Structure of the Mammalian Vertebræ," by A. H. C. Zietz, F.L.S.. Assistant Director of the South Australian Museum. "Description of Australian Curculionidæ, with Notes on Previously Described Species," by Arthur M. Lea, Government Entomologist, Tasmania. Mr. Zietz exhibited some lumbar vertebræ of various mammalians, both fossil and those now existing, to illustrate his paper.

Ordinary Meeting, September 4, 1906.

The President (J. C. Verco, M.D., F.R.C.S.), in the chair.

Ballot.—Miss Ellen Milne Bundey was elected a Fellow.

Exhibits.—Mr. Edwin Ashby exhibited a number of bird skins, from Port Keats, Northern Territory, sent by Mr. C. E. May. Amongst these the white-headed eagle (*Haliastur girrenera*), found also in Queensland, where it has been noticed to kill snakes. The great-billed cockatoo (*Calyptorhynchus macrorhynchus*), with others of the same sub-family, for purposes of comparison. The Oriental cuckoo (*Cuculus intermedius*), very numerous during the wet season; the spur-footed cuckoo (*Centropus phasianus*), having a very large and straight hind claw; a mound-building bird (*Megapodius duperreyi*); the nutmeg pigeon (*Myristiciora spilorrhoa*); the little green pigeon (*Chalcophaps chrysochlora*), with its bronze-green wings; the fawn-breasted kingfisher (*Dacelo cervina*) (*Halcyon sanctus*), and Macleay kingfisher; a bar-shoulder dove (*Geopelia humeralis*); the red-collared lorikeet (*Trichoglossus rubritorques*), found at Port Keats all the year, seeming to fill the place in Northern Australia that the blue mountain does in the South. Mr. Ashby also showed skins of the white-quilled honeyeater (*Entomyza albipennis*), said to have a gold ring around the iris; a Drongo (*Chibia bracteata*); white-gaped honeyeater (*Ptilotis unicolor*). Mr A. H. C. Zietz, F.L.S., several leeches found on a dog-shark by Mr. E. J. Bradley at Port Willunga (specific name, *kontobdella*). Mr. J. G. O. Tepper, F.L.S., a case of Australian *Cicadidæ*. The first time that a named series of this family of *Homoptera* (*Hemiptera*) had been exhibited here.

Papers.—"Radium at Moonta Mines," by S. Radcliff, communicated by Professor W. H. Bragg, M.A. "Certain New Mineral Species, associated with Carnotite in the Radio-active Ore Body, near Olary," by Douglas Mawson, B.Sc., B.E. "Preliminary Analytical Notes on the Minerals Described in the Preceding Paper," by Professor E. H. Rennie, D.Sc., and W. T. Cooke, D.Sc.

Annual Meeting, October 2, 1906.

The President (J. C. Verco, M.D., F.R.C.S.) in the chair.

The annual report and balance-sheet were read and confirmed.

Election of Officers.—President, J. C. Verco, M.D., F.R.C.S.; Vice-Presidents, Professor E. H. Rennie, M.A., D.Sc., and Rev. Thomas Blackburn, B.A.; Hon. Treasurer, Walter Rutt, C.E.; Members of Council, Walter Howchin, F.G.S., Lecturer on Geology and Palæontology at the Adelaide University, and Edwin Ashby; Auditors, J. S. Lloyd and David Fleming.

Exhibits.—A new *Caladenia*, in formalin, was exhibited and described by R. S. Rogers, M.A., M.D. J. G. O. Tepper, F.L.S., some remarkable galls, found on the twigs of *Eucalyptus leucoxylon*, in a more or less dense cluster of acutely conical form, from one to two inches long, each containing only one larva. On May 16 some clusters were placed in a glass case, and the twig kept fresh as long as possible.

On September 5 following 16 hymenopterous insects were observed to have emerged, and one was removed alive from a gall. These proved to be small wasps allied to the family *Chalcididæ*, and probably new. On the same twig, deforming the leaves, were scale-like galls, from which emerged numerous minute black wasps *(Chalcidid)*. Among these last were found a single pair of another species, marked by gold-green spots, probably parasites upon one or other of the foregoing. The first of the above-named galls was unknown to W. W. Froggatt, F.L.S., the Government Entomologist of New South Wales, to whom they had been submitted for examination. Mr. TEPPER also exhibited photographs of a gigantic hemlock, grown in Professor Ludwig's garden, Greig. These plants attained to nearly 14 ft. in height, and were of such vigorous and rapid growth as to attain to one inch per minute. The seed from which these plants were raised was from a remarkable plant which appeared adventitiously in Mr. Tepper's garden, Norwood, already noticed in these proceedings. According to Dr. Ludwig, who is a prominent botanist, these plants are giant forms of an endemic European species of hemlock *(Conium maculatum)*. Mr. TEPPER showed photographs of witch broom, a proliferous growth on birch-trees, produced by a fungus *(Japhrina)*, and three other conspicuous fungi, *Asteronia radiosum*, on roses; *Phragmidium violaceum* and *P. rubi*, found on blackberries.

PAPERS.—"The Ionisation of the Various Gases by the Alpha Particle of Radium," by Professor W. H. BRAGG, M.A. "Note on the Localities Attributed to Australian Lepidoptera by Oswald Lower," by A. JEFFERIS TURNER, M.D. "Further Notes on Australian Coleoptera, with Descriptions of New Genera and Species," by Rev. THOMAS BLACKBURN, B.A. "Madreporaria from the Australian and New Zealand Coasts," by JOHN DENNANT, F.G.S. "Notes on South Australian Marine Mollusca, with Descriptions of New Species," by J. C. VERCO, M.D. "Anthropological Notes on the North-Western Coastal Tribes of the Northern Territory of South Australia," by HERBERT BASEDOW. Professor E. H. RENNIE, D.Sc., M.A., in referring to Professor Bragg's laborious researches on the alpha particle of radium, congratulated him on the work he had accomplished, and observed that the amount of ionisation seemed to depend more upon the physical character of the gases concerned than upon their chemical constitution.

Address at the Annual Meeting of the Royal Society of South Australia, October 2, 1906, by Dr. J. C. Verco, President.

Three years have passed since you placed me in the presidential chair, and, with an indulgence which has been highly appreciated, you have twice excused me from the customary annual address. The honour of this responsible and dignified position, conferred for the fourth time, demands in courtesy and gratitude an effort on my part to discharge this difficult task.

It is specially difficult to me, for two reasons. Medical science, the basis of my profession, and the work of my life, with which I am, of course, more intimately acquainted than with anything else, is not represented among the subjects which engage your attention. A medical association, composed of medical practitioners only, furnishes the appropriate opportunity for record of medical facts, exhibition of medical cases, and the discussion of medical questions. They would be out of place in a presidential address here, forbidden by the ethics of the profession and the character of the audience.

The department of natural history which has chiefly enlisted my interest, malacology or conchology, is but a recreation, and can only receive the amount of attention which a busy man can afford for play. This forbids my speaking with the well-grounded confidence of some esteemed and envied experts, and makes me diffident of launching out into those broad generalizations which alone could be acceptable to other than conchologists. The more minute and technical details of this study are suitable rather for our ordinary or sectional gatherings.

