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.

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Adelaide:

W. C. RIGBY, 74, KING WILLIAM STREET.

DECEMBER, 1906.

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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—

$$\begin{aligned} RI &= 2\cdot 95 \times 104\cdot 4 \\ &= 308, \text{ uncorrected.} \end{aligned}$$

Correcting for want of saturation—

$$\begin{aligned} RI &= 308 \times \frac{1134}{1088} \\ &= 321. \end{aligned}$$

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—

$$\begin{aligned} & 1\cdot 065 \times 321 - \cdot 065 \times 231 \\ = {} & 342 - 15 \\ = {} & 327. \end{aligned}$$

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.

$$\therefore\ A\,N = \frac{He}{mv_0} \cdot \frac{a^2}{2}$$

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:

$$\tfrac{1}{2}\, m \frac{dv}{ds} = kv^{-2}, \text{ s being measured from O,}$$

$$\text{and therefore } v^4 \propto (a - s)$$

$$\text{so that } \frac{v^4}{v_0^{\,4}} = \frac{a-s}{a}.$$

$$\text{Thus } \rho = \frac{mv_0}{He}\left(1 - \frac{s}{a}\right)^{\frac{1}{4}};$$

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 a 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 a 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 a 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 a particle is slightly deflected, but the whole trace is not appreciably disturbed. The aluminium diminishes the range of every a 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 a 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 a particles of uniform velocity, which is analogous to confining one's attention in the star problem to

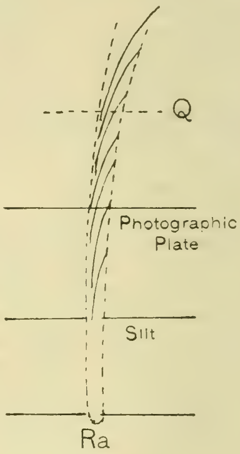


Fig. 3

* 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.

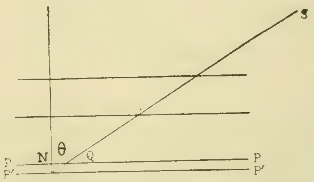
Let the stopping power of the radio-active material per radio-active atom be s. This means that if an α particle passes parallel to the axis along a cylinder containing only as much matter as goes with one radio-active atom of the radio-active material, the loss of range is on the average s times the 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

$$O N = \frac{n_0\delta r}{ns} \cdot \cos\theta \cdot$$

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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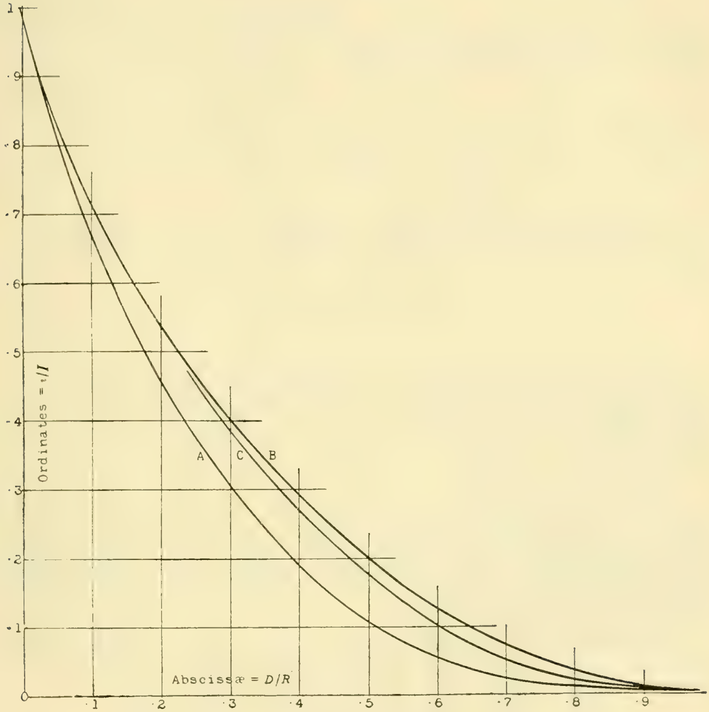
* Even if there be errors in the theory which leads to this formula, the present argument is not injured, for the formula correctly represents the actual facts.

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

$$\frac{4si}{Nln_0}=\int_{R-D-D'}^{R-D}\left\{1-\left(\frac{D}{R-r}\right)^2\right\}\left\{\sqrt{(r+d)}-\sqrt{d}\right\}dr$$

$$+\int_{o}^{R-D-D'}\left\{\left(\frac{D+D'}{R-r}\right)^2-\left(\frac{D}{R-r}\right)\right\}\left\{\sqrt{(r+d)}-\sqrt{d}\right\}dr$$

$$=\frac{2}{3}(R-D+d)^{\frac{3}{2}}-\frac{2}{3}(R-D-D'+d)^{\frac{3}{2}}-2D'\sqrt{d}$$

$$-D\sqrt{(R+d-D)}+(D+D')\sqrt{(R+d-D-D')}$$

$$+\frac{D^2}{\sqrt{(R+d)}}\log.\frac{\sqrt{(D+D')}\left\{\sqrt{(R+d)}+\sqrt{(R+d-D)}\right\}}{\sqrt{D}\left\{\sqrt{(R+d)}+\sqrt{(R+d-D-D')}\right\}}$$

$$-\frac{D'^2+2DD'}{\sqrt{(R+d)}}\log.\frac{\sqrt{R}\left\{\sqrt{(R+d)}+\sqrt{(R+d-D-D')}\right\}}{\sqrt{(D+D')}\left\{\sqrt{(R+d)}+\sqrt{d}\right\}}$$

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

$$\int_0^{\cos.^{-1} D/R} \int_0^{R - D \sec.\theta} \sin\theta.\, r.\, d\theta.\, dr.$$

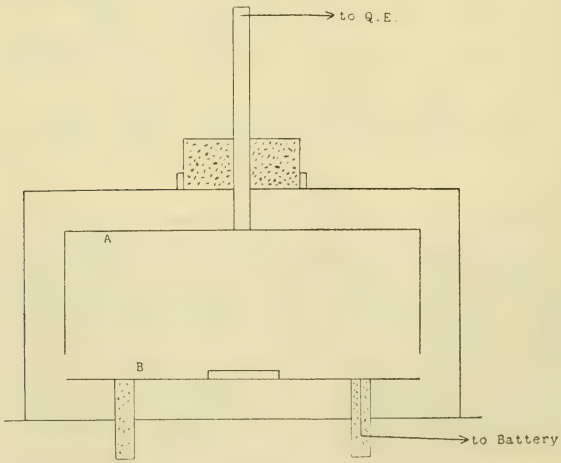
$$i.e., \text{ to } R^2 - D^2 + 2RD \log. \frac{D}{R}.$$

$$\text{Thus} \quad i/I = 1 - \frac{D^2}{R^2} + 2\frac{D}{R} \log. \frac{D}{R}.$$

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 $\rho d = \cdot 000949$, $i/I = \cdot 456$. The abscissa of curve A corresponding to this ordinate is ·205. Consequently the ρd of full range is equal to $\cdot 000949 / \cdot 205 = \cdot 00463$. 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 $\rho d = \cdot 000317$ 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 $\rho d = \cdot 000133$ 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.

