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ART. I.—*The Theory of Temporary Stars.*

By E. F. J. LOVE, M.A., F.R.A.S.

[Read 13th March, 1902.]

1.—Introductory.

The two rival theories concerning the origin of temporary stars—or *Novae*—respectively ascribe their phenomena to collision and to eruption. Till within the last three years the collision theory was preferred by astrophysicists, a large majority of them deeming the spectroscopic evidence conclusive in its favour; but the publication by Wilsing[1] of his famous memoirs "On the interpretation of the typical spectrum of new stars," and "On the effect of pressure upon the wavelength of the lines in the hydrogen spectrum," put a new face on the matter by showing that the emission from the star of gases under pressure was competent to account for the spectroscopic phenomena. Of special importance was his experimental proof of the fact that the dark lines must, on this hypothesis, always be more refrangible than the corresponding bright ones, since this fact was one of the principal difficulties in the way of the collision theory, or for that matter of any reasonable mechanical explanation of the typical spectrum, a difficulty emphasized of recent years by Mrs. Fleming's discovery of a considerable number of *novae* on the Draper memorial photographs.[2]

Such was the state of the question when *Nova Persei* made its appearance on 21st February, 1901. Owing partly to its great brilliancy—even in the latest stages discussed here it was still very little below the 6th magnitude—partly to the improvement in photographic processes, the transformations of this star have been studied with a degree of closeness, accuracy and continuity never approached in the case of other *novae*. Naturally each investigator attempts to explain his results in terms of the

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1 Ap. J., x., pp. 113, 269.

2 See Pickering (Ap. J., xiii., p. 173) for a list of these.

theory which he favours most; my object, therefore, in writing this paper is to discuss the work done on the star at different observatories during last year, in order to see what light it throws, taken as a whole, on the claims of the rival theories.

2.—Early History of the Outbreak.

Nova Persei was the first of the temporaries to have its spectrum examined before and during, as well as after, its epoch of maximum luminosity. Discovered by Anderson on 21st February, its spectrum was photographed by Pickering[1] at Harvard on the 22nd; by Vogel[2] at Potsdam, as well as at Harvard on the 23rd—the night of the maximum, when the star for a short time held the proud pre-eminence of "the brightest star in the northern heavens"—and at the Lick[3] and Yerkes[4] observatories, as well as at Harvard on the 24th; all other photographs known to me are of later date.

These earliest photographs prove that on 22nd February the spectrum was that characteristic of the "Orion group" of stars; it showed a continuous spectrum crossed by a comparatively small number of fine dark lines, practically undisplaced from their normal positions, among which those of hydrogen and the magnesium line $\lambda 4481$ were decidedly the most prominent; Pickering records these as "bright on the less refrangible edge;" there was no sign of the typical spectrum. One the next night Pickering found K present; otherwise the spectrum was "apparently unaltered," but the star was obscured by clouds, and the photograph faint. On the same night, however—and, judging from the difference in longitude of the two observatories, some time previous to Pickering's photograph—Vogel obtained two plates, showing a bright continuous spectrum, crossed by broad hazy hydrogen absorptions,[5] and by a number of fine dark lines, H and K being conspicuous among the latter, but he

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1 Ap. J., xiii., pp. 170, 232.
2 Ap. J., xiii., p. 217.
3 Ap. J., xiv., p. 269.
4 Ap. J., xiii., p. 238.
5 Possibly the cloudy weather prevented these from showing on Pickering's second plate.

found no trace of bright lines or bands on his plates ; the broad hazy absorptions were displaced towards the violet by an amount corresponding to a velocity of 700 kilometers per second towards the sun. By the 24th the typical *nova* spectrum was fully established. It differed slightly from that of *Nova Aurigae*, showing the bright bands much broader, and the dark ones less dark relatively to their surroundings, than they appeared in the spectrum of the earlier star.[1] These bands, in addition to the lines of hydrogen, included the "enhanced lines" of iron, calcium and magnesium, and (possibly) D_3; H and K showed both as bands and as fine lines.

3.—Bearing of the Earliest Observations on Theory.

This may be summed up as follows :—

1. The star, when near the maximum, was certainly exceedingly hot. The coincidence of the first spectrum with that of the Orion stars establishes this fact, which is even better attested by its great extension into the ultraviolet and the high relative intensity of that portion. The presence of "enhanced line" absorptions proves the same thing.

2. The change to a typical *nova* spectrum, though rapid, was gradual. Pickering, on the basis of his own photographs, regards it as "very sudden"; but the coincident work of Vogel shows that the dark bands made their appearance before the bright ones, and that at first they were feeble ; consequently the setting up of the typical spectrum seems to have had nothing catastrophic about it.

3. Pickering[2] calls attention to a possible *experimentum crucis* for deciding between the rival theories. He points out that, on the collision hypothesis, the maximum separation of the bright and dark bands should occur at the epoch of maximum brightness, and considers that the comparison of his second and third photographs shows that the separation had increased between 23rd and 24th February—*i.e.*, after the maximum was passed—and consequently the collision hypothesis cannot be true.

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[1] Pickering (Ap. J., xiii., Plate iv.) reproduces the spectra of the two stars.
[2] Ap. J., xiii., p. 277.

Of course his argument falls to the ground if, on the night of 23rd February, the bright bands were absent from the spectrum. It seems to me that the presence of the bright edges of the fine absorptions, recorded by Pickering, may be regarded as doubtful, seeing that Vogel got no trace of them on plates taken under better atmospheric conditions; the latter observer, indeed, is of opinion that a large part of the bright light of the *continuous* spectrum of that night was due to very dense hydrogen. If this be the case, these observations, taken alone, do not furnish the *experimentum crucis*, which will have to be discussed —if at all—on the basis of evidence furnished by the later observations.

4.—Second Stage of the Star's History.

While the typical spectrum was predominant, a number of photographs of the spectrum were taken at the Lick[1] and by Lockyer at South Kensington,[2] which demonstrate the important fact that the wavelengths of the bright hydrogen lines increased progressively in value for a time, while the wavelengths of the dark lines—which were much shortened—remained nearly stationary in magnitude. As Lockyer gives no measures, but merely records the fact that a change did occur, I have put together the scattered measures of the Lick observers in Tables I. and II.

TABLE I.—DARK BANDS.

Line	Normal λ.	Feb. 25.	Mar. 13.	Mar. 18.	Ap. 1.	Ap. 5.
Hζ -	3889	—	3870	3870	—	—
Hε -	3970	3952	3950	3950	—	—
Hδ -	4102	4084	4081	4081	4100	4103
Hγ -	4341	4322	4318	4319	4340	—
Hβ -	4862	4838	4835	4837	—	4861

1 Ap. J., xiv., *loc. cit.*
2 M. N., lxi., App., pp. 15, 21, 37.

TABLE II.—BRIGHT BANDS.

Line.	Normal λ.	Feb. 25.	Mar. 13.	Mar. 18.	Ap. 1.	Ap. 5.
Hζ -	3889	—	3896	3893	—	—
Hε -	3970	—	3974	3975	3971	3972
Hδ -	4102	4094	4105	4108	4102	4102
Hγ -	4341	4335	4342	4347	4341	4342
Hβ -	4862	4853	4863	4869	4864	4861

From these figures we see that the dark bands were at first strongly shifted towards the violet, regaining their normal positions about the beginning of April. The bright lines, too, were at first displaced towards the violet (though less than the dark ones) but by the middle of March this was exchanged for a much smaller displacement towards the red, the lines returning to their normal positions at about the same time as the dark ones. In the April photographs, therefore, the characteristic paired lines are no longer seen, being replaced by broad bright bands in the normal positions, upon which broad hazy absorptions are mesially superposed.

The gaps in the Lick series of photographs are bridged by those taken at South Kensington, as well as at the Yerkes[1] and Stonyhurst[2] observatories. These agree with the Lick photographs in showing that early in March the bright lines were displaced towards the red; while the South Kensington plates show that on 26th February[3] the displacement either way—if it existed—must have been small. On the other hand, the Stonyhurst observations tend to show—in opposition to the Lick observations—that the bright-line displacements remained unchanged from 3rd March to 26th April; it is, however, to be noted that Father Sidgreaves' method of comparison is much better suited to differential measurements than to absolute

1 Ap. J., xiii., pp. 173, 238.

2 M. N., lxii., p. 137.

3 It must not be forgotten that South Kensington is more than ten hours ahead of the Lick Observatory in longitude; a fact of fundamental importance where possibly rapid changes are concerned.

determinations of wavelengths,[1] while Lockyer's direct comparison, on 25th April, between the $H\beta$ and D_3 lines of the *Nova* and those furnished by vacuum tubes, showed the wavelengths on that date to be normal. The Yerkes plates also, to a certain extent, support the Lick results; seven plates taken before 22nd March gave for the wavelength of $H\epsilon$ 3973, six plates subsequent to that date made it 3970. The cumulative evidence is strongly in favor of the accuracy of the Lick determinations of the absolute wavelengths of the bright lines as against those of Stonyhurst.

There still remains a difficulty about the dark lines. The Yerkes and Stonyhurst observers agree in representing them as dying out *in sitû*, and completely disappearing before the end of March, owing possibly to decay in brightness of the continuous spectrum. It is, however, noteworthy (1st) that these bands had each of them several components, the more refrangible of which disappeared first, and (2nd) that Lockyer's simultaneous observation and plotting of the intensity curves for the bright bands shows their maxima as shifting from the violet towards the red side of the bands. In other words, the phenomena, taken as a whole, seem to indicate a gradual coalescing of the bright and dark bands, such as the Lick observers found completed in the beginning of April.