Instead, then, of dealing with any special branch of science, which would interest only a few, let me speak in a general way about our Society, review the work it has done during my term of office, see what it has accomplished, and in what way it may be improved and ourselves made more efficient.

During the past three years the Royal Society has displayed a healthy versatility. We have had quite a satisfactory variety. Such institutions are always in danger of becoming, at least temporarily, lop-sided, from the overbalancing influence of some able and industrious worker. He not only supplies the greater part of the subject-matter for the meeting himself, but is surrounded by juniors whose activities are drawn into the same channel by the attracting power of his scientific earnestness and knowledge. Our transactions reveal no such depressing state as this.

Geology has been well represented, and we may say considerably advanced, by the assiduous labours and acute deductions of Mr. Howchin, who has pursued his examination of the Mount Lofty Ranges and the southern parts of South Australia, extending well into the interior, especially with reference to the Cambrian glacial formation. He has done honour to our Society, as well as to himself, by his persistent prosecution of this question, in spite of many difficulties, so as to connrm the truth of the glacial theory and establish the exact age of the glacial period. Mr. Etheridge has added to the list of South Australian Cambrian fauna some species discovered by Mr. Howchin. Mr. Basedow has described the geological features of the country in the far north-west and has treated of the Tertiary exposures around Happy Valley; while Messrs. Iliffe and Basedow have discussed the question of thrust conglomerates.

In the Memoirs of the Royal Society have also been published fasciculi giving detailed descriptions of the fossil bones of gigantic extinct animals, from Lake Callabonna, by Professor Stirling (Director of the South Australian Museum) and Mr. A. H. C. Zietz (Sub-Director). The latter gentleman has also had the pleasure of announcing recently the completion of the restoration of the skeleton of the Diprotodon, the first of its kind known in the world; and he has read a note upon an important modification of certain portions of its vertebral bones, which he has detected, and which suggests an underlying law of variation according to position in the animal kingdom.

The allied department of Mineralogy and Petrology has been very capably dealt with by Dr. Woolnough and Mr. Mawson, the past and present lecturers on this subject at the University of Adelaide.

In close association with this subject is one which has excited considerable popular interest, some little commercial speculation, and intense scientific excitement: radio-activity and the radio-active substances. We have had important contributions from Mr. Mawson and Mr. Radcliff on deposits of lodes containing these peculiar minerals, with valuable analyses of some of them by Professor Rennie. We have been enlightened and science has been enriched by accounts from Professor Bragg of his investigations in the physical laboratory of the University, in reference to the radium emanations, the alpha particles, etc., and the scientific generalizations to which these investigations point—investigations which are being conducted with competitive industry and commendable rivalry in many of the world's laboratories. We will welcome further and early discoveries from our fellow-member, and wish him the distinction of priority in the recognition of some of the great fundamental laws that govern the ultimate ions and electrons of matter and force.

Here we may pause for a moment to recognize the indebtedness of the Royal Society to these members of the professorial and teaching staff of the Adelaide University, and notice how such sister institutions minister to each other. Since the day when the late Professor Tate took the Chair of Natural Science, and, impressed with the value of a Royal Society, practically remodelled the then existing institution and made it what it is, we have been under deep obligation to the University staff; and as that seat of learning grows with the progress of the State we may hope to derive greater and more varied benefits. Happily, the benefit is mutual. For it is a definite advantage to have at hand an institution such as ours, through which the results of their labours may be made public; and more, may be given a world-wide publicity, and so may secure the credit they deserve, and be made useful as stepping-stones for further advances.

In Botany we have the description of a new Aroid by Mr. Maiden, and some few exhibits by Mr. Howchin, Mr. Tepper, and Mr. Smeaton. In this particular division we seem to be rather feeble. Is it through lack of some capable leader, who is not already overburdened with other work; or, more likely, through the unfounded fear of imposing trivialities upon a learned Society? Is there not some enthusiastic botanist in our State who will take the lead and organize our junior botanists, direct a search for new forms, urge a more thorough acquaintance with the old, and who will stimulate them with a desire to study the many absorbing and delightful questions about the life-history of our plants? In the Far North there must be opportunities of successful hunting in unfrequented localities for unrecorded species, and charming surprises for the tireless explorer of out-of-the-way gorges, deserts, and waterholes. Yes, and even equal surprises for the inquisitive and patient observer of the tiny details of form, habit, disease, and use of the plants which grow on the Mount Lofty Ranges or the widespread Adelaide Plains.

I am pleased to notice on the agenda-paper for this evening "A Description of a New Caladenia, by Dr. Rogers." May we congratulate him on the discovery of a new plant, and ourselves upon the discovery of a new contributor to our original work, and of a new botanist; and may we hope to find in him the leader we have been referring to, who will organize the botanical forces of our State and stimulate them to individual and concerted activity?

The animal kingdom appears to offer greater attraction and afford more abundant opportunity for original research, doubtless because of its infinite variety and the numerous problems its larger life presents for solution. Our results here have been very rich.

Insect life is inconveniently abundant in parts of our State; but these become a veritable paradise for collectors. Mr. Basedow, during the Government expedition to the North-West, gathered about 450 species, which have been presented to the Museum. Mr. Blackburn, who deals with the Australian Coleoptera; Mr. Arthur Lea, with the Curculionidæ; Mr. Tepper, with the Orthoptera, etc.; Dr. Jefferis Turner, Mr. Oswald B. Lower, and Mr. Meyrick, with the Lepidoptera, are veterans and experts in entomology, and can always be relied on for abundance of copy in their voluminous papers upon these interesting families; while Mr. Tepper and Mr. Zietz, from the treasury of the Adelaide Museum, bring forth things new and old for exhibit at our meetings.

One lesson seems to suggest itself from looking over the volumes of the Society and noting the material supplied by these gentlemen—the distinct advantage to science which accrues from definite specialization. A person may confine himself to some circumscribed domain and do good work; in fact, do far more and better work than if his energies are spread over too extensive an area. He becomes acquainted with his district, and thoroughly comprehends it. By taking up some single class, or even some separate family, he can grasp it without too great toil; he is able to deal with his material accurately and confidently; and becomes a chief referee. Apparently there is not much probability of exhausting his material, which seems to be almost unlimited in our island continent. He may be somewhat lonely in his researches, and be precluded from exciting a general audience with his technical minutiæ; but it is an enviable loneliness of supremacy which he enjoys or endures, and is balanced by a more intense personal interest and the glad consciousness of good work well done.

Might not this specialization be imitated with advantage in other realms of natural history? They may be less crowded with multitudinous forms, and their determination, classification, and description may not therefore be such a lifelong occupation. But it is wonderful how many species may be found, if diligently and intelligently sought, where there seemed but few. And then the degrees of their variation can be studied and measured. Besides this, there remains, after their classification and enumeration, the deeper, more absorbing, and shall I say the more elevating, investigation of their physiology, rather than their anatomy, their real natural history, the thousand-and-one questions which are raised by an observation of their life, the answers to which will amply reward as well as delightfully tax the patience and ingenuity of the enquirer.