* 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 $\left(\frac{456}{476}\right)^2 = {\cdot}916$.

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* 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 $\frac{S_T}{S_U} = \frac{\sqrt{232} + 2\sqrt{16}}{\sqrt{239} + \frac{8}{3}\sqrt{16}} = \frac{23 \cdot 2}{26 \cdot 2}$

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 α 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 α 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 α 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$\frac{1}{3}$-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 $\frac{1}{2}$ 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 $\frac{1}{3}$ 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 *chlœnota*, 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 chlœnota, 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 $\frac{2}{3}$, 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, brignt 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 $\frac{1}{3}$, 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, $2\frac{1}{3}$-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.

* 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 *Platyphœus*,† 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 1½ mm. in length *Australiæ.*
          More than 1½ 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

* *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

* 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

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* *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, 4¾ 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, 5½ 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 subfrontal 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 sub-triangular, 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 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 ($1\frac{2}{3}$), 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 *Axiologa*, 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 subterminal 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 post-median 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 MONOIDES, 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; Handlist 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. Pullcine, 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, 1¾ 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.

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.

* 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. 4*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.

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 $1\frac{1}{4}$ diam.; *b*, calice of same, magnified $2\frac{1}{2}$ diam.

5. *Dendrophyllia atrata*—*a*, corallum, magnified $1\frac{1}{2}$ 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.

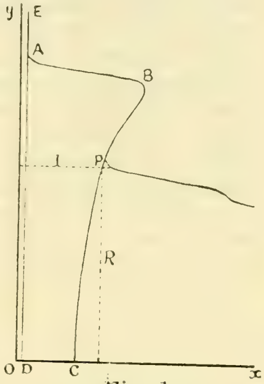

Fig. 1.

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-

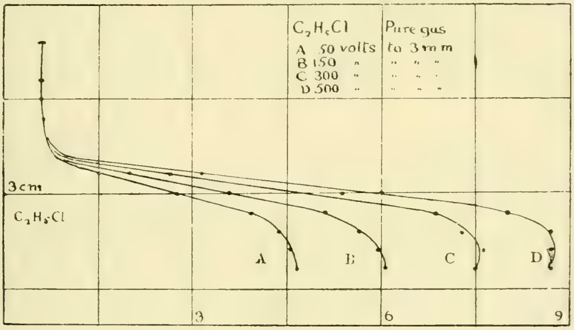

Fig. 2.

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

* 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 a 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 a 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 a particle at the end of its path.

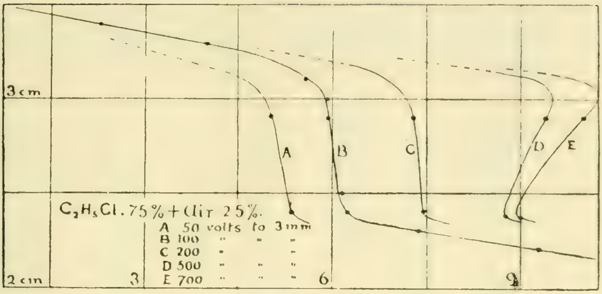

Fig. 3.

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 a 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 189·5 × 1·32

=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.

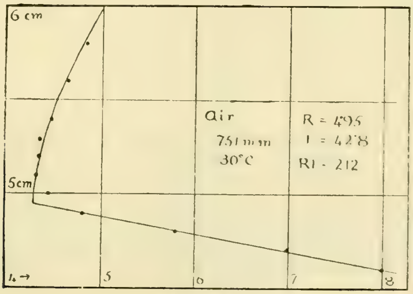

Fig. 4.

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.

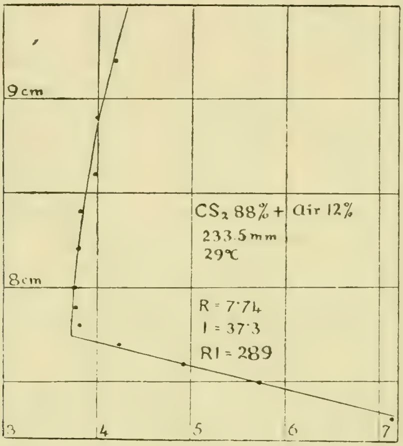

Fig. 5.

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)—

$$\frac{495}{774} \cdot \frac{751}{233{\cdot}5} = 2{\cdot}06$$

Hence—

If x be the percentage of gas, we must have

$$x \times 2{\cdot}2 + 1 - x = 2{\cdot}06 \therefore x = 88{\cdot}5.$$

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.

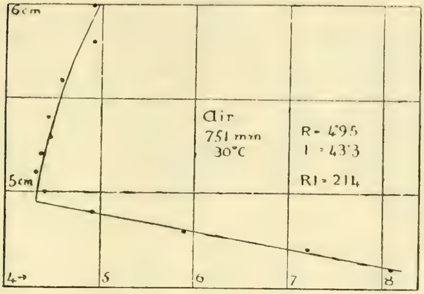

Fig. 6.

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 α 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

$$\cdot945\ RI + \cdot055 \times 213 = 289$$

$$\text{whence } RI = 294$$

$$\text{Hence specific ionisation of } CS_2 = 294/213 = 1{\cdot}38.$$

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 α 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.	Percentage 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 $d = 1{\cdot}33$. 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 $r + d = {\cdot}5 + 1{\cdot}25 = 1{\cdot}75$, and at the latter $2 + 1{\cdot}25 = 3{\cdot}25$. But $\sqrt{3{\cdot}25}/\sqrt{1{\cdot}75} = 1{\cdot}36$; 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 occurrence 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, v/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 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

* 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.