We must not lose sight of the *fine* dark lines due to metallic absorptions, which were examined with special care by the Lick observers. H, K, D_1 and D_2 were present as very narrow, sharp lines, side by side with the broader absorptions of calcium (and sodium ?). These narrow lines were very slightly displaced towards the red, and agreed—within the limits of experimental error—in showing that their source was recedimg from the sun with a speed of approximately 7 kilometres per second, this value being steadily maintained, up to the middle of August,[2] quite independent of the changes in either the heavy absorptions or the bright lines.

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1 A fact of which he himself appears to be fully conscious. It may be added that he considers a good many of his plates to have been over-exposed to such an extent as to unduly broaden the lines. Can this have produced slight displacements of the maxima, which we know were never central?

2 When the last recorded measurements were made.

5.—Bearing of the Second Stage Phenomena on Theory.

1. If we desire to express these phenomena in terms of the collision theory as usually presented, we must proceed as follows :—

The sources of the bright and dark bands possessed, before and during maximum, little or no relative velocity in the line of sight ; two days later they were moving in the same direction—towards the sun—but with different speeds ; a fortnight later they were moving in opposite directions with the enormous relative velocity of 1800 kilometres per second ; and after another fortnight both came to rest. Meanwhile, another body concerned in the phenomena was travelling slowly away from the sun with uniform speed.

I cannot imagine how such a series of performances is possible ; neither collision nor orbital motion fits the facts. But it does seem to me that we have here as strongly marked a case of Pickering's *experimentum crucis* as Pickering himself could desire ; consequently, as far as *Nova Persei* is concerned, we must abandon all such explanations of the spectrum as are based on the assumption of relative motion of different bodies.[1]

2. Wilsing's hypothesis fits the facts very well. The variations, both in magnitude and direction, of the linear displacements are readily explicable as due to pressure changes ; we need only suppose that in the earlier stages the pressure of the incandescent gases was comparatively low, then rapidly increased, remained almost stationary for a time, and finally fell off ; while the fact, attested by all the observers, of the multiplicity of the maxima in both bright and dark bands is readily explained by the very probable supposition of different pressures in different parts of the gaseous layer—pressures, moreover, which can in all cases be estimated in numbers of atmospheres by no means unreasonably great.

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[1] Had the distance between the bright and dark bands remained constant, the deductions would have been different.

6.—Later History of the Star.

On March 19th the *nova* entered upon the third stage of its life history, so far as we can ever know it. The decline in its luminosity, previously very rapid, became extremely slow; but the star now assumed the character of an irregularly periodic variable of rapidly lengthening period, its brightness fluctuating between the 4th and 6th magnitudes.[1] With this variation in brightness was associated a variation in the spectrum, which showed two well-marked types; the first type agreed with the spectrum already described, save that the metallic lines were steadily weakening; the second type differed from the first by the absence, or at least the great relative weakness, of the continuous spectrum, the absence of dark bands, and the gradual emergence of new bright ones. The conditions of change from one spectrum-type to the other were very carefully studied by Sidgreaves[2], who found that it was associated with the absolute brightness of the star, and not with the phase of the light-variation; whenever the magnitude sank below 4·57 the second type appeared, whenever it rose above that value the first type was re-established. Pickering[3] to a certain extent supports this conclusion, as all the second type photographs secured by him, with one exception, were taken at minima; the exception is important, as he records that "the magnitude of the star was the same on 12th and 13th April, but the spectrum was different;" there appears, however, to be a possibility of error on his part, as the light-curves of Lockyer and Child agree in showing that, on both dates, the brightness was near to Sidgreave's critical value, being slightly below it on the 12th and above it on the 13th; the same thing is shown by Rambant's observations[4], which give the magnitude on 12th April as 4·67, and on 13th April as 4·49; on the whole, Sidgreaves seems to be right.

The most noteworthy of the early changes in the spectrum of the second type are the disappearance of the "enhanced" metallic lines and the gradual emergence of characteristic nebular

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1 Lockyer (M.N., lxi., App. p. 59) and Child (M.N. lxi., p. 483) give drawings of the light curve for February, March, and April.

2 *Loc. cit.*

3 Ap. J., xiv., p. 80.

4 M.N., lxi., p. 467.

lines together with those of helium[1]. Among the nebular lines, λ 4363 made its appearance on 22nd March[2], while λ5007 was certainly, and λ3869 possibly, observed on 28th March, the two latter showing themselves as extensions towards the violet of λ5019 and $H\zeta$; on this last point all the observers are in agreement.

By 19th June, owing to the gradual dying out of old lines and development of new ones, the bright-line spectrum had closely approximated to the nebular type[3]; the periodic variations had meanwhile largely died out, though the steady fall in brightness[4] still went on.

The apparent transformation of the star into a nebula was not a surprise, as the same fate had befallen *Nova Aurigae*; owing, however, to the faintness of that object, the process in its case could not be watched, and was only ascertained to have taken place several months afterwards, when the *nova*, for some unknown reason, experienced a great revival in its light. *Nova Cygni* is also known to have undergone a similar change, but in its case—though the measurements were not precise enough to allow any dogmatising on the subject—it seems likely that the two principal nebular lines were present in the spectrum from the first, which in the early spectrum of the other two they certainly were not.[5] It may be added that, as far as the scanty observations go, *Nova Aquilae*[6] appears to have had a similar history to *Novae Aurigae* and *Persei*, a history which we may, therefore, regard as typical of *novae* in general.

By the beginning of August the bright-line spectrum of *Nova Persei* had fully assumed the nebular type, so far as the wavelengths of the lines were concerned; moreover, five nebular lines of unknown origin (among which three, forming a group, of wavelengths 3869, 3968[7] and 4363, are characteristic nebular

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1 Lockyer, M.N., lxi., App., p. 37.

2 Sidgreaves, *loc. cit.*

3 Pickering, Ap. J., xiv., p. 81.

4 Carefully recorded by Gore, M.N., lxii., p. 156.

5 The spectrum of *Nova Cygni* afterwards reverted to the stellar type (Harvard Observatory Annual Report, 1879-80, p. 7) just as those of *Novae Cassiopeiae* and *Coronae* appear to have done. Lockyer asserts (M.N., lxi., App., p. 19) that *Nova Cygni* is now a nebula. What his authority for the statement is I do not know.

6 Pickering, Ap. J., xiii., p. 172.

7 The Lick observers show conclusively that these must not be identified, as they have been in the past, with helium and hydrogen lines.

lines, while $\lambda 5007$ and $\lambda 4959$ are the "chief" nebular lines) together with the helium line $\lambda 4713$, were the strongest lines in the spectrum. Omitting $\lambda 4959$, these appear *alone* in the reproduction[1] of one of Sidgreaves' plates, showing that they were then brighter than the hydrogen lines lying near them.

But a comparison of Sidgreaves' results with those of the Lick observers shows that in some respects the spectrum differed widely from that of a typical nebula. In the first place, the relative intensity of the lines was always altering, and was never that of a typical nebular spectrum. Throughout August and September Sidgreaves[2] and Lockyer[3] found that $\lambda 3869$ was the brightest line in the spectrum, though $\lambda 5007$ is not merely the brightest line in the spectrum of ordinary nebulae, but absolutely dwarfs all others. However, by 6th October, when Sidgreaves brought his series to a close, $H\beta$ and $H\gamma$ were the only surviving hydrogen lines, while $\lambda 5007$ and $\lambda 4959$ had asserted their superiority both over them and over $\lambda 3869$, though not to anything like the normal extent.

Another pronounced difference between the two spectra was the great width and diffuseness of the lines, combined with their complex structure. This showed that the hot gases, though similar in chemical nature to those of nebulae, were in a condition of far greater density. This is further borne out by the fact that, of the helium lines present, every one without exception[4] belongs to Kayser and Runges' "high density" series.

A further difference of a very important character consisted in the continued existence of a continuous spectrum by no means faint for a 6th magnitude star,[5] crossed by the old series of narrow dark lines, the displacements of these lines indicating the same steady but low velocity as they had done early in the year.

The discovery by Ritchey,[6] on 20th September, of a fairly large nebula surrounding the star, falls within the period covered by the later spectrographic researches. In itself a most interesting

1 All the lines are stated by Sidgreaves to be visible on the negative, but obviously those wiped out in the reproduction must be the weakest.

2 *Loc. cit.*

3 P.R.S., lxix., p. 137.

4 Shown by a table given by the Lick observers; *loc. cit.*, p. 290.

5 Sidgreaves, *loc. cit.*, p. 150.

6 Ap. J., xiv., p. 167.

—and quite unexpected—phenomenon, its interest pales in comparison with that of the changes subsequently found to be apparently going on in it; for a photograph taken seven weeks later[1] shows that the nebula was, to all appearance, rapidly expanding in all directions, and that one portion of it, apparently in contact with the star, had greatly increased in luminosity during the the interval, while the rest of the nebula had lost much of its light.[2]

7.—The Theory in the light of the later observations.

In this section there are many points for discussion. I have, as above, distinguished them by numbers.

1. Variations in brightness *per se* are readily explicable on the collision theory by attributing them to successive encounters, as Lockyer and others have pointed out; they are equally easy to explain on the eruption theory, by ascribing them to alternate expansions and contractions of the gaseous matter, consequent upon the checking of the outrush. Of the two hypotheses, the second accounts satisfactorily for the quasi-periodicity of the light-variations, which are pretty much what we should expect if it were true[3]; while unless we are to assume a quasi-periodicity in space of the structure of the invaded system, similar to the quasi-periodicity of the light-curve, it is difficult to see how the theory of successive collisions can be made to fit the facts; a theory which necessitates any such subsidiary hypothesis is, to my mind, self-condemned.

2. Neither theory can be regarded as satisfactorily accounting for the change of spectrum from a stellar to a nebular type.[4]

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1 Ap. J., xiv., p. 293.