"The great and wide sea, wherein are things creeping innumerable, both small and great beasts," has proved an abundant storehouse. Dredging excursions undertaken of recent years, confined at first to our two gulfs, but which have gradually extended fifty miles into the ocean, and to a depth of 300 fathoms, beyond what is known as "the continental shelf," have provided material for congenial work to several of our members. Mr. Dennant, an Honorary Fellow, who has long been engaged upon the Tertiary corals, has written several papers on the recent corals of South Australia and Victoria, and has figured many novel and lovely forms. Mr. W. H. Baker has taken up the crustaceans, and his pencil has beautifully illustrated what his pen has accurately described. Mr. Basedow and Mr. Hedley have dealt with the Nudibranchs, and Mr. Basedow with some Naticoid genera, in two papers, which have been brilliantly but quite naturally adorned by his capable brush; and as leisure has permitted I have dealt with some Gasteropod shells.

Mr. Hedley, upon whom the distinction of an Honorary Fellow was recently very properly and worthily conferred by you, has supplied a paper upon some new land shells collected by Mr. Basedow on the Government North-West Expedition.

And last, though by no means least, if "the proper study of mankind is man," are two valuable papers by Mr. H. Basedow, "Anthropological Notes," on certain aboriginal tribes in the North-West of Australia and in the Northern Territory. Here have been recorded and will be preserved numerous observations on their physique, manners and customs, dietary, and primitive art. It has been enriched by many photographs and coloured drawings, and will be a valuable reference when the tribes have become extinct.

Besides these papers we have had, of course, at every meeting, exhibits of a very instructive and educational sort. Minerals, fossils, plants, flowers, birds, fish, frogs, leeches, insects, crabs, spiders, and a remarkable new Hydroid (discovered by Mr. Bradley), and polyzoa, shells, and seaweeds. These frequently provoke more comment and lead to more personal contributions than the set papers, and constitute an attractive feature of our Society.

Nor must we neglect to mention the different Sections—the Field Naturalists', the Microscopical, and the Malacological—where much preliminary work is done, where workers are trained, and material is provided for not a few of the papers presented to the monthly meetings. Possibly less public recognition is bestowed upon them than they deserve.

Special mention may here be made of the efforts and successes of the Field Naturalists in connection with the fisheries protection and the preservation of our native flora and fauna, and we are very hopeful of securing a large tract of country in Kangaroo Island as a reserve for the latter purpose and as a health resort.

This record is, to my mind, one of which we need be in no degree ashamed, with which we may be very pleased, though of course we ought not to be satisfied with it, and by which we should be encouraged. It indicates assiduous and intelligent endeavour along truly scientific lines. And along many lines. And this variety of subjects dealt with is one of the most satisfactory features, and the one I wish to be most impressed with, and wish most to impress. Only by such diversity can the Society be made generally interesting or generally useful, and deserve its name. Apart from this, it is liable to degenerate or develop (whichever view we may take of it) into a Geological Society, or an Ornithological, or a Physical, or a Malacological. But there seems no danger of this. We could wish, however, for still further extension and variety. And there is abundant scope. As we have indicated, we want some botanical enthusiasts—horticultural, floricultural, agricultural—to observe phenomena in the vegetable world and record them, propound their difficulties, and enlist the sympathy and co-operation of their fellows.

We need a phycologist to deal with our seaweeds—a most prolific field, and a very attractive one; and withal one easily explored, for it can be worked from the shore, and one which will yield a very beautiful collection for a home cabinet.

So in the animal kingdom. The ants and the spiders in their abundance, and with their marvellous forms and habits, are waiting for an admirer and investigator.

We need someone to devote himself to Malacology—as distinct from Conchology—the study of the shellfish themselves. It is an inexhaustible subject. It may be comparatively easy for the beginner, and may be made as intricate and elaborate as the advanced student may desire. It is, moreover, a pressing need, and by it alone can we arrive at a natural classification of our mollusca.

Then there are the beautiful polyzoa, the foraminifera, the starfish, the sea urchins, and the fish, all awaiting examination, classification, and description—worlds to be conquered by any intelligent lady or gentleman with the energy to enter on the campaign; and the crypt of our Museum and the results of our dredgings will provide material for the leisure of a lifetime.

Can we not persuade some such individual to overcome the initial difficulties, and begin a work which, the longer it is pursued, will become less a task and more an absorbing recreation.

We may think we have not the leisure for such study and work. But it is wonderful how much leisure we can find for what we enjoy doing, and by using time and effort and means, which we would otherwise waste, fill up our hours with what will last, give ourselves an immensity of pleasure, and contribute in our degree to the advancement of knowledge. Is there anything more enjoyable than the discovery of a new fact, a new object, a new truth, something the world has never seen or known before? This pleasure, in a new country like ours, every one can secure who has intelligence, force of will, and perseverance.

In looking backward, there is ground for gratification. Now for a glance forward.

In the early part of the coming year we expect to be accommodated in the new building now being erected by the Government in Kintore Avenue. There we shall have ample space for our meetings, and shall also have better arrangements for our valuable library. Perhaps I might say "our invaluable library," for most of our books are the periodical publications of learned societies in different parts of the world, and could be secured or replaced with difficulty.

Three years ago it was becoming a burden to us, but the prospect of our new quarters has raised the hope of not only retaining our accumulation of scientific books, but of having them in such condition as to be available to our workers in every department of science.

Their intrinsic value is one thing; their practical value is quite another. That depends on their contents; this upon their utility. In order to be useful they must be accessible and convenient for reference. This they have not been for many years, if they have ever been, because they have not been bound and have not been kept in proper order or properly catalogued. We blame no one for this, because no one is to be blamed. It is a case of "*res angusta*"—lack of funds. It takes all our subscriptions and all our grants from the Government to pay our few incidental expenses, and the comparatively enormous expense of bringing out our yearly volume, by which, through exchanges, we get our library. We trust the Government, which has proved itself commendably favourable to our requests for assistance, will come to our aid in this special need, and earn the gratitude of the Society.

May we ask: Where is the person who will emulate the enlightened generosity of the donor of the Barr-Smith library in the University of Adelaide? He will not only confer a lasting favour upon a body of self-denying workers, who have to spend all they can spare in prosecuting their own researches but will be advancing the knowledge of his State and enlarging the science of the world.

We have reason to hope that the Government will place on the Estimates a sum for next year equal to what we were granted last year. We need all we can get. Our work is largely limited by the funds we have at our disposal. Had we more to spend, we could effect more. In time past the question of the acceptance of papers of value has had to be considered simply from the standpoint of whether the Society could afford to pay for the printing. And now some contributors are only able to publish in our Transactions because they agree to find the money to pay for their illustrations, or because the cost is guaranteed by others. This is in part the explanation of the variety of our recent volumes. The funds of the Society are too small to bear the strain of such costly plates. We think the Government would do well to increase its grant by another £50. The sum would be a trifle to the country, but a boon to the Society, and would be well and carefully spent in the highest form of education, and the most utilitarian, that of original research.