* 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. of 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,

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* 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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University of Adelaide.

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.
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, Handlist 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. 224; Ten.-Woods, Proc. Roy. Soc., Tasm., 1878 for 1877, p. 45; Brazier, Proc. Linn. Soc., N.S.W., 1883, p. 224; 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 *Trichotropidæ*, 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.

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.

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 clastic 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

* 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.

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, the 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. cærulea, 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 punctuation 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., $2\frac{3}{4}$-$3\frac{1}{5}$ 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.*

* 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 the 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 mechidioides*, 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

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* 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 3ᵘˢ 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 3ᵘˢ, 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., 9⅓ 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 crebre 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., 4⅗ 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., 4¼ 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 punctuation 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^{o} quam 2^{us} vix (quam 4^{us} multo) breviori; antennis 9-articulatis articulo 4^{o} 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., 6¼ 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° quam 2^us vix (quam 4^us manifeste) breviori; antennis 9-articulatis, articulo 4° 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., 8⅕ l.; lat., 4¼ 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, $2\text{-}2\frac{3}{5}$ 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., $6\frac{1}{5}$ 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.

* 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'urvillaca potatorum*, when fully grown, is from 12 to 24 ft. long, and nearly $\frac{1}{4}$ 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; *Scenopæus 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: radioactive 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 spurfooted cuckoo (*Centropus phasianus*), having a very large and straight hind claw; a mound-building bird *(Megapodius duperreyi);* the nutmeg pigeon *(Myristicivora 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 confirm 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.

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Presented by the respective Editors, Societies, and Governments.

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——— American Philosophical Society, Proceedings, vol. xliii., No. 179; vol. xliv., Nos. 180, 181; Transactions, vol. xxi, part 2.

St. Louis—The Academy of Science, vol. xiv., No. 7: vol. xv., Nos. 2-5; Classified List, vols. i.-xiv.

Sacramento—University of California, Pubs. of College of Agriculture, Bulletins Nos. 149-176; Circulars Nos. 5-13; Historical and General, part 1.

San Francisco—California Academy of Science, Geology, Report of the State Earthquake Investigation Commission; Zoology, Proceedings, vol i., No. 6.

——— University of California, The Morphology of the Hupa Language, vol. iii.

Washington—Smithsonian Institution, U.S. Nat. Museum, Bulletins, No. 53, part 1, Nos. 54 and 55. Proceedings, vols. xxviii. and xxix. Contributions, vol. x., parts 1, 2; Annual Report, 1904.

——— Annual Report of Board of Regents, 1904.

——— Annual Report of Bureau of American Ethnology, Bulletins Nos. 28, 29.

Washington—United States Geological Survey, Monographs, vol. xlvii., xlviii., parts 1, 2; Profes-fessional Papers, Series B, Geology (Descriptive), Nos. 44, 34.

———— Department of the Interior, Annual Report, No. 26; Mineral Resources, 1904, do. do., Bulletin, Nos. 243-7, 251, 254, 256, 257, 262, 263, 265-6, 268-274, 276.

———— Water Supply and Irrigation, Nos. 119-154, 157-165, 169-171.

———— United States, Department of Agriculture, Yearbook, 1905.

———— Academy of Sciences, Proceedings vol. vii., pp. 1-188, 251-402; vol. viii., pp. 1-166.

———— National Academy of Science, Memoirs, vol. ix., Philippine Islands, Manila Department of Interior Ethnol. Survey, Pubs. vols. i. and ii., part 1; do. do., Bureau of Government Laboratories, No. xxii., 1905.

Urbana—Illinois State Laboratory of Nat. Hist., Bulletin, vol. vii., art. 5.

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.

F. 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,
Theo. Godlee, } Auditors.

October 22, 1906.

GENERAL INDEX.

[Generic and specific names printed in italics are described as new.]