2 The question obviously suggests itself—Is the nebular spectrum due to the star or to Ritchey's nebula? The answer, I take it, must be that it is due to the star, otherwise we should find on the plates a narrow stellar spectrum crossed by long bright lines, just as in Huggin's photograph of the combined spectrum of the Orion nebula and the trapezium stars; but nothing of the kind appears to have been observed. Besides, the nebula is too faint an object to give *any* spectrum in the time allotted to the exposures by the spectrographers.

3 The light curve closely resembles the displacement curve of a damped vibrating system.

4 Lockyer's meteoritic hypothesis might have done so, had the spectrum passed through some or all of the stages characterised by him as Polarian, Aldebarian, and Antarian (M.N., lxi., App., p. 19) before assuming the nebular type; but this, apparently, it failed to do.

Sidgreaves' work shows that the change from the first to the second type—which probably marked the inception of the nebular type—was pretty sharply associated with a definite level of temperature; probably, therefore, the assumption of the complete nebular type corresponds to a lower temperature level. Why a nebular spectrum should be associated with relatively low temperature is quite another question; possibly the two rival theories are not concerned in the answer to it, which may be a matter of chemistry alone. Too much stress must not be laid on the coincidence in point of time between the periodic variation of light and the appearance of the nebular lines, seeing that in the case of *Nova Aurigae* the variable period came to an end long before any nebular lines showed themselves; moreover, in the case of η*Argûs* the variable period *preceded* the maximum epoch, while in that of *Nova Cygni* there is no evidence for its existence.

3. The discovery of a nebula surrounding the star lends plausibility, at first sight, to the hypothesis of successive collisions, and was naturally claimed in support of it; but it seems to me that the details of Ritchey's investigation tell in a different direction. The rapid brightening (alluded to in §6) of the patch of nebula in contact with the star might of course have resulted from a new collision, the evidence of which reached us between 20th September and 11th November; but in that case we might reasonably expect to find that a rise in luminosity of the star occurred somewhere between these epochs. Nothing of the kind was, as a matter of fact, observed.

4. We must now consider the unique problem offered by the observed expansion of the nebula.

Taking Ritchey's measurements of the distances between the star and the principal nebular condensations, we are led by simple inspection to conclude that the rate of expansion was the same all over the nebula, these distances increasing by about one-seventh of their total amount in fifty-four days. This is well shown in Table III., in the first column of which we have the letters used by Ritchey to designate the principal condensations, in the second and fourth the angular distances of these from the star on two dates, expressed in seconds of arc, in the third the quotients obtained on dividing the numbers in the second column by 7, and in the fifth those obtained on dividing the numbers in the fourth column by 8.[1]

TABLE III.

Condensation.	Sep. 20.	Nos. of previous column ÷ by 7.	Nov. 13.	Nos. of previous columns ÷ by 8.
a	430″	61½	497″	62
b	374″	53½	420″	52½
c	346″	49½	381″	47½
d	350″	50	395″	49½
e	371″	53	427″	53½
f	366″	52	378″	47

The agreement between the third and fifth columns of Table III. is very striking,[2] and fully warrants us in assuming that the rate of expansion at all parts is pretty much the same. The difficulty lies in the interpretation of this fact, not in its establishment.

Kapteyn[3] and Wilson[4] have independently arrived at the conclusion that what we see is not a motion of the nebulous matter, but the light of the outburst reflected successively from more and more distant parts of a pre-existing nebula; Wilson has computed the distance of the *Nova* on this assumption, and finds it to be about 250 light-years. The hypothesis accounts very well for the agreement between the rates of expansion at different points, and obviates the ascription of enormous velocities to masses of matter; nevertheless it appears to me that there are serious difficulties in the way of its acceptance.

In the first place, the apparent rate of expansion was too slow to be consistent with it; the time interval from 23rd Feb. to 13th Nov. is 263 days, that from 23rd Feb. to 20th Sept. is 209

[1] Ritchey's method of measuring these distances on enlarged photographs, by means of a scale, is obviously better suited to the determination of ratios than of differences; hence the method of comparison adopted above, which uses the actual measurements, and neglects the differences tabulated by Ritchey.

[2] The only discrepancy of any real importance is that furnished by condensation *f*.

[3] Astr. Nach., No. 3756.

[4] Nature, 2nd Jan., 1902.

days; had we, however, used 263 and 209 (or 5 and 4) as divisors in drawing up Table III., instead of 8 and 7, the discrepancies between the third and fifth columns would have been serious.[1] Another difficulty is the brightening up of the central patch of nebula, already mentioned as an obstacle in the way of the collision theory; to explain it on Kapteyn and Wilson's hypothesis we should certainly have to assume an increase of the star's luminosity at a late stage of its history, which, as we have seen, probably did not occur.

If we are prepared to go the length of supposing that the substances forming the nebula were ejected from the star, we shall find that this hypothesis accounts, better than the others, for the facts above-mentioned. We may regard it as practically certain that the rate of radial expansion of emitted gases would diminish as the volume increased, hence the objections to Kapteyn and Wilson's theory, based on Table III., do not apply to this one, but rather tend to support it. Again, the brightening of the central patch of nebula furnishes no difficulty to the ejection hypothesis; it may well be that the outflow from the star, though immensely slowed down, is still going on—possibly is intermittent; but intermittence in the outflow does not demand the same variation in luminosity as a new collision or an actual revival of light, indeed the intermittent outflow would probably hold the light-variations in check. In suggesting this alternative hypothesis, I am fully conscious of its extravagance; this, however, is scarcely as great as it looks, on the contrary the enormously rapid outgrowth of the tails of bright comets—which are probably formed under the action of forces immeasurably weaker than those at work in a *Nova*—seems to give it some degree of plausibility.

The question can hardly be settled until the star has been examined for parallax. If this prove to be measurable, Kapteyn and Wilson's hypothesis would be at once disproved; while the ejection hypothesis would be somewhat strengthened, since the

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[1] Kapteyn and Wilson both suggest that the discrepancy in the values of the star's distance furnished by the earlier and later photographs *may* be due to the inclination of the nebula to the line of sight; but this can, I think, hardly hold good in the case of a body whose greatest angular diameter is only a few minutes of arc. However that may be, the objection stated above is a grave one.

velocities it demands would then be of the same order of magnitude as those concerned in the formation of comets' tails. If, however, the parallax be too small for measurement—as has been the case with all *Novae* yet investigated—the ejection hypothesis would be discredited, while the other grave objections to that of Kapteyn and Wilson would still hold good.

8.—Conclusion. The Origin of Temporary Stars.

The evidence collected in this paper does, as I think, disprove the theory which attributes the spectroscopic phenomena to the relative motion of different bodies, and shows them to be well explained by ascribing them to disturbances in a gaseous mass. That being so, we must go further, and admit that the spectroscope throws no light on the origin of *novae;* since it gives us no inkling of the cause which impelled the star to suddenly rise enormously in temperature and then clothe itself with fiery vapours.

The origin of the *novae* must therefore be discussed from considerations other than spectroscopic. My own view is that nothing we know of but collision is competent to originate a *nova;* the only other assignable cause is chemical action within the star, and I do not see how to reconcile a chemical hypothesis with the facts, seeing that the star attained a temperature such as probably no compound could experience without decomposition. This conviction has been materially strengthened by a conversation with Professor Lyle, who gives it as his opinion that—even in the most favourable case—the generation of heat by chemical action alone could not have been rapid enough to account for the enormously sudden rise in luminosity.[1]

The final conclusion is, therefore, the following:—

A collision—the direct evidence of which is not forthcoming—took place in the heavens, resulting in a great development of heat in the colliding masses; this was followed by a tremendous outpouring, in all directions, of incandescent gases. The subse-

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[1] Williams's photographs of the region in the heavens in which the outbreak occurred show (M.N., lxi., p. 337) that the star was below the 12th magnitude on 20th February; hence its light must have increased *at least* 5000 times in less than 28 hours.

quent history of the ejected gases is disclosed to us by the variations of the bright and dark line spectra, that of the main body by the dying down of the continuous spectrum. These combine to show that the star has throughout retained the general character of an Orion—or at least of a Sirian—star, while the mass of gas surrounding it now differs from an ordinary nebula mainly in its state of aggregation. The exact relation between the outbreak and the changes going on in Ritchey's nebula is a problem for the future to solve.

Art. II.—*Further Descriptions of the Tertiary Polyzoa of Victoria.—Part VIII.*

By C. M. MAPLESTONE.

(With Plates I. and II.).

[Read 3rd April, 1902.]

Catenariopsis morningtoniensis, Map. (Pl. I., Fig. 1).

This species I described in Part II. of these papers (P.R.S.V., vol. xii., pt. 1, p. 11), from a specimen of a single free zooecium from Mornington, and I stated there was nothing to show the character of the zoarial growth but that it was probable it might originate from a creeping stolon like Ætea. I have found a fragment of a univalve shell from the Gellibrand River deposit with several groups of zooecia upon it, they are adherent like those of Hippothoa; the zooecia are in single series; they do not grow from the median line, but from one side, near the distal end. In only one of the zooecia is the thyrostome perfectly preserved; it shows, as I supposed, a structure of a similar character to that of Steganoporella; the "descending plate" mentioned in the description divides the zooecial cavity into two chambers in a somewhat similar manner to the "cryptocyst" of that genus, leaving an "opesiule" on each side. A figure is given showing the zooecium with the perfectly preserved thyrostome and the proximal part of one growing out from it. The zooecium is misshapen and unsymmetrical, owing to the presence of some cells of an encrusting zoarium of an indefinable species interfering with it.

Smittia macgillivrayi, nov. nom. S. transversa, McG.