So, too, some of our more wealthy colonists might give themselves the pleasure of making a donation to the Royal Society of a sum, either small or great—the larger the better—as an endowment, or as a fund to be spent at the rate of not more than so much a year in current expenses. In doing this they would be doing a good work, and erecting a monument to their memory more enduring than brass, as well as more lustrous and more refined.

We are anticipating to welcome, at the beginning of 1907, in our city, the members of the Association for the Advancement of Science. We trust the gathering will be a large one, a select one, and an enjoyable one, and representative of the most advanced thought in Australasia. And that when our visitors have gone there shall remain a sort of afterglow—a perceptible philosophic influence, a conscious scientific inspiration, which shall intensify the desire for wider, closer, and more careful work, and bestow a higher appreciation of everything in Nature which can be certified as fact and everything in science which is confirmed as truth.

In taking the chair as President for the coming year, let me thank all my colleagues on the Council for their very kindly consideration and loyal support during my term of office. Entirely new to its duties, I have had much to learn and still have. Let me congratulate the members of the Royal Society on the good work done in the past, its healthy state at present, and its favourable prospects for the future. Let me encourage everyone to do something towards increasing its efficiency. Make some contribution, either spoken or written, an observation which seems new to you, insignificant though it may appear, or ask an explanation of some phenomenon which seems strange or incomprehensible. In this way you may set someone else to work, or incite someone to set you to work, and so by your question if not your quest you will add your mite to the treasury of science and your help to the Royal Society.

President's Address.—Mr. Howchin proposed:—"That the President be heartily thanked for his interesting and stimulating address, and that it be printed in the Transactions and Proceedings for this year." Carried.

[In April, 1905, Messrs. Iliffe and Basedow read a paper before the Society on "The Formation Known as Glacial Beds of Cambrian Age in South Australia." This paper came on for discussion at the following evening-meeting, and the report of such discussion was included in the printed proceedings. As the paper in question was not accepted for publication it was obviously unfair to the authors to publish criticisms on it. That such should have been done was an oversight and a matter of regret.—Ed.]

ANNUAL REPORT, 1905-6.

The Council is pleased to report that the work of the Society has been carried on successfully during the past year.

The discovery of radio-active minerals in the State has enabled Professor Bragg and Professor Rennie to take part in the investigations now engaging the attention of European and American scientists.

Specimens of these minerals from South Australia and other States of the Commonwealth have been exhibited from time to time by Mr. Douglas Mawson, B.Sc.

Among other exhibits of the year the ornithological specimens shown by Mr. Edwin Ashby deserve mention.

The publications of the Society are now sent to 172 learned bodies in various parts of the world. They are distributed as follows:—Great Britain and Ireland, 27; British dependencies, 46; European countries, 56; the United States of America, 34; Mexico, South America, Japan, and the Pacific, 9.

The index to the first 25 volumes of the Transactions and Proceedings is in the press, and will be issued shortly.

In June last a deputation from this and the South Australian Astronomical Society waited upon the Government to ask that a seismograph might be installed at the Observatory. It is hoped that a sum will be placed upon the Estimates for this purpose.

More recently a public meeting, summoned under the auspices of this Society by the Field Naturalists' Fauna and Flora Preservation Committee, was held in the Mayor's Parlour. It was then determined that a deputation should wait upon the Premier to ask for a permanent reserve upon Kangaroo Island. As a result, it is probable that about 300 square miles of the western end of the island will be set aside, both for the better preservation of native plants and animals, and for a sanatorium or health resort.

Three Fellows have been elected during the year. The membership now includes 11 Hon. Fellows, 67 Fellows, 2 Associates, and 4 Corresponding Members.

The large room now being built for the Society by the Government is expected to be ready for occupation early next year. The increased space will allow the library more adequate accommodation, and members will thus be able to make better use of the valuable scientific works of which it consists.

The Council is pleased to add that the Field Naturalists' and the Microscopic and the Malacological Sections report satisfactory progress.

Jos. C. Verco, President.
G. G. Mayo, Secretary.

TREASURER, IN ACCOUNT WITH ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Dr.	£ s. d.	£ s. d.
October 1, 1905.		
To Balance		190 6 1
,, Subscriptions—		
Royal Society	60 7 0	
Field Naturalists' Section (2 years)	24 0 0	
Malacological Section ...	3 7 6	
Microscopical Section ...	9 2 6	
		96 17 0
,, Donations to Research Endowment Fund		5 10 0
,, Government Grants—		
Subsidy on Subscriptions ...	60 6 9	
For Printing Scientific Reports relating to South Australia	150 0 0	
		210 6 9
,, Sale of Transactions		2 11 0
,, Bank Interest		5 8 0
		£510 18 10

Cr.	£ s. d.	£ s. d.
By Transactions—		
Printing	96 10 3	
Illustrating	66 6 6	
Publishing	7 5 11	
Indexing	20 0 0	
		190 2 8
,, Memoirs—		
Publishing		8 13 9
,, Grants in Aid—		
Field Naturalists' Section ...	24 7 6	
Malacological Section ...	2 10 0	
Microscopical Section ...	7 0 0	
		33 17 6
Library—		
Covering Shelves		0 7 11
,, Wages—		
Caretaker's		3 5 0
,, Printing, Postage, and Stationery		9 8 3
,, Advertising		1 11 0
,, Exchange on Cheques		0 1 6
,, Balance in Savings Bank—		
Revenue Account	258 1 3	
Research Endowment Fund	5 10 0	
		263 11 3
		£510 18 10

Walter Rutt, Treasurer.
September 30, 1906.

Audited and found correct,
J. S. Lloyd, F.I.A.S.A., Auditor.

DONATIONS TO THE LIBRARY

For Year 1905-1906.

TRANSACTIONS, JOURNALS, REPORTS, Etc.

Presented by the respective Editors, Societies, and Governments.

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LIST OF FELLOWS, MEMBERS,

ETC.,

OCTOBER, 1906.

Those marked (L) are Life Fellows. Those marked with an asterisk have contributed papers published in the Society's Transactions.

Any change in the address should be notified to the Secretary.

Date of Election

Honorary Fellows.

1893. *Cossman, M., Rue de Maubeuge, 95, Paris.
1897. *David, T. W. Edgeworth, B.A., F.R.S., F.G.S., Prof. Geol., Sydney University.
1888. *Dennant, John, F.G.S., F.C.S., Inspector of Schools, Camberwell, Victoria.
1876. Ellery, R. L. J., F.R.S., F.R.A.S., Gov. Astron., the Observatory, Melbourne, Victoria.
1890. *Etheridge, Robert, Director of the Australian Museum of New South Wales, Sydney.
1905. Gill, Thomas, I.S.O., Under-Treasurer, Adelaide.
1905. *Hedley, Chas. H., Naturalist, Australian Museum, Sydney.
1892. *Maiden, J. H., F.L.S., F.C.S., Director Botanic Gardens, Sydney, New South Wales.
1898. *Meyrick, E. T., B.A., F.R.S., F.Z.S., Thornhanger, Marlborough, Wilts, England.
1876. Russel, H. C., B.A., F.R.S., F.R.A.S., Gov. Astron., Sydney, New South Wales.
1894. *Wilson, J. T., M.D., Prof. of Anatomy, Sydney University.