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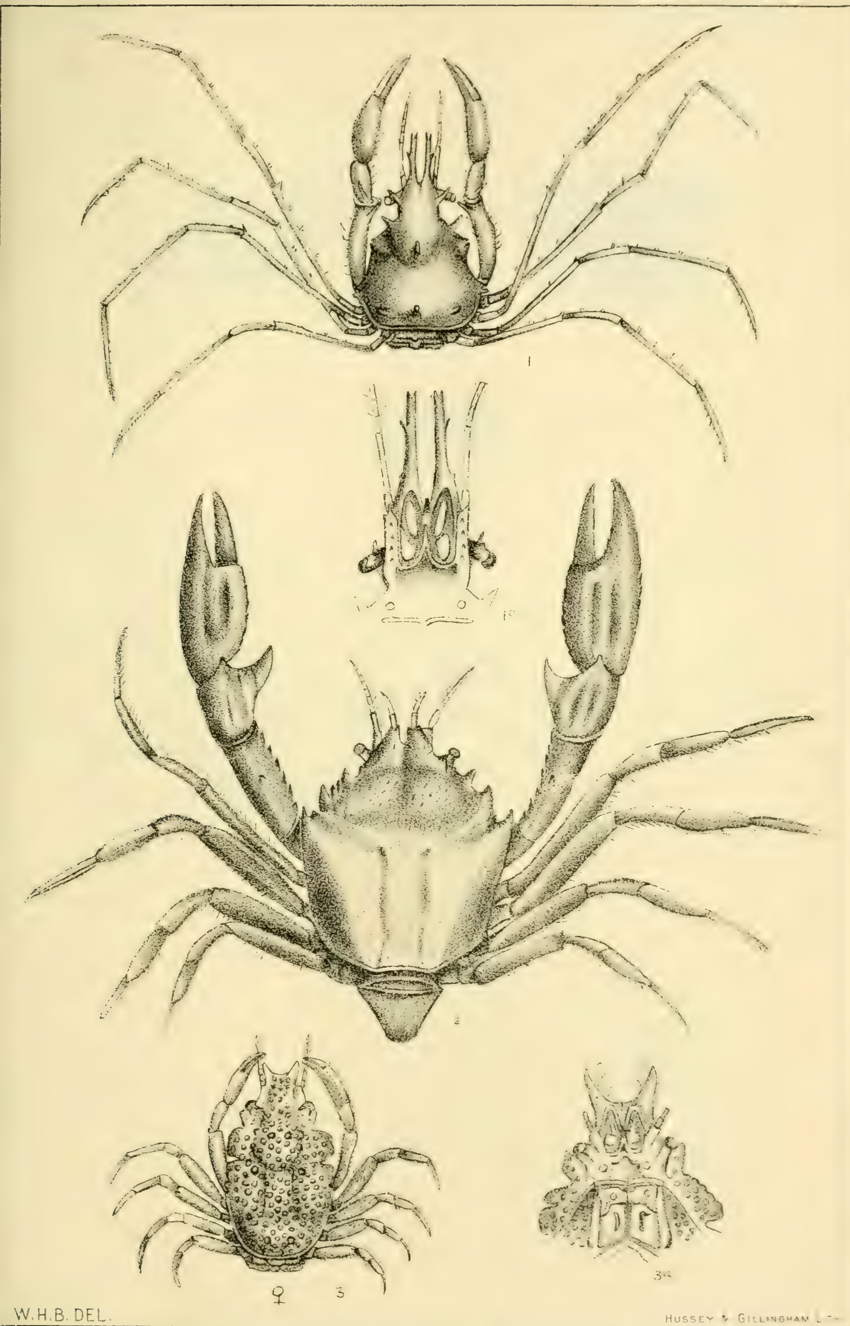
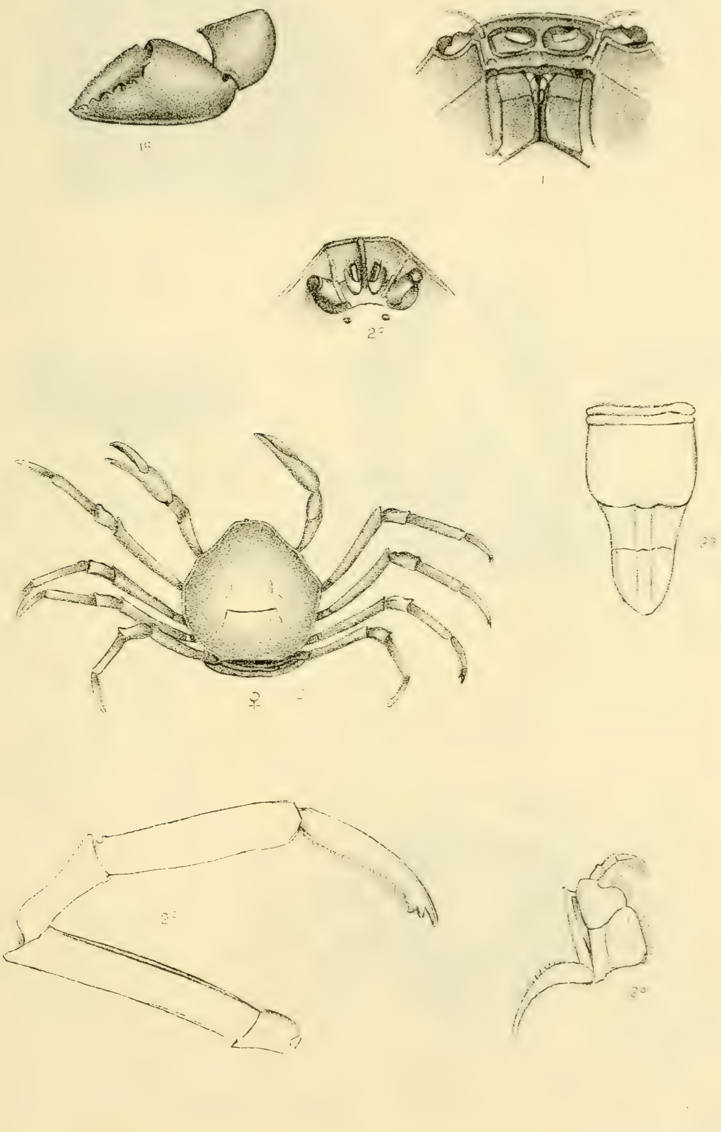
PLATES I. TO XII.



1. STENORHYNCHUS RAMUSCULUS. 2. PARATYMOLUS LATIPES.
3. EURYNOME GRANULOSA.



W.H.B. DEL.

HUSSEY & GILLINGHAM LITH.