Dr. MacGillivray, in his Monograph of the Tertiary Polyzoa of Victoria (T.R.S.V., vol. iv., p. 92) describes a species of Smittia as S. transversa, having apparently overlooked the fact that

Busk described a species under the same name in the report of the "Challenger" Polyzoa (p. 152, pl. xviii., fig. 7), which is quite different; consequently a new name is required for S. transversa, McG., and I have much pleasure in giving it the name of S. macgillivrayi, in honor of Dr. MacGillivray and in recognition of his excellent work in both recent and fossil Polyzoa.

Microporella marginata, n. sp. (Pl. I., Fig. 2).

Zoarium cylindrical. Zooecia oblong, with raised margins, perforated with a marginal row of small pores and also scattered pores on the surface. Thyrostome arched above, nearly straight proximally, with a crescentic pore below it.

Locality.—Spring Creek (T. S. Hall).

A single specimen. The raised margins are uncommon in this genus.

Smittia centralis, var. laevigata, Waters. (Pl. I., Fig. 3).

Mr. Waters, in Q.J.G.S., vol. xxxvii., p. 337, describes S. centralis, and on the same page describes a variety, "laevigata," which differs from the type species in having only a few elongated pores near the edge instead of a double row, and he gives a figure of it (pl. xiv., figs. 7 and 8) but none of the type species.

I have found specimens of var. laevigata in the Mitchell River deposits (I have not seen the type species) which bear ooecia and which have the peristomes perfect. The peristome in the type is said to be "very much raised and projecting with a large pore (probably avicularian) immediately below the orifice; peristome transversely oval;" that of var. laevigata is said to be "less well preserved." The specimens found by me are undoubtedly those of var. laevigata; the peristome is perfect, it is much raised and projecting, but the lower lip is nearly straight, with a very narrow spout or sinus, and there is no pore immediately below the orifice. In some cases the spout or sinus is closed at the top, and this would lead to the supposition that the "pore" spoken of by Mr. Waters was really a closed sinus. The ooecia are rounded, but nearly flat in front, partially immersed and adherent upon the zooecium above. Owing to the primary orifice or thyrostome being hidden by the peristome no internal denticles can be seen, and there are no avicularia upon the zooecia, so I consider it somewhat doubtful if this species should be placed in Smittia.

I would here wish to observe that owing to the very unsatisfactory state of the classification of the Lepralioid or Escharine group of the Cheilostomata it is impossible, until a thorough revision be made, to correctly and definitely place some of the species described in this paper, but I have tentatively placed them in the genera to which I consider they should be assigned.

Porella rhomboidalis, n. sp. (Pl. I., Fig. 4).

Zoarium encrusting. Zooecia rhomboidal, with very highly raised margins; nearly flat, with scattered pores over the surface except on a smooth area below the thyrostome. Thyrostome orbicular, with a very wide sinus proximally.

Locality.—Mornington (T. S. Hall).

The greater portion of the only specimen found is figured. It is a very distinct form, the very highly raised margins being very characteristic. The thyrostome is of a very similar form to Porella dennanti described below, therefore I place it in Porella although there is no avicularium within the sinus. Some of the "pores" do not pass through the cell wall, and show as slight cavities only.

Porella areolata, n. sp. (Pl. I., Fig. 5).

Zoarium encrusting. Zooecia irregularly hexagonal; margins narrow; surface somewhat depressed, with large irregularly shaped areolae round the margin which extend sometimes to the centre. Thyrostome orbicular, with a large rounded sinus, within which is a small avicularium.

Locality.—Spring Creek (T. S. Hall).

The very large and irregular areolae are peculiar to this species.

Porella otwayensis, n. sp. (Pl. I., Fig. 6).

Zooecia small, elongated ; surface covered with pores. Thyrostome orbicular, with a small sinus below, in which is a small avicularium ; margin thickened and raised. Ooecia globular, subimmersed, with a small circular depressed area in front minutely punctured.

Locality.—Cape Otway (J. Dennant).

This is a curious little species. The surface is covered with large pores, the dividing line between the zooecia is scarcely discernible, the thyrostome is thickened and raised, more especially in the fertile zooecia and in them with the ooecia form a pyriform elevation. The ooecia have a round perforated area and are curiously like those of Shizoporella ambita Waters.

Porella dennanti, n. sp. (Pl. I., Fig. 7).

Zoarium encrusting. Zooecia obscurely hexagonal, flat, with a more or less regular row of large pores round the margin ; margins slightly raised. Thyrostome orbicular, with a wide sinus in the lower part, within which is a small avicularium. Ooecia large, globular and partly immersed.

Locality.—Mitchell River (J. Dennant).

A single specimen, but clearly distinct from any described species ; the nearest to it is Porella ordinata (Smittia ordinata, McG.).

Mucronella proboscoides, n. sp. (Pl. I., Fig. 8).

Zooecia very large, elongated, quadrate ; surface nearly flat, covered with small pores. Thyrostome orbicular, with a broad square denticle (lyrula) in the middle of proximal margin and a small pointed one (cardella) on each side. An enormous elongated mucro or rostrum immediately below the thyrostome, projecting at nearly a right angle to the surface.

Locality.—Griffins, Moorabool (T. S. Hall).

A single specimen consisting of one zooecium only. In the front view the enormous rostrum, or mucro, hides the proximal part of the thyrostome, but by tilting it longitudinally at an angle of 45° it is seen as shown at Fig. 8*a*. The true character of the rostrum can only be seen when viewing it from the side. and Fig. 8*b* shows its appearance in this position; it is only magnified about half as much as the other figures. There are traces of a few spines on the distal margin of the thyrostome.

Mucronella conica, n. sp. (Pl. I., Fig. 9).

Zooecia elongated; surface convex, covered with rather large pores. Thyrostome orbicular, with a pointed median denticle and two lateral ones. Peristome thickened and developed proximally into a large thick, obtuse, conical mucro.

Locality.—Filter Quarries (T. S. Hall).

This is allied to M. proboscoides, but the zooecia are smaller, convex and perforated with large pores; the peristome is thickened, the conical mucro is much broader in proportion to its length, the median denticle in the throstome is small and acute (Fig. 9*a*), and there are no traces of spines.

Porella angustata, n. sp. (Pl. I., Fig. 10).

Zoarium encrusting. Zooecia very small and narrow, smooth, with raised margins, two pores near the base of the cell. Thyrostome orbicular, with a small acute mucro on the proximal margin, and a small avicularium below it on or within the peristome, which is raised in that part.

Locality.—Mitchell River (J. Dennant).

A single specimen. This is one of those species which are difficult to place generically; the mucro would place it in Mucronella, but the small avicularium being within the external margin of the peristome, I place it in Porella.

Mucronella irregularis, n. sp. (Pl. II., Fig. 11).

Zoarium encrusting. Zooecia irregular in shape; surface rugose, with raised ridges in places. Thyrostome transversely elliptical, with a small pointed mucro in the proximal margin, with a small pore below it. One or two small elliptical avicularia on the surface, with a denticle on each side.

Locality.—Mitchell River (J. Dennant).

A single specimen not very well preserved (the front wall is apparently broken away in places) but easily distinguished by the shape of the thyrostome and avicularia. The ridges on the surface are very irregular, and do not appear to indicate the margins of the zooecia. The small pore below the proximal margin of the thyrostome would seem to place this in Porina, but I do not think it extends through the cell-wall.

Mucronella airensis, n. sp. (Pl. II., Fig. 12).

Zoaria ligulate, with zooecia on both sides. Zooecia irregular in shape, raised towards the distal end; surface finely granulated. Thyrostome orbicular, with a raised peristome; a very small mucro in the proximal part of the margin. A small, elongated, avicularium on the side of the raised peristome; also several small broadly-oval ones scattered over the surface.

Locality.—Aire Coastal Beds (T. S. Hall).

The elevation of the peristome, and the surrounding portion of the surface is very marked; the small, oval avicularia have half the area covered.

Mucronella personata, n. sp. (Pl. II., Fig. 13).

Zoarium encrusting. Zooecia elongate, quadrate, with a single or double row of pores round the margin; margin slightly raised. Thyrostome suborbicular or unguiform, with a curved flat mucro in the proximal margin; peristome narrow, raised; a small, oval avicularium on each side of the thyrostome. Ooecia orbicular, immersed, smooth, with a rounded, shallow pit in front of each side of a slightly-raised carina.

Locality.—Aire River (A. E. Kitson).

This is a very well-marked species; the mucro is a simple curved extension of the wall of the zooecium, and were it not so prominent it would probably be considered to be a Lepralia. The dorsal surface has a round perforation near the distal end, which is visible through the opening of the thyrostome.

Trigonopora, nov. gen.

Zooecia elongated, quadrate. Thyrostome inversely subtriangular, curved distally, with a mucro in the proximal angle. Sides with a mucro at the distal ends, forming a small, circular channel or opening on each side.

The leading characteristic of this genus is the form of the thyrostome.

Trigonopora vermicularis, n. sp. (Pl. II., Fig. 14).

Zoarium encrusting. Zooecia quincuncial, elongated, quadrate, but broader distally. Thyrostome inversely subtriangular, curved distally, with a small mucro in the proximal angle; sides with a mucro on the distal ends, forming a small circular channel or opening on each side. Surface with vermiform markings, at the end of some of which are pores.

Locality.—Cape Otway (J. Dennant).

I at first assigned this species to Mucronella on account of the mucro in the proximal part of the thyrostome, but the character of the whole thyrostome is so peculiar that I have formed a new genus for its reception, as it cannot be included in any existing genus; the distal part is a simple curve in the median portion, but at each end the margin goes round in a small circular, almost closed, curve, and then turns sharply proximally forming a mucro on each side in so doing, and in the rounded proximal angle there is a small mucro.

Porina tuberculosa, n. sp. (Pl. II., Fig. 15).