Corresponding Members.

1881. Bailey, F. M., F.L.S., Colonial Botanist, Brisbane, Queensland.
1880. *Foelsche, Paul, Inspector of Police, Palmerston, N.T.
1893. Stretton, W. G., Palmerston, N.T.
1905. Thomson, G. M., F.L.S., F.C.S., Dunedin, New Zealand.

Fellows.

1895. *Ashby, Edwin, Royal Exchange, Adelaide.
1902. *Baker, W. H., Glen Osmond Road, Parkside.
1901. *Basedow, Herbert, Kent Town.
1887. *Blackburn, Rev. Thomas, B.A., Woodville.
1886. *Bragg, W. H., M.A., Prof. of Mathematics, University of Adelaide, S.A.
1905. Brookman, George, North Gilberton.
1883. *Brown, H. Y. L., F.G.S., Gov. Geologist, Adelaide.
1899. Browne, T. L., Marlborough Chambers, Adelaide.
1893. Brummitt, Robert, M.R.C.S., Gilberton.
1904. Brunkskill, George, Semaphore, S.A.
1906. Bundey, Miss Ellen Milne, 148, Molesworth Street, North Adelaide.

1904. CHRISTIE, WILLIAM, Adelaide.
1879. *CLELAND, W. L., M.B., Ch.M., J.P., Colonial Surgeon, Resident Medical Officer Parkside Lunatic Asylum, Lecturer in Materia Medica, University of Adelaide.
1895. CLELAND, JOHN B., M.D., Perth, Western Australia.
1876. (L) COOKE, EBENEZER, Commissioner of Audit, Adelaide.
1887 *DIXON, SAMUEL, Bath Street, New Glenelg.
1902. EDQUIST, A. G., Hindmarsh.
1886. FLEMING, DAVID, Barnard Street, North Adelaide.
1904. GARTRELL, JAS., Burnside.
1904. GORDON, DAVID, Gawler Place, Adelaide.
1880. *GOYDER, GEORGE, A.M., F.C.S., Analyst and Assayer, Adelaide.
1896. GREENWAY, THOS. J., Adelaide.
1904. GRIFFITH, H., Hurtle Square, Adelaide.
1896. HAWKER, E. W., F.C.S., Adelaide.
1899. *HIGGIN, A. J., F.I.C., Assistant Lecturer on Chemistry, School of Mines, Adelaide.
1891. *HOLTZE, MAURICE, F.L.S., Director Botanic Gardens, Adelaide.
1883. *HOWCHIN, WALTER, F.G.S., Lecturer on Geology and Palæontology, University, Adelaide.
1902. ILIFFE, JAS. DRINKWATER, B.Sc., Prince Alfred College, Kent Town.
1893. JAMES, THOMAS, M.R.C.S., Moonta.
1902. JEFFREYS, GEO., Gilbert Place, Adelaide.
1900. *JOHNCOCK, CHAS. F., Morphett Vale.
1897. *LEA, A. M., Gov. Entomologist, Hobart, Tasmania.
1884. LENDON, A. A., M.D. (Lond.), M.R.C.S., Lecturer on Forensic Medicine and on Chemical Medicine, University and Hon. Physician, Children's Hospital, North Terrace, Adelaide.
1856. *LLOYD, J. S., Alma Chambers, Adelaide.
1888. *LOWER, OSWALD B., Broken Hill, New South Wales.
1905. MAWSON, DOUGLAS, B.Sc., B.E., Lecturer on Mineralogy and Petrology, University, Adelaide.
1874. MAYO, GEO., G., C.E., Hon. Secretary, 116, Franklin St., Adelaide.
1897. *MORGAN, A. M., M.B., Ch.B., Angas Street, Adelaide.
1884. MUNTON, H. S., North Terrace, Adelaide.
1859. (L) MURRAY, DAVID. Adelaide.
1883. PHILLIPPS, W. H., Adelaide.
1886. POOLE, W. B., Savings Bank, Adelaide,
1904. REISSMANN, CHARLES, M.A., M.D. (Cantab.), B.Sc. (Lond.), etc., Adelaide.
1885. *RENNIE, EDWARD H., M.A., D Sc. (Lond.), F.C.S., Professor of Chemistry, University of Adelaide.
1905. *ROGERS, R. S., M.A., M.D., Flinders Street, Adelaide.
1869. *RUTT, WALTER, Chief Assistant Engineer, Adelaide.
1891. SELWAY, W. H., Treasury, Adelaide.
1893. SIMSON, AUGUSTUS, Launceston, Tasmania.
1857. *SMEATON, THOMAS D., Mount Lofty.
1900. SMEATON, STIRLING, B.A., C.E., Engineer-in-Chief's Office. Adelaide.
1871. SMITH, ROBERT BARR, Adelaide.
1881. *STIRLING, EDWARD C., C.M.G., M.A., M.D., F.R.S., F.R.C.S., Professor of Physiology, University of Adelaide, Director of S.A. Museum.
1906. SNOW, F. H., Mutual Chambers, Adelaide.

1904. Taylor, William, St. Andrews, North Adelaide.
1906. Taylor, Harry, Robe Terrace, Medindie.
1886. *Tepper, J. G. O., F.L.S., Entomologist, S.A. Museum. [Corresponding Member, 1878.]
1897. *Torr, W. G., LL.D., M.A., B.C.L., Brighton, S.A.
1894. *Turner, A. Jefferis, M.D., Wickham Terrace, Brisbane, Queensland.
1902. Vandenbergh, W. J., F.R.S.L., F.R.S.E., F.R.M.S., J.P., Barrister and Solicitor, Pirie Street, Adelaide.
1889. Vardon, Joseph, J.P., Gresham Street, Adelaide.
1878. *Verco, Joseph C., M.D., F.R.C.S., Lecturer on the Principles and Practice of Medicine and Therapeutics, University of Adelaide.
1883. Wainwright, E. H., B.Sc. (Lond.), Wellington Road, Maylands.
1878. Ware, W. L., J.P., Adelaide.
1859. Way, Right Hon. Sir Samuel James, Bart., P.C., D.C.L., Chief Justice and Lieutenant-Governor of South Australia, Adelaide.
1904. Whitbread, Howard, Currie Street, Adelaide.
1902. *Woolnough, Walter George, D.Sc., F.G.S., University, Sydney, New South Wales.
1886. *Zietz, A. H. C., F.L.S., C.M.Z.S., Assistant Director, South Australian Museum, Adelaide.

Associates.

1901. Collison, Miss Edith, B.Sc., Flinders Street, Adelaide.
1904. Robinson, Mrs. H. R., "Las Conchas," Largs, South Australia.

APPENDICES.