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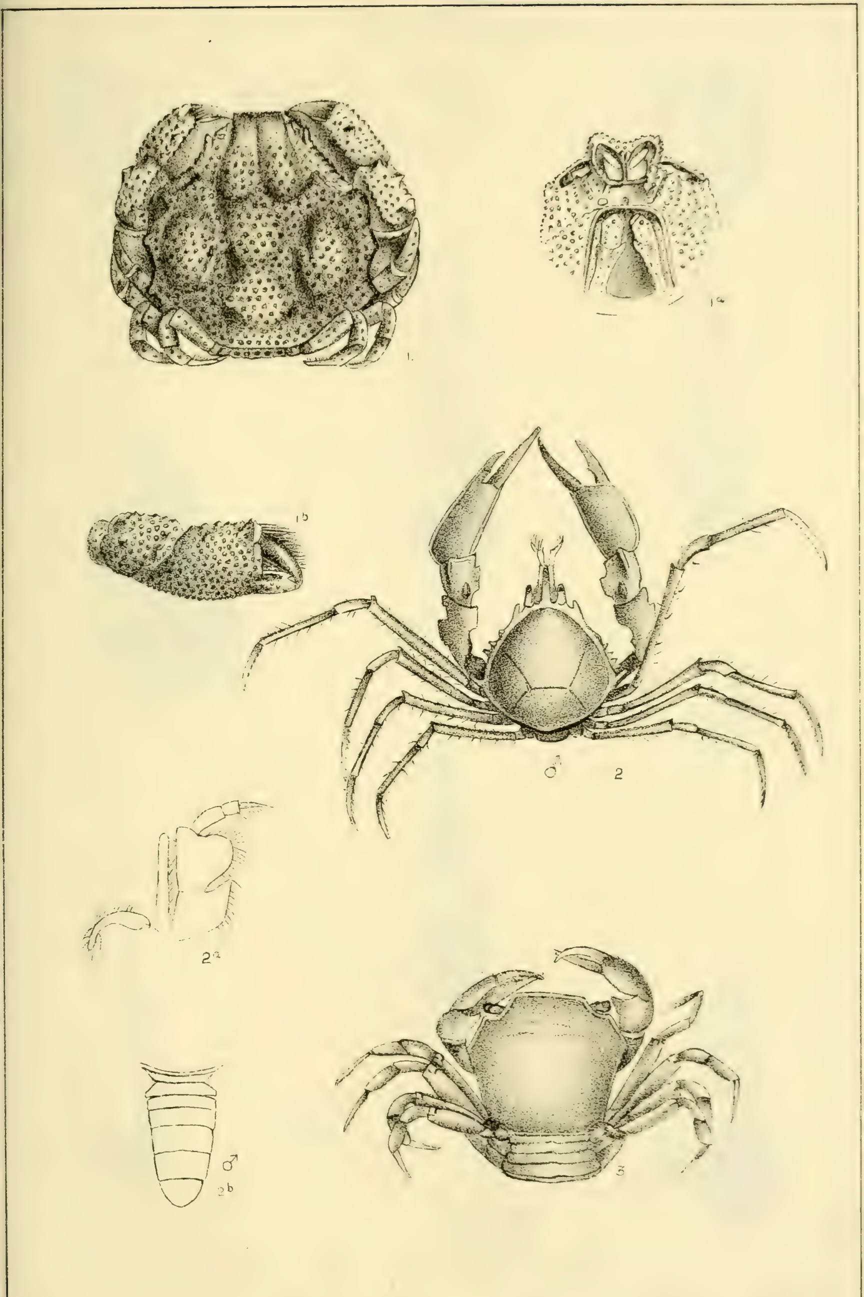
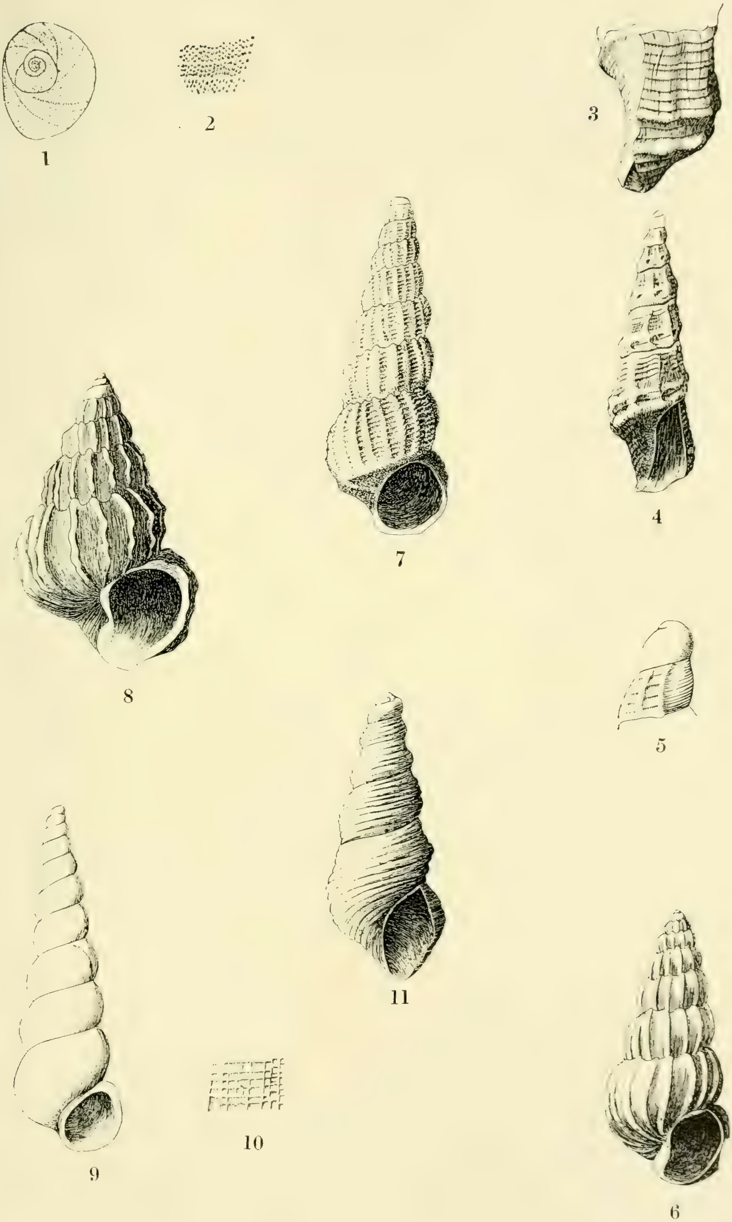
2.- ELAMENA TRUNCATA.



1. TRICHIA AUSTRALIS. 2. HYMENOSOMA ROSTRATUM. 3. LITOCHEIRA GLABRA.



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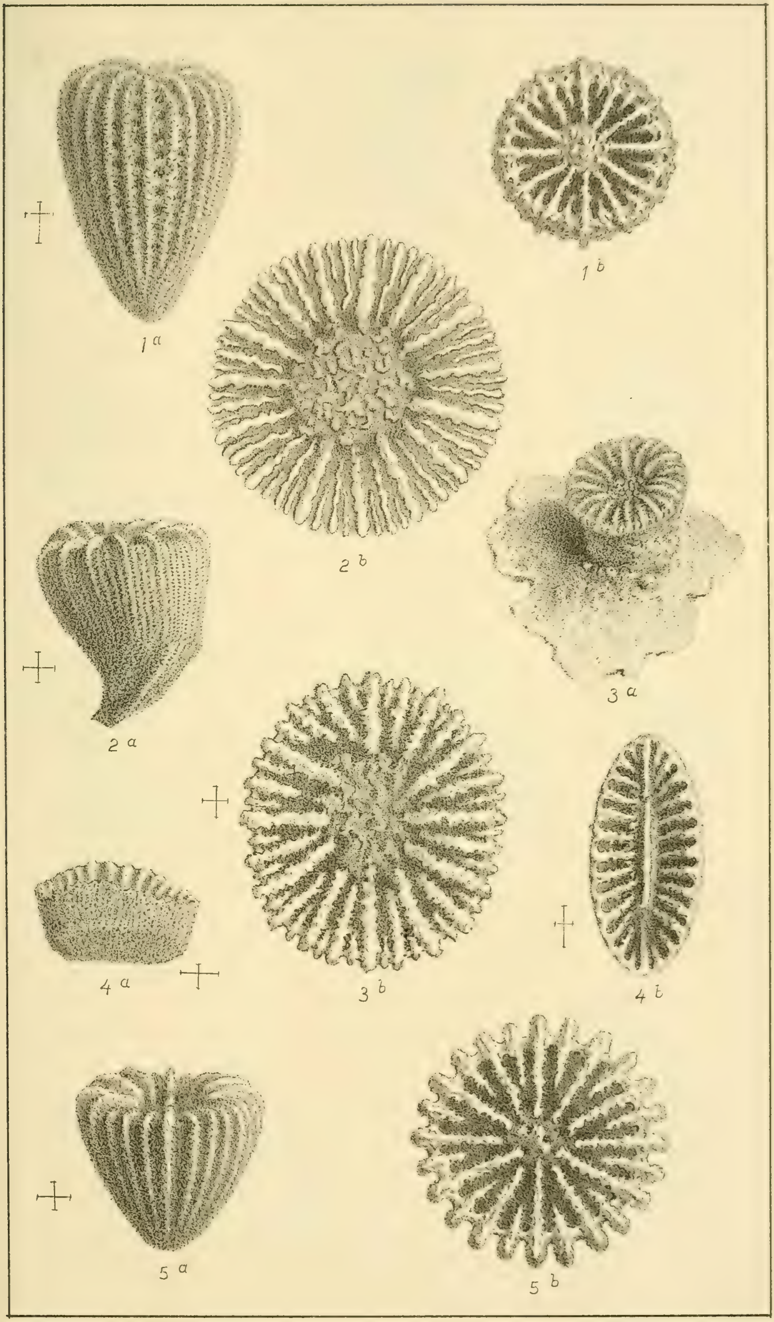