Zoaria cylindrical. Zooecia in longitudinal series, large, elongated, quadrate, separated laterally by distinct, raised margins. Surface covered with scattered tubercles. Thyrostome transversely elliptical; peristome elevated, thin, with a very large elliptical opening below it, the upper margin of which is curved and overlaps the opening. A sessile avicularium on each side of the thyrostome, and equally elevated with it.

Locality.—Gellibrand River (A. E. Kitson).

This is somewhat similar to Porina cribraria, McG. It differs, however, from that species in the zooecia being much longer, and in having the surface covered with tubercles instead of "rounded deep pits," and the large peristomial pore is not simply "rounded," but is transversely elliptical, with a curved over-arching upper margin or lip; a side view of it is shown on the left side of the figure near the bottom of the upper left-hand zooecium, and it is clearly quite different from that of P. cribraria.

Lagenipora morningtoniensis, n. sp. (Pl. II., Fig. 16).

Zooecia ventricose, surface granulated, with median or lateral ribs. Thyrostome suborbicular; peristome elevated distally, and laterally forming an irregularly trilabiate orifice; a round avicularium at the end of a subtubular process, adherent to the wall of the zooecium.

Locality.—Mornington (T. S. Hall).

The shape of the zooecium and the irregularly elevated peristome are very similar to L. simplex, McG.

Lagenipora airensis, n. sp. (Pl. II., Fig. 17.)

Zooecia ventricose; a slightly-raised scutiform area below the thyrostome, radially divided into subtriangular elevations, below which are sometimes one or two ribs enclosing a subtriangular area. Thyrostome orbicular or horseshoe shaped with a sinus at each proximal angle; peristome elevated distally, and laterally, forming a trilabiate orifice.

Localities.—Aire Costal Beds (Hall and Pritchard); Mitchell River (J. Dennant).

This is a remarkable form, and in some respects resembles L. morningtoniensis, but it is much larger; the peristome rises round the thyrostome in collar-like elevations, distally and laterally; there are one or more ribs on the front of the cell. I have several specimens, and they show considerable variation owing, chiefly, to the difference in the zoarial growth. The specimens from which the figures are taken are from the Aire Coastal Beds, they are glomerate, and were chosen for illustration because the form of the thyrostome and peristome are better preserved than in those which are encrusting; in the latter the zooecia are quite distinct from one another, and they have two ribs diverging from the bottom of the scutiform area to the base of the zooecia, and the triangular space enclosed by them is slightly concave. The structure of the scutiform area is very similar to that of the front wall of Membraniporella or of some Catenicellidae.

Lekythopora mooraboolensis, n. sp. (Pl. II., Fig. 18).

Zoarium glomerate. Zooecia orbicular or subconical; surface granulated. Thyrostome with a long tubular peristome, with a small tubular avicularian process adherent to it; aperture of peristome oval with a small mucro (?) projecting inwards. Primary orifice too far down the peristomial tube to be visible.

Locality.—Moorabool (T. S. Hall).

A single specimen of three or four zooecia. The granulated surface of the zooecia is yellowish, owing to iron stain, but the peristomial tube is white and semitranslucent. The mucro seen in the aperture of the peristome is probably the projecting side of the avicularian tube.

Lekythopora kitsoni, n. sp. (Pl. II., Fig. 19).

Zoarium ligulate, with zooecia on both faces. Zooecia flask-shaped, with a circular depressed area in front. Thyrostome small, orbicular, with a thickened rim or margin.

Localities.—Waurn Ponds (T. S. Hall); Darriman (A. E. Kitson).

This species is plentiful in the Waurn Ponds deposit, and I had assumed it was peculiar to it, but recently I found a few specimens in the Darriman deposit. All of them present a granular or subcrystalline appearance under the microscope, rendering it very difficult to be sure of their structure, but it is evidently a Lekythopora. Many of the specimens are somewhat worn, and look something like Adeona clavata in a bad state of preservation, and probably it has been taken for that species.

Notwithstanding that there may be some doubt as to the correctness of the diagnosis of this species, owing to its peculiar state of preservation, I have described it because its presence in the Waurn Ponds and Darriman deposits, and in no other, indicates that these deposits belong to the same horizon.

(?) Porella minutissima, n. sp. (Pl. II., Fig. 20).

Zoarium encrusting. Zooecia very small, undefined; surface covered with scattered mamillae. Thyrostome with a highly-raised subtubular peristome, on the proximal part of which and adherent to it is a tubular process, probably avicularian.

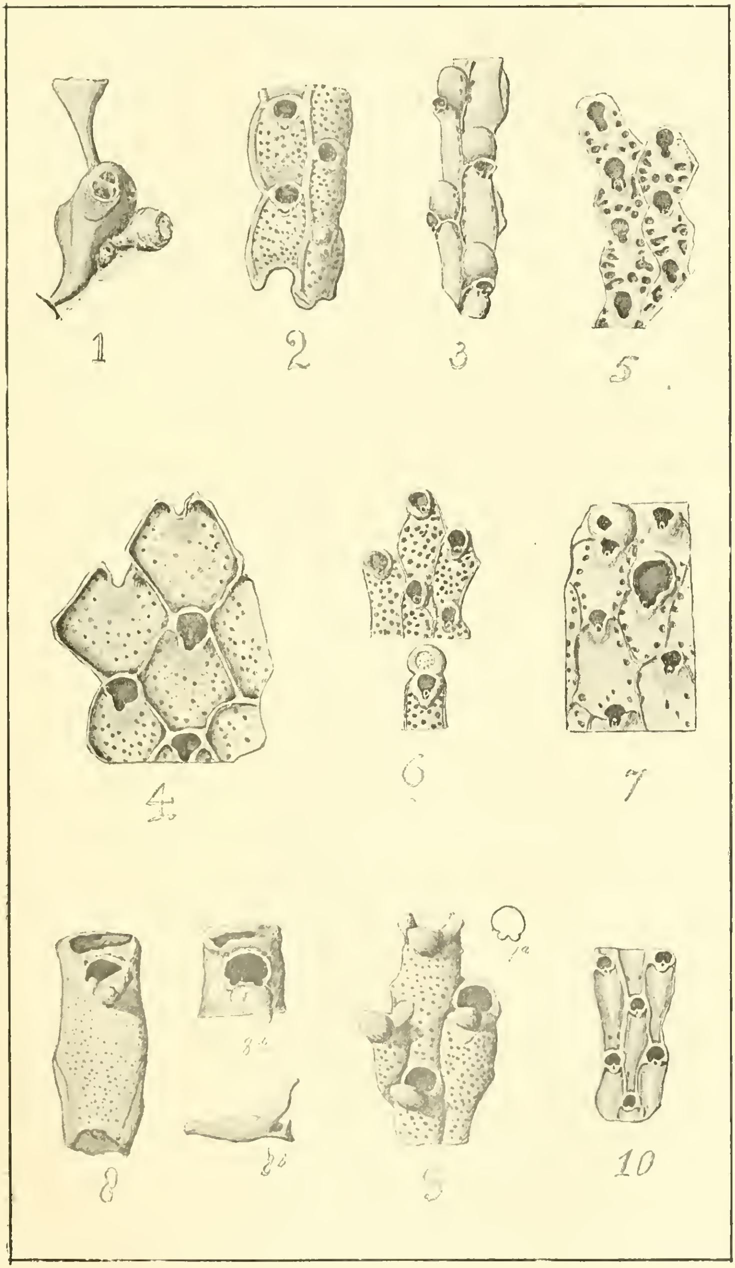
Locality.—Mitchell River (J. Dennant).

This is a single specimen and evidently grew round a small cylindrical alga. It is a very small celled species; the figure is magnified a little more than double the extent of the others. Just above the thyrostome on one side (shown in two of the zooecia figured) there is a small circular opening divided into sectors by radiating ribs, and most of the mamillae have a small perforation in the centre. It is a very puzzling species, and its position is very doubtful, as the primary aperture of the thyrostome cannot be seen; indeed, I had given up the idea of describing it, but I do so now to bring under notice the very peculiar circular opening near the thyrostome, the like of which I have never seen in a similar position in any species of polyzoa.

EXPLANATION OF FIGURES.

Plate I.