FIELD NATURALISTS' SECTION

OF THE

Royal Society of South Australia (Incorporated).

TWENTY-THIRD ANNUAL REPORT OF THE COMMITTEE

For the Year Ending September 30, 1906.

When reviewing the work of the Section during the past twelve months, there is no doubt that a good class of work is being done by the members in the various branches of scientific interest. It may seem difficult to estimate the character of the work, and report that there is an improvement, but this judgment is based upon the keener interest shown by members at the evening meetings, and their general desire for information on field days.

The evening meetings were as follows:—

1905.

October 17. Chairman's Annual Address, "The Dead Months of our Orchid Year," Dr. R. S. Rogers, M.A.

November 13. Meeting in Mr. Berrett's Woolshed during the three days' excursion at Barossa.

November 21. Notes on the Barossa excursion, by Mr. Douglas Mawson and Mr. J. W. Mellor.

1906.

May 15. Paper, "Trapdoor Spiders," Dr. J. C. Verco.

June 19. Papers, Mr. T. D. Smeaton on "Insect Life," and by Mr. E. J. Bradley, on "The New Hydroid" discovered by Mr. R. Barringer.

July 17. Paper on "Eucalyptus," by Mr. J. M. Black.

August 21. Discussion on the proposed Kangaroo Island Reserve.

At these meetings there was an average attendance, and interest in the proceedings was well maintained.

The following excursions have been held:—

1905.

Oct. 7. Coromandel Valley.

Oct. 21. Upper Sturt to Belair and Blackwood.

Nov. 11, 12, 13. Barossa, three days' excursion.

Nov. 25. Uraidla.

Dec. 9. Annual picnic, Bridgewater.

1906.
Jan. 27. Outer Harbour, and dredging in the Port River.
Feb. 10. Outer Harbour and dredging in the Port River.
May 19. Railway Viaducts.
June 2. Pine Forest, Plympton.
June 16. Black Hill, Athelstone.
July 14. Slape's Gully.
July 28. Fifth Creek, Black Hill.
August 18. Fourth Creek, Morialta.
Sept. 1, 2, 3. Port Willunga, three-days' excursion.

The attendance at the excursions has been above the average of previous years, although the weather has on several occasions been uninviting. The work at the excursions has been recorded in the press reports. Field Work is where the constitution of the Society demands that we should be strongest, and there is no doubt that in the field a good deal of private collecting and observation goes on that does not appear in the reports. The Society is under obligation to friends who afforded hospitality and permission to visit their properties. The exhibits gathered during the excursions and collected by members have been of the usual interesting and instructive character.

Eleven new members were elected, bringing the membership up to 104.

The balance-sheet presented shows a balance of 3s. 3d. to credit in the General Fund, and of £4 14s. 7d. in the Excursion Fund. The unusual balance in this account accrued through the popularity of two dredging trips.

R. S. Rogers, Chairman.
E. H. Lock, Hon. Sec.

EIGHTEENTH ANNUAL REPORT OF THE NATIVE FAUNA AND FLORA PROTECTION COMMITTEE OF THE FIELD NATURALISTS' SECTION OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA, FOR THE YEAR ENDING SEPTEMBER, 1906.

The Committee's last report referred to their letter to the Commissioner of Crown Lands regarding the destruction of penguins and mutton birds and other petrels. In October last the following communication was received in reply:—"The Hon. Commissioner directs me to inform you that he has, as suggested by you, asked the keepers of lighthouses to endeavour to have the provisions of the Birds Protection Act, 1900, enforced in their respective localities, to prevent the destruction of penguins, mutton birds, and other petrels."

The chief work of the Committee in the past year has been in connection with the establishment of a large National Reserve for the native fauna and flora on the western portion of Kangaroo Island. In April they met and appointed a sub-committee to obtain information and take the necessary steps for bringing the matter before the authorities. In July a plan of action was decided upon, and on the 25th of that month, at a well-attended meeting in the Mayor's Parlour, the following resolutions were carried:—

On the motion of Dr. Verco, seconded by Professor Stirling, C.M.G.: "That this meeting is of opinion that the large area at the western end of Kangaroo Island should be set apart as a national reserve for the native fauna and flora."

Proposed by Dr. R. S. Rogers, seconded by Mr. Samuel Dixon: "That provision should be made for a health resort being established on the area."

Proposed by Professor Rennie, seconded by Mr. W. H. Selway: "That a deputation wait upon the Government as early as possible to present these resolutions."

On 7th August, in response to about one hundred and fifty circulars and post cards, sent out on behalf of the Committee, a large deputation waited upon the Premier (the Hon. Thomas Price), and brought the matter before him, with the reesult that he promised that the Lighthouse Reserve, containing 60 square miles, should be reserved for the purpose, and that, if it could be done without dipping too deeply into the coffers of the Treasury, the increased area asked for should be given. (The area of the whole block asked for was about 300 square miles.)

Under instructions from the Committee, their Secretary, on 15th August, wrote to the Premier sending him a plan of Kangaroo Island, on which was shown the boundary of the proposed reserve, marked by a red line along the eastern boundaries of the leaseholds Nos. 725, 1004, and 1121, expressing the hope that all the area might be dedicated as a reserve as early as possible, and suggesting that eight gentlemen should be appointed trustees, four on the nomination of the University, each of whom should have special knowledge of one of the following branches of Natural History, namely, animals, birds, fishes, and plants, and four similarly qualified, on the nomination of the Royal Society. The Committee hope they may receive a reply before long.

Saml. Dixon, Chairman of Committee.
M. Symonds Clark, Hon. Sec. to Committee.

Adelaide, September 18, 1906.

FIELD NATURALISTS' SECTION OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA.

Statement of Receipts and Expenditure for Year ending September 30, 1906.

Dr. Receipts.	£	s.	d.	Expenditure. Cr.	£	s.	d.
To Balance in hand, September 30, 1905 ..	1	18	2	By Subscriptions paid to Royal Society, 1905	11	7	6
,, Grant from Royal Society for 1905 ...	12	0	0	,, Advertising	2	6	6
,, Subscriptions for 1905-6	12	7	6	,, Printing	6	12	0
				,, Postages	5	16	5
				,, Balance	0	3	3
	£26	5	8		£26	5	8

Audited and found correct.

J. S. Lloyd, F.I.A.S.A., Auditor.

Adelaide, September 18, 1906.

E. H. Lock, Hon. Secretary

MALACOLOGICAL SECTION

OF THE

Royal Society of South Australia (Incorporated).

ANNUAL REPORT FOR 1905-6.

During the year 1905-6 the Section continued the revision of the census of the marine mollusca of South Australia, and the families *Naticidæ, Amnicolidæ, Rissoidæ, Turritellidæ, Scalaridæ, Vermetidæ*, and *Cerithiidæ* were passed in review. It was then considered advisable, on account of the large amount of new and undescribed material dredged during a recent vacation trip by the Chairman (Dr. Verco), to reconsider the list of gastropoda already reviewed. The result was that several known species new to South Australia were added to the list, and new species were described. Following Zittel's order the new revision now covers the families *Patellidæ, Acmæidæ, Haliotidæ, Scissurellidæ, Cocculinidæ*, and *Fissurellidæ*. The following list, which forms the first of a series, gives the South Australian species, with the original reference, and some of the synonyms: —

Family PATELLIDÆ.