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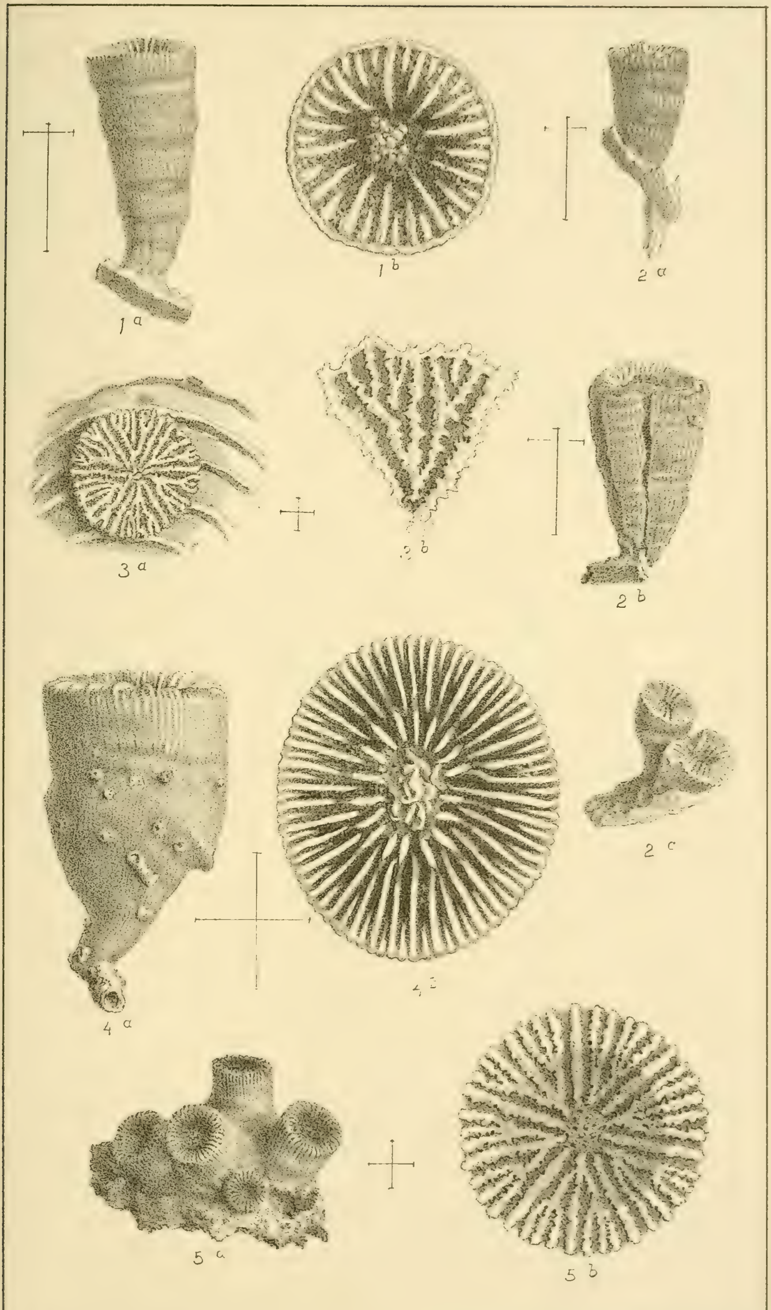

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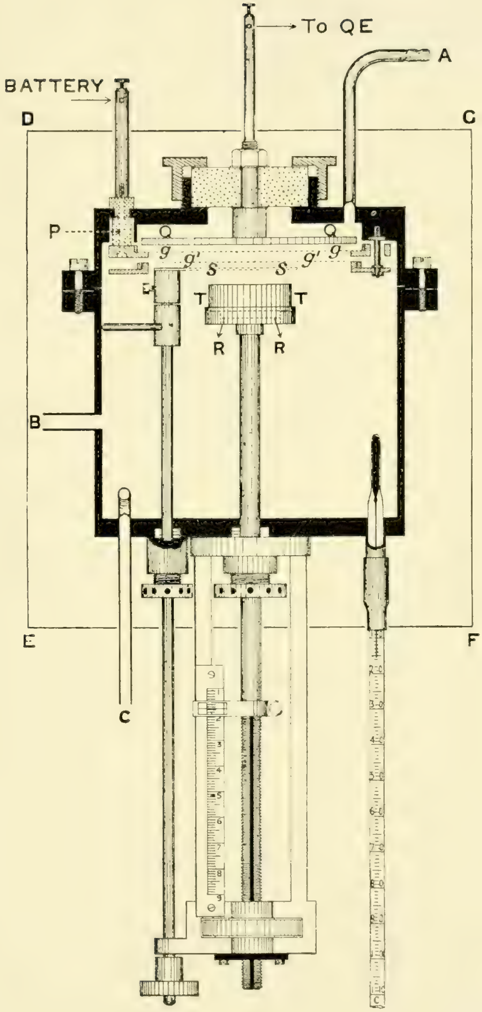