Fig. 1. Catenariopsis morningtoniensis.
,, 2. Microporella marginata.
,, 3. Smittia centralis, var. laevigata.
,, 4. Porella rhomboidalis.
,, 5. Porella areolata.
,, 6. Porella otwayensis.
,, 7. Porella dennanti.
,, 8. Mucronella proboscoides.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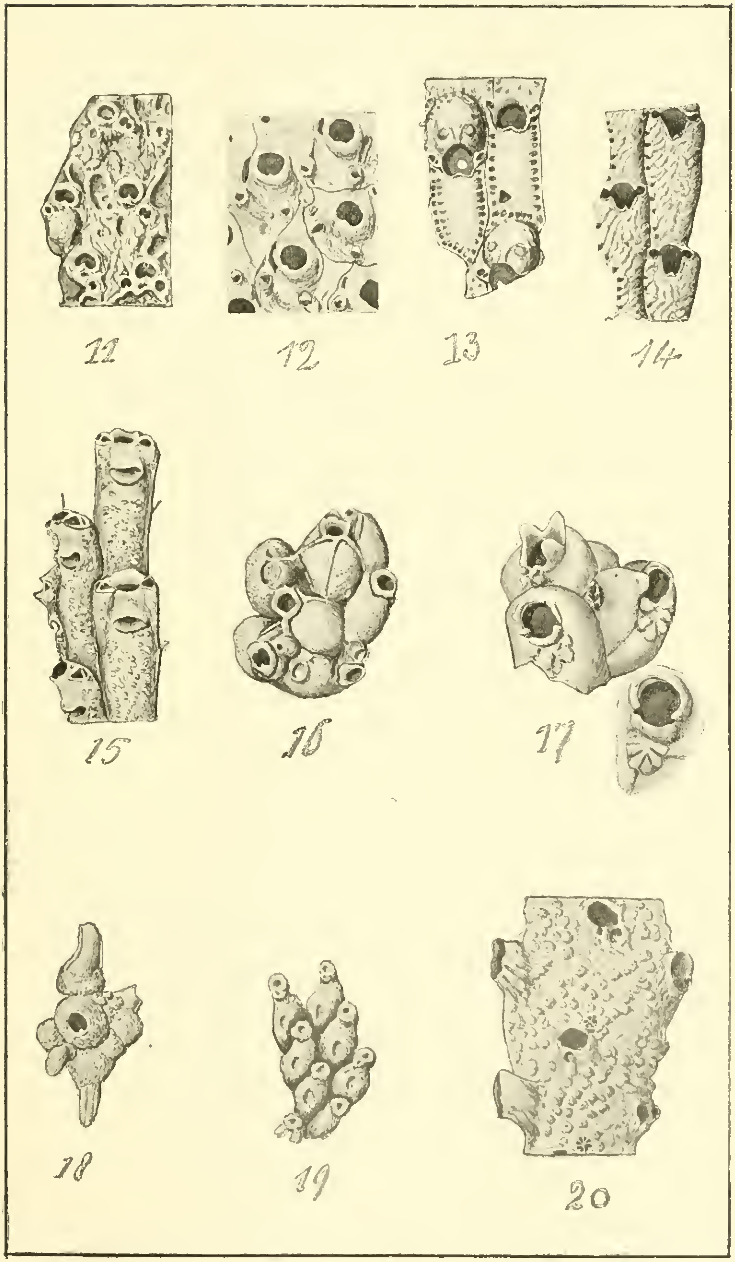
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Fig. 8*a*. the same, thyrostome.
" 8*b*. the same, side view of zooecium.
" 9. Mucronella conica.
" 9*a*. Mucronella thyrostome.

PLATE II.

" 10. Porella angustata.
" 11. Mucronella irregularis.
" 12. Mucronella airensis.
" 13. Mucronella personata.
" 14. Trigonopora vermicularis.
" 15. Porina tuberculata.
" 16. Lagenipora morningtoniensis.
" 17. Lagenipora airensis.
" 18. Lekythopora mooraboolensis.
" 19. Lekythopora kitsoni.
" 20. (?) Porella minutissima.

Figs. 1 to 19 magnified about 12 diameters. Fig. 20 about 25.

Art. III.—*On the Occurrence of Glacial Beds at Wynyard, near Table Cape, Tasmania.*

By A. E. KITSON, F.G.S.

(With Plate III.).

[Read 3rd April, 1902.]

The beds referred to occur on the north-west coast of Tasmania, at and near the township of Wynyard, as may be seen from the accompanying map. This is based on the map of Tasmania, compiled in the Surveyor-General's Department, Hobart, and published in 1899. Scale, 8 miles to 1 inch.

The only papers on the geology of the district that I have seen are those specified hereunder.[1]

In the locality under review the beds extend along the coast from a point about midway between Table Cape and the mouth of the Inglis River at Wynyard, to some little distance past the mouth of Seabrook Creek, which enters Bass Strait about 3 miles east of the Inglis River. The whole of the outcrops of the beds east of the Inglis occur at, or little above, sea level, and for the greater portion of the distance can be seen only at low tide. The same remarks apply to the area west of the Inglis; but here the presence of cliffs along the shore line enables the beds to be seen in section, though only to the depth of a few feet.

On the western side of the Inglis, near its mouth, bluish-grey shales with occasional pebbles are observable at low tide. They

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1 T. Stephens, M.A.: Remarks on the Geological Structure of Part of the North Coast of Tasmania, with special reference to the Tertiary Marine Beds near Table Cape—Proc. Roy. Soc. Tasmania, 1869. R. M. Johnston, F.L.S.: Further Notes on the Tertiary Marine Beds of Table Cape—Proc. Roy. Soc. Tasmania, 1876. R. A. Montgomery, M.A.: Report on the Mineral Fields of the Gawler River, Penguin, Dial Range, Mount Housetop, Table Cape, Cam River, and portion of the Arthur River Districts—Report of Secretary for Mines, Tasmania, 1895-6. G. A. Waller: Report on the recent discovery of Cannel Coal in the Parish of Preolenna, and upon the New Victory Mine, near Arthur River—Report Dept. of Mines, Tasmania, 1901-2.

have a low dip of 4° to 7° from about south-west to west. These shales show rather pretty curves in the beds, and can be traced to the adjacent cliff, where a bed of conglomerate of varying thickness up to 6 feet overlies them on the eastern side of the point, which has been called Sandy Cove Bluff by Mr. Johnston. This bluff, about 180 feet high, consists of a series of fossiliferous beds of limestone of Eocene age capped by basalt. Mr. Johnston has illustrated it by section in the paper quoted.

The Eocenes are divided by Mr. Johnston into two convenient divisions; the lower, the Crassatella bed, a few feet only in thickness; the upper, the Turritella bed, 78 feet thick. Overlying this is a mass of volcanic rock (basalt, etc.) over 80 feet in thickness. The Turritella bed is of special interest as it contains leaves of dicotyledonous plants as well as marine shells, and in it, also, has been found the oldest known Australian marsupial, which Professor Spencer, M.A., F.R.S., has described[1] under the name of Wynyardia bassiana.

Further north-west, on the opposite side of Sandy Cove, the beds appear in better section, and consist of boulder clay merging into conglomerate. Overlying this is a conglomerate of Eocene age derived from the glacial beds. This conglomerate contains numerous remains of mollusca, corals, etc. It varies up to about 4 feet in thickness, and clearly indicates the littoral nature of the beds. This Eocene conglomerate can also been seen in the cliff at Sandy Cove Bluff, but there it occurs only in very small patches.

Nearer Table Cape, in Freestone Cove, the till passes upwards into a fine-grained, greenish-grey argillaceous sandstone, with few pebbles; and some distance seawards a patch of this rock forms an islet, standing several feet above the general level of the sea floor.

The surface of the glacial beds on which the marine Eocenes have been laid down is rather uneven, and consequently the Eocenes come to sea level, and again rise above it before finally disappearing beneath it about one mile to the north-west of Sandy Cove, where the basalt of Table Cape forms the cliffs.

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[1] Professor W. Baldwin Spencer, M.A.: A Description of Wynyardia bassiana, a Fossil Marsupial from the Tertiary Beds of Table Cape, Tasmania—Proc. Zool. Soc. London, 1900, pp. 776-795.

The till consists of a matrix of tough mud, with embedded pebbles, blocks, and masses of various rocks in greater or less number.

In general appearance it has a strong resemblance to the glacial beds near Bacchus Marsh, Victoria, described[1] in various publications by Professor David, B.A., F.R.S., and Messrs. E. J. Dunn, F.G.S., G. Officer, B.Sc., L. Balfour, B.A., E. G. Hogg, M.A., Geo. Sweet, F.G.S., and C. C. Brittlebank, and to those recently described[2] by Professor E. G. Hogg, M.A., as occurring at Little Peppermint Bay, south of Hobart, Tasmania. Both of these occurrences are regarded as of Permo-Carboniferous age.

The included pebbles in the Wynyard beds are rounded, sub-angular, and angular in shape. Many of them, especially those of a softer nature, show distinct striae. They comprise various rocks, such as indurated and normal sandstones, quartzites, lydianite, banded and ordinary jaspers, quartz of several colors, felsites and mica schists of various colors and kinds, spotted mica schist, quartz schist, indurated fine conglomerates, lode quartz showing included pieces of slate, fine-grained grey and red granitoid rocks, argillaceous and siliceous slates and shales, hornstones, coarse grey aplite, agates, chalcedony, fossiliferous and non-fossiliferous crystalline limestone, and several varieties of igneous rocks of dark color and fine and medium texture.

E. J. Dunn, F.G.S.: Notes on the Occurrence of Glaciated Pebbles and Boulders in the so-called Mesozoic Conglomerate of Victoria—Proc. Roy. Soc. Victoria, vol. xxiv., pt. i.; The Glacial Conglomerates of Victoria—Aus. Ass. Advt. Science, Melbourne, 1890. Graham Officer, B.Sc., and Lewis Balfour, B.A.: Preliminary Account of the Glacial Deposits of Bacchus Marsh—Proc. Roy. Soc. Victoria, vol. v., n.s., 1892; Further Note on the Glacial Deposits of Bacchus Marsh—Proc. Roy. Soc. Victoria, vol. vi., n.s., 1893. Geo. Sweet, F.G.S., and C. C. Brittlebank: The Glacial Deposits of Bacchus Marsh District—Aus. Ass. Advt. Science, Adelaide, 1893, vol. v. The Glacial Deposits of Bacchus Marsh, G. Officer, L. Balfour, and E. G. Hogg, The Glacial Geology of Coimaidai—Aus. Ass. Advt. Science, Brisbane, 1895, vol. vi. Professor T. W. Edgeworth David, B.A., F.G.S.: Evidences of Glacial Action in Australia in Permo-Carboniferous Time—Quart. Jour. Geol. Soc., May, 1896, vol. lii., part ii. C. C. Brittlebank, Geo. Sweet, F.G.S., and Professor T. W. Edgeworth David, B.A., F.G.S.: Further Evidence as to the Glacial Action in the Bacchus Marsh District, Victoria—Aus. Ass. Advt. Science, Sydney, 1898, vol. vii. Graham Officer, B.Sc., and Evelyn G. Hogg, M.A.: The Geology of Coimaidai, Part i.—Proc. Roy. Soc. Victoria, vol. x., n.s., pt. i., 1897; The Geology of Coimaidai, Part ii.—Proc. Roy. Soc. Victoria, vol. x., n.s., pt. ii., 1897.