1. HELCIONISCUS TRAMOSERICUS, Martyn. Universal Conchology, vol. i., pl. xvi. *P. diemenensis*, Philippi; *P. variegata*, Reeve.

2. HELCIONISCUS ILLIBRATUS, Verco. Trans. Roy. Soc. S. Aust., 1906, vol. xxx., p. 205, pl. x., f. 6 to 14.

3. PATELLA USTULATA, Reeve. Conch. Icon., Reeve, 1855, vol. viii., pl. xxxi., f. 88, a, b. *P. tasmanica*, Ten.-Woods.

4. PATELLA ACULEATA, Reeve. Conch. Icon., Reeve, 1855, vol. viii., pl. xxxii., f. 90. *P. squamifera*. Reeve.

5. PATELLA HEPATICA, Pritchard & Gatliff. Proc. Roy. Soc. Vict., 1902 (1903), vol. xv. (n.s.), part 2, p. 194. *P. striata*, Pilsbry (*non* Quoy & G.).

6. PATELLA CHAPMANI, Ten.-Woods. Proc. Roy. Soc. Tasm., 1875 (1876), p. 157. *Acmæa alba*, Ten.-Woods.

7. NACELLA PARVA, Angas. Proc. Zool. Soc. Lond., 1878, p. 862, pl. liv., f. 12.

8. NACELLA COMPRESSA, Verco. Trans. Roy. Soc. S. Aust, 1906, vol. xxx., p. 208, pl. viii., f. 11-12.

9. Nacella crebrestriata, Verco. Trans. Roy. Soc. S. Aust., 1904, vol. xxviii., p. 144, pl. xxvi., f. 20, 21.

10. Nacella Stowæ, Verco. Trans. Roy. Soc. S. Aust., 1906, vol. xxx., p. 209, pl. x., f. 4, 5.

Family ACMÆIDÆ.

11. Acmæa octoradiata, Hutton. Cat. Marine Moll. of New Zealand, 1873, p. 44. *A. perplexa*, Pilsbry.

12. Acmæa alticostata, Angas. Proc. Zool. Soc. Lond., 1865, p. 56, pl. ii, f. 11.

13. Acmæa marmorata, Ten.-Woods. Proc. Roy. Soc. Tasm., 1875 (1876), p. 156. *A. latistrigata*, Angas.

14. Acmæa calamus, Crosse & Fischer. Jour. de Conch., 1864, p. 348, and 1865, p. 42, pl. iii., f. 7, 8.

15. Acmæa flammea, Quoy & Gaimard. Voy. Astrolabe, Zool., vol. iii., p. 354, pl. lxxi., f. 15, 16. *A. crucis*, Ten.-Woods; *jacksoniensis*, Rve.; *Gealei*, Angas.

16. Acmæa conoidea, Quoy & Gaimard. Voy. Astrolabe, Zool., vol. iii., p. 355, t. 71, f. 5, 7.

17. Acmæa subundulata, Angas. Proc. Zool. Soc. Lond., 1865, p. 155.

18. Acmæa punctata, Quoy & Gaimard, Voy. Astrolabe, Zool., vol. iii., p. 365, pl. lxxi., f. 40, 42.

19. Acmæa septiformis, Quoy & Gaimard. Voy. Astrolabe, Zool., vol. iii., p. 362, pl. lxxi., f. 43, 44, 1834. *A. scabrilirata*, Angas; *petterdi*, Ten.-Woods.

20. Acmæa cantharus, Reeve. Conch. Icon., Reeve, vol. viii., pl. xl., f. 131, 1855.

Family HALIOTIDÆ.

21. Haliotis albicans, Quoy & Gaimard. Voy. Astrolabe Zool., vol. iii., p. 311, t. 68, f. 1, 2.

22. Haliotis cyclobates, Peron. Voy. Terr. Aust., vol. ii., 1816, p. 80. *H. excavata*, Lamarck.

23. Haliotis roei, Gray. King's Voy., vol. ii., appendix, p. 493.

24. Haliotis nævosa, Martyn. Univ. Conch., t. 11, f. 63.

25. Haliotis granti, Pritchard & Gatliff. Proc. Roy. Soc. Vict., vol. xiv., n.s., part 2, p. 183, pl. x. (?) *H. conicopora*, Peron.

26. Haliotis emmæ, Reeve. Gray, MSS. Brit. Mus. Cat. Conch., Icon., Reeve, vol. iii., pl. x., f. 29.

27. Haliotis rubicundus, Montfort. Conch. Syst., p. 114, 115. *H. tricostalis*, Lamarck.

Family FISSURELLIDÆ.

28. Fissurella omicron, Crosse & Fischer. Jour. de Conch., 1864, p. 348; 1865, p. 41, pl. iii., f. 4, 6.

29. Megatebennus concatenata, Crosse & Fischer. Jour. de Conch., 1864, p. 348, pl. iii., f. 4, 6; 1865, p. 41, pl. iii., f. 1, 3.

30. Megatebennus trapezina, Sowerby. Proc. Zool. Soc. Lond., 1834, p. 126. *F. scutella*, Sowerby; *javaniensis*, Lamarck; *tasmaniensis*, Bonnet.

31. Lucapinella nigrita, Sowerby. Proc. Zool. Soc. Lond., 1834, p. 127. *F. crucis*, Beddome.

32. Lucapinella oblonga, Menke. Moll. Nov. Hall. p. 33. *Pritchardi*, Hedley.

33. Macrochisma producta, A. Adams, Proc. Zool. Soc. Lond., 1850, p. 202.

34. Macrochisma tasmaniæ, Sowerby. Conch. Illus. 1841, p. 5, No. 45, pl. lxxiii., f. 39. *Fissurella macrochisma*, Chemnitz; *tasmanica*, Ten.-Woods; *Weldii*, Ten.-Woods.

35. Glyphis jukesii, Reeve. Conch. Icon., Reeve, 1849, f. 45. *G. fimbriata*, Reeve.

36. Zidora tasmanica, Beddome. Proc. Roy. Soc. Tasm., 1883, p. 169. *Z. legrandi*, Tate.

37. Emarginula candida, A. Adams. Proc. Zool. Soc. Lond., 1851, p. 85, No. 30.

38. Emarginula dilecta, A. Adams. Proc. Zool. Soc. Lond., 1851, p. 85, No. 28.

39. Emarginula superba, Hedley. Records, Aust. Mus., vol. vi., part 3, p. 16, pl. xxxvii., f. 7-8.

40. Emarginula, sp. nov.

41. Aff. Rimula, gen. nov.

42. Subemarginula emarginata, Blainville. Malac., 1825, p. 501, pl. xlviii., bis, f. 3. *E. Australis*, Quoy & Gaimard.

43. Subemarginula rugosa, Quoy & Gaimard. Voy. Astrolabe, Zool., vol. iii., p. 331, pl. lxviii., f. 17-18. *E. conoidea*, Reeve; *candida*, Adams; *tasmaniæ*, Sowerby.