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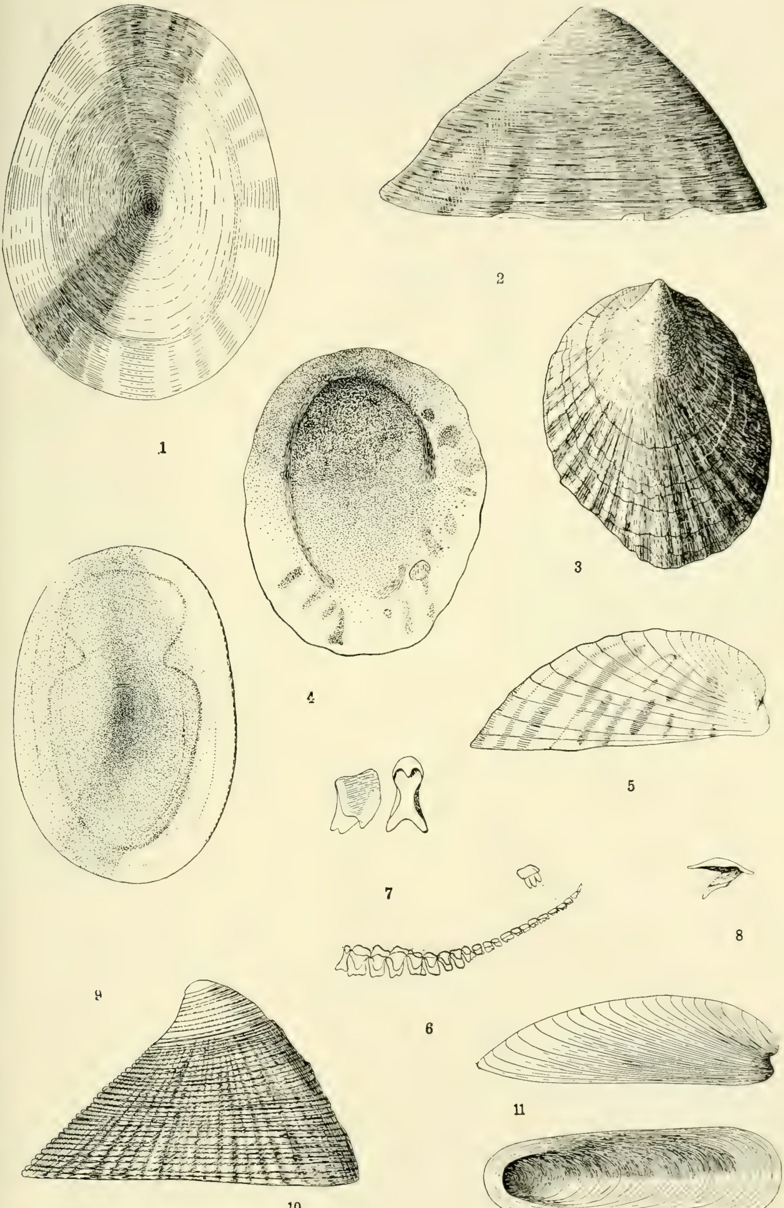

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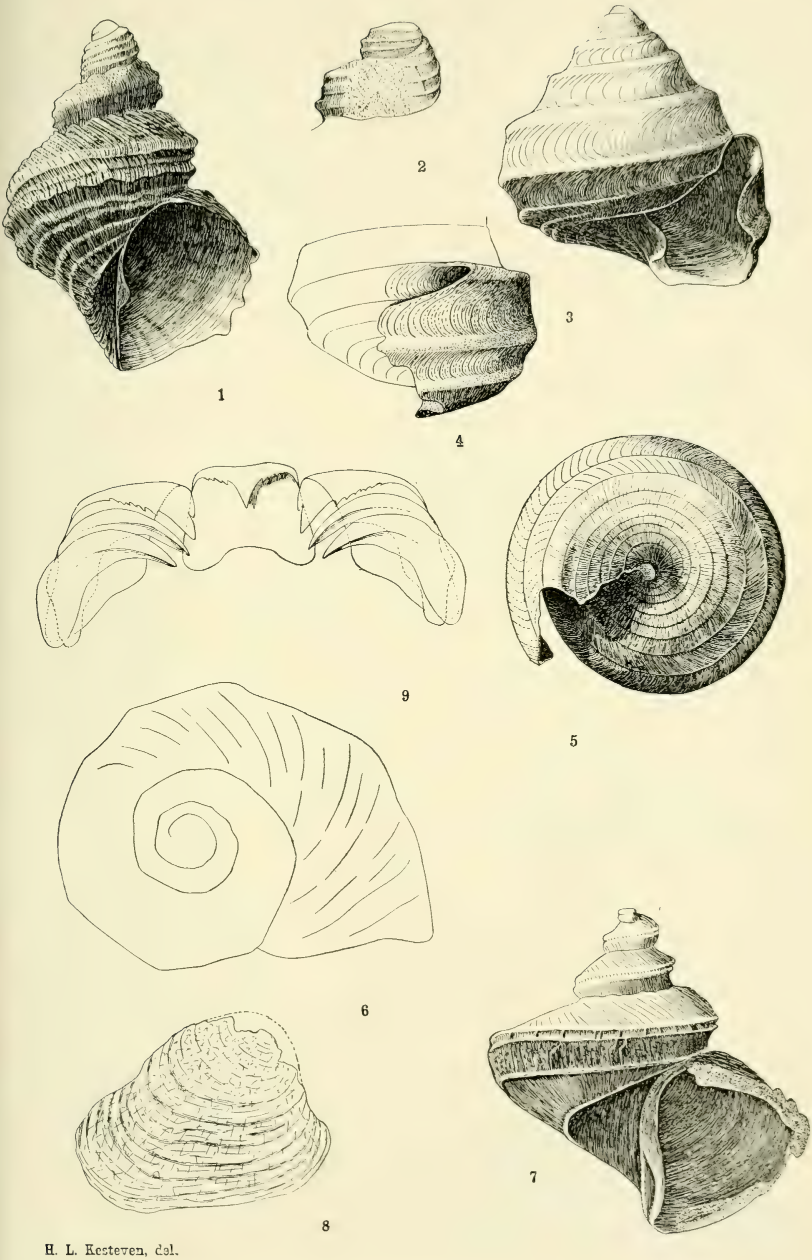