2 Professor E. G. Hogg, M.A.: The Glacial Beds of Little Peppermint Bay, Tasmania —Report of Secretary for Mines, Tasmania, 1900-1, and Proc. Roy. Soc. Tasmania, 1902.

These are like dense basalt, and show clusters of dark-colored crystals, probably augite.

The included rocks vary in size from mere gravel to blocks of granite, quartzite, and sandstone, several tons in weight. One of these granite blocks may be seen embedded in fine sediment in Freestone Cove, and large blocks of highly-jointed quartzite occur in the uppermost portion of the bed on the north-eastern point of Sandy Cove Bluff. Small pieces of these quartzites are observable in the immediately-overlying Eocene derived conglomerate. Veins of calcite up to several inches in thickness traverse the glacial beds in various places.

Fossils have been found in some of the pebbles of the glacial conglomerate. They have heen described[1] by Mr. Robt. Etheridge, jun., as Silurian types, comprising Pentamerus tasmaniensis, R. Etheridge, fils; Spirifer, 3 spp.; Strophomena (?); Tentaculites; Orthis; and Atrypa (?). No fossils, however, of contemporaneous age have been noticed in the glacial deposits, as has already been pointed out by Messrs. Stephens and Montgomery.

Mr. Stephens has described[2] these Wynyard conglomerates as follows:—"The horizontally bedded conglomerates and breccias of very variable character and uncertain age which occur at intervals between Port Sorell and Table Cape appear to come next in geological order, but may belong to the last-named series of rocks" (the Mersey Coal Measures of Permo-Carboniferous age). " . . . At the mouth of the Inglis . . . . large angular blocks of granite and porphyry, the former sometimes weighing several tons, together with rolled pebbles of many of the Primary rocks, are here seen embedded in a fine-grained mudstone, this being evidently derived from the denudation of some of the softer slates, and deposited as mud on the margin, or in the bed of some ancient river or estuary, which occupied a basin with nearly the same principal boundaries as the modern Inglis. These massive blocks of granite and other rocks, which are not now found *in situ* within several miles of their present position, I consider to

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1 R. Etheridge, jun.: Description of Remains of Trilobites from the Lower Silurian Rocks of the Mersey River, and Brachiopoda from the Conglomerate of Table Cape—Proc. Roy. Soc. Tasmania, 1882.

2 *Loc. cit.*

furnish more conclusive evidence of glacial agency in the geological history of Tasmania than I have met with elsewhere, and they strongly corroborate the testimony afforded by the seemingly erratic boulders which occur at various points in the basin of the S. Esk."

Mr. Montgomery, in speaking of these conglomerates, says[1]:—"In New South Wales it has been noted that both above and below the Greta Coal Series, which corresponds with the Mersey Coal Measures of Tasmania, there occur layers of erratic boulders, probably deposited by ice during periods of continued low temperature in the Southern Hemisphere. These cold periods might supply an explanation of the paucity of fossils in the Wynyard formation, and ice action would likewise account for the occurrence of large and heavy boulders in it in a mudstone matrix, instead of the more usual one of coarse sand and gravel, which is the ordinary result of the sorting of detrital material by wave action. During my examination, however, I did not see any boulders exhibiting ice striation, or of such size as not to be accountable for by the ordinary forces at work on every sea shore."

Besides the rocks already mentioned by him Mr. Stephens says:—"Among the rolled pebbles which line portions of the beach near Table Cape . . . . . there have been found from time to time fragments of a hard compact shale, varying in color from dark brown to dull black, and so closely resembling the so-called 'kerosene shale' of Hartley, N.S.W., both in appearance and behaviour under the simple tests to which I have subjected it, that they may be considered identical . . . . . and the discovery at different points of several specimens all identical in character, force us to the conclusion that it is of Pre-Tertiary age, and that portions of the series from which it has come, though removed by denudation near the coast line, will one day be found at no great distance inland."

Mr. Montgomery, also, referring to these loose fragments of coal found on the beach near Wynyard, says[2] that "high up in it" (the Wynyard formation) "the fossiliferous beds and the coal seam may yet be found."

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1 *Loc. cit.*
2 *Loc. cit.*

It is interesting to note that these predictions, first by Mr. Stephens, and later by Mr. Montgomery, have been fully verified, as the upper beds of the series to which the glacial deposits belong, and containing seams of cannel coal, as pointed out[1] by Mr. Geo. A. Waller, have been discovered some little distance inland from Wynyard, in the basin of the Inglis River.

At the mouth of the Inglis, east of the breakwater, till may be seen at low tide, and here appears about horizontal. About three-quarters of a mile further east shaly mudstones, very much jointed, show in the beach floor. They dip about N. 70° W. at 11°. The successively superimposed beds show beautiful serrated edges at right angles to the shore line, where the ever restless waves have furrowed them. There is also a pretty, wavy appearance along the different beds, and they are jointed to a great extent.

Traced further eastwards along the shore hard, tough conglomerates, consisting principally of normal and altered sedimentary rocks, are visible on the beach just to the west of Seabrook Creek, with an overlying bed, seen only in places, of an exceedingly hard, fine, dense, bluish-grey sandstone, greatly resembling many sandstones in the Victorian Mesozoic Coal Measures, even to their characteristic pitted weathering.

To the east of the point of basalt running into the sea on the eastern side of this creek blocks of similar conglomerate can also be seen. They contain veins of calcite up to 6 inches in thickness.

The glacial beds were not observed east of this place, the shore line as far as Burnie, wherever examined, being occupied by recent deposits, by basalt, or by highly inclined, folded and contorted siliceous slates, sandstones, and quartz schists, having a general strike between N.N.E. and N.E. These are regarded by Mr. Stephens as possibly forming the base of the Lower Silurian (Ordovician) series, or even of being still older in age, while Mr. Montgomery speaks of them as of Cambro-Silurian age.

They contain multitudes of quartz veins and small reefs, especially near Burnie. A number of anticlines and synclines can also be observed at low tide, the former especially being splendid examples, showing beautifully the rounded curves of the strata.

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[1] *Loc. cit.*

They also show numerous intrusions of igneous rocks of several kinds, occurring as dykes and lenticular patches, probably plugs. These can be seen specially between Cooee Creek and Burnie. The rock in some cases is of fine texture, and has a granitic appearance; in others it is like basalt, but very much decomposed. The intruded rocks are considerably altered along the contact, especially, as might be expected, in the case of the larger intruding masses, which have entangled among them blocks and pieces of the sedimentary rocks. Several of these igneous rocks have been examined by Mr. W. H. Twelvetrees, F.G.S., Government Geologist of Tasmania, and Mr. W. F. Petterd, who describe[1] them as gabbro.

The relation of these glacial beds of Permo-Carboniferous age to those of early Palaeozoic (Cambro-Silurian) age was not noticed by section anywhere along this part of the coast. Near Seabrook Creek their contact with the folded rocks was obscured owing to the flat nature of the beach, and its sandy character. Perhaps it may be visible at low tide.

The only place back from the coast where the glacial beds were noticed by me is in a small section about half a mile inland, near the bridge over the Inglis River on the Table Cape road. Here the rocks are shaly mudstones with pebbles, showing a dip of about 4° 30′ to N. 25° W. The contained pebbles are of rocks similar to those before mentioned. Mr. Montgomery, however, states[2] that the conglomerates, which he calls the "Wynyard Formation," occupy an extensive area to the south of Wynyard, between the Inglis and Cam Rivers, and as far back as the Campbell Range, and the Arthur River. He also says:—"It is possible that the Wynyard Formation is the base of the Coal Measures." Mr. Waller holds the same opinion, for he says[3]:— "There is now little reason to doubt that the 'Wynyard Formation' forms the base of the Permo-Carboniferous system."

The occurrence of coal seams in the same series as contains the glacial deposits is a matter of interest as tending to show the close relationship between the glacial deposits of Permo-