44. Scutus anatinus, Donovan. Rees, Encycl., vol, v., Nat. Hist. Plates, Conchology, pl. xvi. *P. elongatus*, Blainville; *australis*, Lamarck; *convexus*, Quoy & Gaimard; *unguis*, A. Adams.

45. Tugalia parmophoidea, Quoy & Gaimard. Voy. Astrolabe, Zool., vol. iii., p. 325, pl. lxviii., f. 15, 16. *T. intermedius*, Reeve; *elegans*, Gray; *ossea*, Adams; *cinerea*, Adams and Sowerby (*non* Gould); *tasmanica*, Ten.-Woods; *australis*, Ten.-Woods.

Family SCUTELLINIDÆ.

46. Scutellina calva, Verco. Trans. Roy. Soc., S. Austr., 1906, vol. xxx., p. 217, pl. viii., f. 9, 10.

47. Scutellina alboradiata, Verco. Trans. Roy. Soc. S. Austr., 1906, vol. xxx., p. 217, pl. viii., figs. 1, 2.

Family SCISSURELLIDÆ.

48. Scissurella australis, Hedley. Mem. of Aust. Mus., vol. iv., part 6, 1903, p. 329, f. 63.

49. Schismope beddomei, Petterd. Quarterly Journ. Conch., 1884, vol. iv, p. 139.

50. Schismope atkinsoni, Ten.-Woods. Proc. Roy. Soc. Tasm., 1876 (1877), p. 149. *S. carinata*, Watson.

51. Schismope pulchra, Petterd. Quarterly Jour. Conch., vol. iv., 1884, p. 139.

Family COCCULINIDÆ.

52. Cocculina tasmanica, Tate & May. Trans. Roy. Soc. S. Aust., vol. xxiv., 1900, p. 102. *Nacella tasmanica*, Tate & May; *N. parva*, var. *tasmanica*, Pilsbry; *C. meridionalis*, Hedley.

The Section has elected Dr. J. C. Verco as Chairman, and Mr. R. J. M. Clucas as Secretary for the coming year.

The balance-sheet is given herewith:—

Receipts and Expenditure for 1905-6.

Dr. Receipts.

	£	s.	d.
To Balance brought forward	1	2	2
,, Subscriptions, 1905-6	1	17	6
,, Debit Balance	1	6	10
	£4	6	6

Cr. Expenditure.

	£	s.	d.
By Gratuity to Caretaker, 1905-6	0	10	0
,, Postages	0	9	0
,, Subscriptions, paid to Treasurer of the Royal Society—			
For 1904-5	1	10	0
For 1905-6	1	17	6
	£4	6	6

Robt. J. M. Clucas, Hon. Secretary and Treasurer.

MICROSCOPICAL SECTION

OF THE

Royal Society of South Australia (Incorporated).

ANNUAL REPORT, 1905-6.

CHAIRMAN—MR. W. FULLER.

COMMITTEE—MESSRS. D. FLEMING, D. MAWSON, B.E., B.Sc., D. GORDON.

HON. SECRETARY.—MR. E. J. BRADLEY, Dover Street, Malvern.

MINUTE SECRETARY—MR. H. A. WHITEHILL.

AUDITORS—MESSRS. T. GODLEE, S. SMEATON, B.A.

The present month, September, 1906, marks the completion of the third session of the Section since its resuscitation in 1903. The interest and attendance of the members during the year have been well maintained, the average attendance at all engagements held in the Royal Society's rooms being seventeen, with a total membership at present of 50. Only one resignation was received during the year, whilst seven new members have been elected. Marked progress has been made in several directions, mainly through several members having devoted their energies to special lines of investigation, whilst the initiation by the Section of a movement for securing an epidiscope, for the use of the various societies affiliated with the Royal Society, the Society of Arts, the Royal Geographical and other Societies, is particularly noteworthy. The value of this instrument as an educational medium and means by which a more general interest may be aroused in the work of the various scientific and art societies can scarcely be over-estimated.

The class for the Study of Microscopic Technique, held at the Adelaide University, continues to do good work in affording opportunity of acquiring up-to-date knowledge in anatomy, biology, and the art of manipulation of objects of microscopical interest.

Meetings and excursions have been held as follows:—

September 26, 1905—Annual general meeting.

October 21—Excursions to creeks near North Arm.

October 24—Paper by Mr. D. Mawson, B.E., B.Sc., on "The Application of Polarized Light in Microscopy," and exhibition of stereographs by Mr. W. P. Dollman.

November 28—Lecture by Dr. Angas Johnson on "Some Parasites of Man," illustrated by a large collection of slides.

January 27, 1906—Dredging Excursion to Port River and Outer Harbour, in conjunction with Field Naturalists' and Boys' Field Club.

March 10—Dredging Excursion to North Arm and Outer Harbour.

March 27—Examination of material obtained as result of excursion to Grange, and discussion of new Hydroid discovered on weed from Patawalonga Creek.

April 24—Mr. E. J. Bradley reported on the successful nature of his studies of the new Hydroid from the Patawalonga Creek.

May 22—Exhibition of various types of modern microscopes, and explanation by Mr. D. Mawson on the use of the petrological microscope, and the optical nature of the accessories.

June 26—Mr. W. P. Poole gave a display of microphotographic lantern slides prepared by himself, and explained the chief points of interest of each object shown upon the screen.

July 24—Lecture and display of preparations of series illustrating life history of the star-fish, *Pentagonaster*, by Mr. E. J. Bradley.

August 28—Mr. W. Fuller showed specimens of skiographic work stereoscopically; Mr. W. P. Dollman exhibited photographic enlargements, etc., and Mr. Bradley gave a chat on *Chirodota*, with exhibits.

EDGAR J. BRADLEY, Hon. Secretary.

September 25, 1906.

MICROSCOPICAL SECTION OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA.

Balance Sheet, Session 1905-6.

Receipts.

	£	s.	d.
Subscriptions, 1905-6	9	2	6
Refund from Field Naturalists' Dredging Excursion, Postal Expenses, and Stationery ...	0	8	5
Balance in hand at beginning of Session ...	1	4	5
Grant from Royal Society	7	0	0
	£17	15	4

Expenditure.

	£	s.	d.
Subscriptions, 1905-6, paid to Treasurer of Royal Society	9	2	6
Postage and Duty Stamps	2	4	9
Stationery	0	1	11
Printing	1	15	0
Attendance (Caretaker)	1	5	0
Cash in hands of Treasurer of Royal Society ...	2	2	6
Balance in hands of Hon. Secretary	1	3	8
	£17	15	4

Edgar J. Bradley, Hon. Secretary.

Audited and found correct,

S. Smeaton, } Auditors.
Theo. Godlee, }

October 22, 1906.

GENERAL INDEX.

[Generic and specific names printed in italics are described as new.]

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