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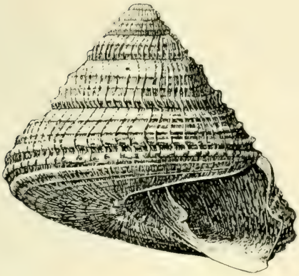
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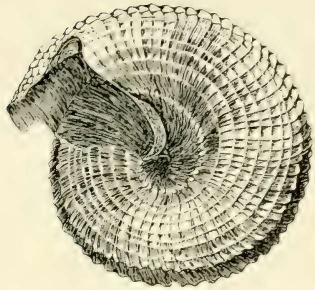
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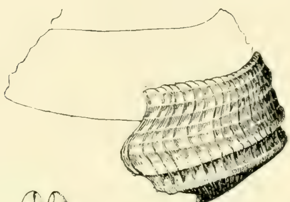
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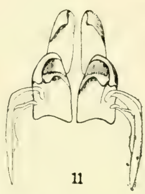
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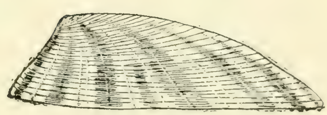
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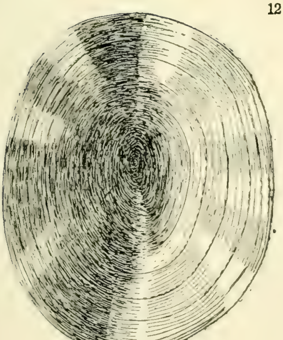
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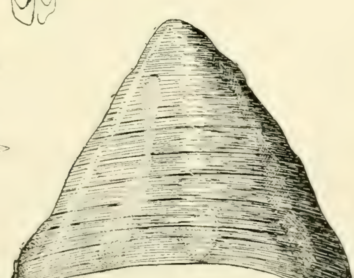
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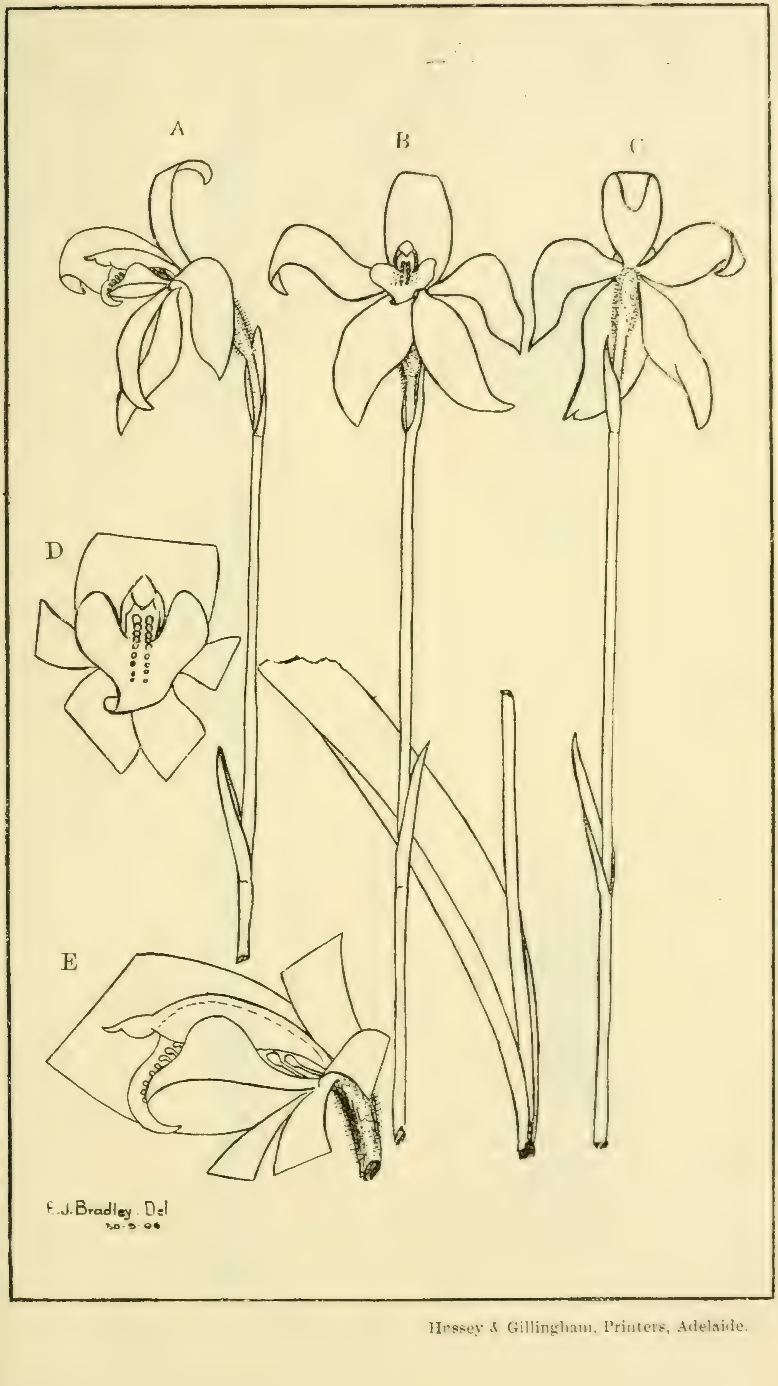

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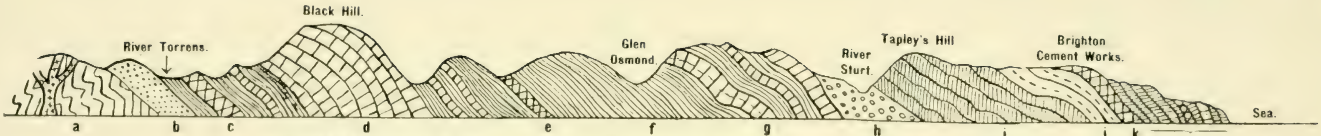

Fig. I.—DIAGRAMMATIC SECTION OF THE LOWER BEDS OF THE CAMBRIAN SERIES, FROM THE RIVER TORRENS TO THE SEA.

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.

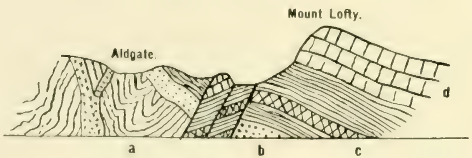

Fig. 2

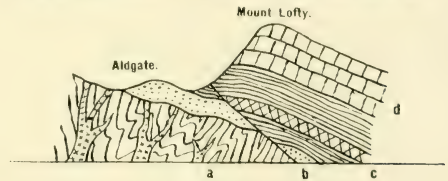

Fig. 3.

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Appendices.