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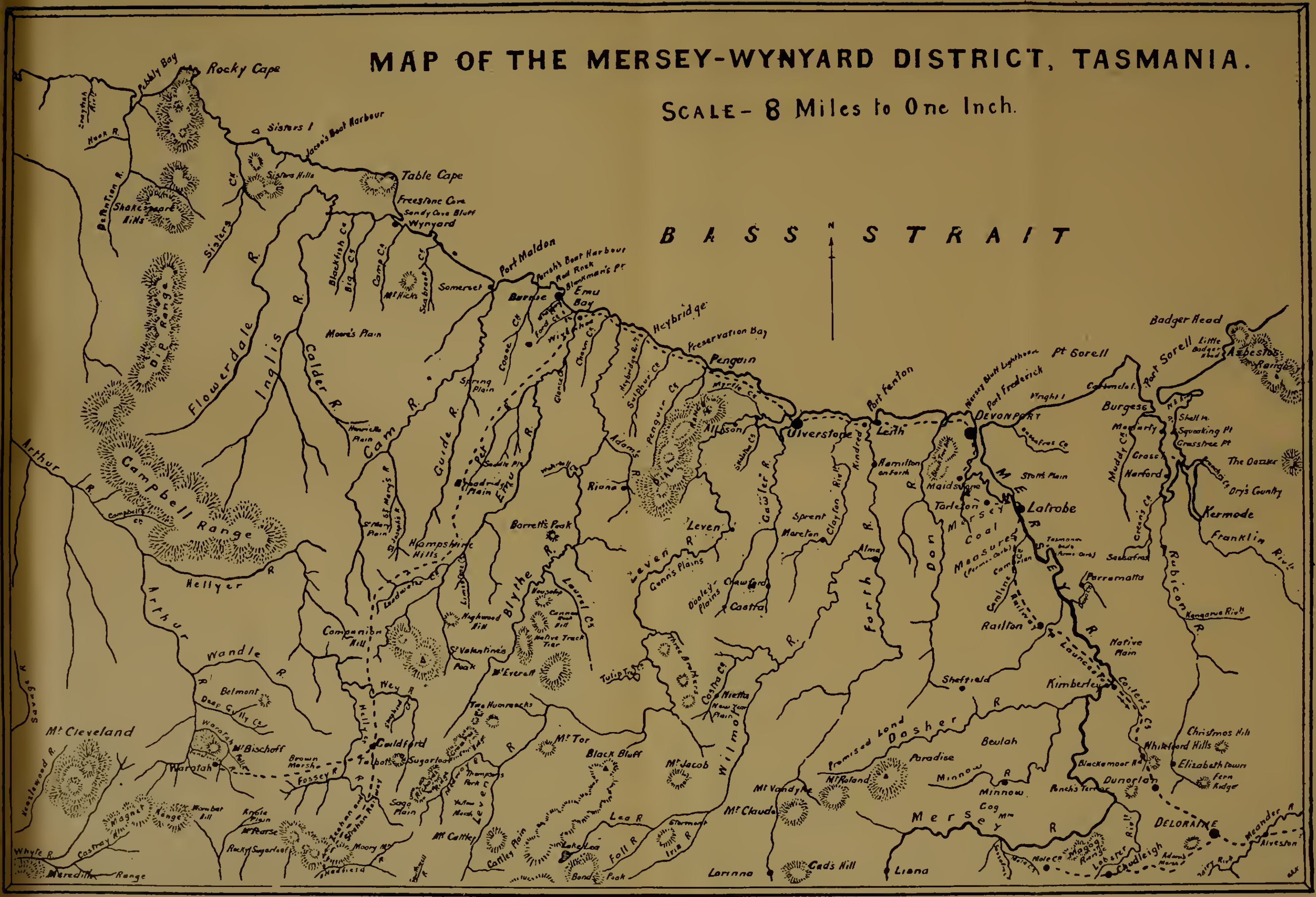
1 The Igneous Rocks of Tasmania—Trans. Aus. Inst. Mining Engineers, vol. v., 1898.

2 *Loc. cit.*

3 *Loc. cit.*


MAP OF THE MERSEY-WYNYARD DISTRICT, TASMANIA.
SCALE – 8 Miles to One Inch.
BASS STRAIT
Rocky Cape
Table Cape
Wynyard
Somerset
Port Maldon
Emu Bay
Heybridge
Preservation Bay
Penguin
Ulverstone
Leith
Port Fenton
Devonport
Port Frederick
Pt Sorell
Badger Head
Latrobe
Railton
Sheffield
Kimberley
Deloraine
Beulah
Paradise
Minnow
Barrett's Peak
Campbell Range
Hellyer R
Arthur R
Wandle R
Mt Cleveland
Waratah
Mt Bischoff
Guildford
Black Bluff
Mt Tor
Mt Jacob
Mt Claude
Mt Roland
Mersey R
Leven R
Forth R
Blythe R
Cam R
Inglis R
Flowerdale R
Calder R
Don R
Dasher R
Meander R
Rubicon R
Franklin Riv.
Kermode
Parramatta
Elizabethtown
Lorinna
Liena
Alveston
Chudleigh
Dunorlan
Riana
Hampshire Hills
Castra
Moore's Plain
St Valentine's Peak
Mt Everett
Sisters Hills
Shakespeare Hills

Carboniferous age of South Africa, New South Wales, Victoria and Tasmania.

Mr. E. J. Dunn, F.G.S., draws attention[1] to the association of coal seams and glacial beds at Ashford, near the northern boundary of New South Wales; also to a paper[2] by Mr. David Draper on the occurrence of Glossopteris, Gangamopteris, etc., associated with coal seams at Boschman's Fontein, Maggie's Fontein, etc., in the Transvaal. Mr. Dunn is of opinion that these boulder beds mentioned by Mr. Draper are portions of the Dwyka conglomerate, to which when first recognised he gave its specific name, from the site where it is characteristically represented. The occurrence in the River Inglis district, south of Wynyard, of marine fossils of Permo-Carboniferous age, in the series containing the glacial beds, and the association of characteristic Permo-Carboniferous plants such as Glossopteris, Gangamopteris, and Noeggerathiopsis, with similar marine fossils in the Mersey Permo-Carboniferous Coal Measures, some 40 miles to the east of this locality, furnish evidence for the correlation of the Mersey series with that south of Wynyard. The wide distribution of massive conglomerates of Permo-Carboniferous age in Tasmania leads one to the opinion that in many other localities than have yet been recognised in that State their glacial origin will be fully demonstrated.

The glacial deposits at Wynyard were first noticed by me in December, 1900, when hurriedly examining the Eocene fossiliferous beds at Wynyard. A strong opinion was then formed that they were of glacial origin, but I was not enabled to examine them carefully at that time.

At the meeting of the Australasian Association for the Advancement of Science held in Hobart in January of this year, I mentioned the matter when the Report of the Glacial Committee was under discussion, and referred to the probable glacial origin of these beds. A subsequent visit in company with the members of the geological excursion of the Association to specially examine the conglomerates fully confirmed this opinion, and the glacial origin of the beds was quickly recognised by the whole party.

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[1] E. J. Dunn, F.G.S.: The Northward Extension of the Derrinal Conglomerate (Glacial —Proc. Roy. Soc. Victoria, vol. x., n.s., pt. ii., for 1897.

[2] Quarterly Journal Geol. Soc., vol. liii., pt. iii., No. 211, p. 310 *et. seq.*, Aug., 1897.

Art. IV.—*Notes on Some Recent Marine Deposits in the Neighbourhood of Williamstown.*

By F. E. GRANT and E. O. THIELE.

[Read 12th June, 1902.]

On the northern shores of Port Phillip, immediately to the west of Williamstown, there is a considerable series of beds of recent age, lying principally in depressions in the basalt, which is the prevailing rock of the district, but which, as a reference to the Geological Quarter-Sheet shows, extends in places for more than a mile inland.

The best section at present exposed for the examination of these beds occurs at a point on the now disused Railway to Altona Bay, about 200 yards west of the Kororoit Creek, about 2½ miles from North Williamstown Railway Station, and about a quarter of a mile from the sea—lying immediately at the back of the Williamstown Racecourse. This particular spot has been referred to by Messrs. Hall and Pritchard[1] as a Post Tertiary marine deposit considerably above sea level. At this point the beds appear to be about 8 feet thick, and do not lie in a hollow in the basalt, but form part of a small rise through which a cutting about 5 feet high has been made for the purposes of the railway. At the north-east end of the cutting the rock is entirely basalt, the surface of which is seen to slope seawards, passing at first under a thin layer of shells and travertine and then disappearing altogether beneath the shell beds, which show for the entire depth of the cutting at its south-western end. These beds consist very largely of shells, interstratified with a a little fine white sand, and are regularly bedded. By careful collection over 80 species of Molluscs, also Echinoids, Polyzoa, Corals, etc., can be readily obtained from the face of the cutting, but we have so far been unable to find any which cannot be

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1 Proc. Roy. Soc. Vic., vol. ix. n. s., art. xiv.

referred to as living species, nearly all of which can be found living in the waters of the bay, although several of the forms are not now common on the neighbouring coast (*e.g.* Murex umbilicatus, Solen vaginoides, etc.). The beds are also traversed in places by seams of hard travertine in which almost all trace of the shells, from which they have been derived, has disappeared. This formation is no doubt due to the action of meteoric waters.

The very large number of shells present, and their perfect state of preservation, point to the beds not being of the nature of drifted sands or dunes. Even the most fragile of the Gasteropods such as Haminea brevis, Eunaticina umbilicata, Amphibola fragilis, Diala monile, Turbonilla mariae, and Turbonilla spina are rarely found in a broken state, while a large percentage of the Lamellibranchs are found as double valves, and appear to be *in situ*, showing no signs of being much weathered or of having travelled very far. Other similar beds along the coast present the same features in this respect, and to the west of the mouth of the Werribee, shell beds more extensive than those at Altona occur. They are there intersected by numerous sewerage channels, and consequently exhibit many fine sections, but we have not had an opportunity of investigating them throughly. The regular bedding of the shells, in every case, is worthy of notice—those of an estuarine type, such as Ophicardelus, Amphibola, etc., being frequently found in layers by themselves, interstratified with others of a more purely marine type—apparently pointing to alterations from time to time in the conditions under which the deposits were laid down. All the beds show a slight dip following the contour of the hill which they form. On sinking through the beds on the floor of the deepest part of the cutting to a distance of about 3 feet, a decomposed wackenitic clay was met with, which gave place to the ordinary basalt of the district at a greater depth.

The top of the beds was ascertained to be $7\frac{1}{2}$ feet above ordinary high water, and as the perfect condition of the shells renders it improbable that they are wind blown, further evidence would appear to be here present of at least 10 feet rise in the level of the land bordering this part of the bay during recent geological time.

In conclusion, we have to thank Messrs. A. Brown. and H. Summers, for taking the height of the beds above sea level.

The following is a list of the mollusca found in the deposit :—

Lamellibranchiata.

Barnea australasiae, Gray
Mactrella ovalina, Lamarck
,, cretacea, Angas
Anapella cuneata, Lamarck
Mesodesyma elongata, Deshayes
Soletellina livida, Lamarck
Tellina deltoidalis, Lamarck
,, decussata, Lamarck
Chione strigosa, Lamarck
,, aphrodina, Lamarck
,, striatissima, Sowerby
,, laevigata, Sowerby
Tapes fabagella, Deshayes
Venerupis crenata, Lamarck
Cardium tenuicostatum, Lamarck
Chamostrea albida, Lamarck
Loripes icterica, Reeve
Arca trapezina, Lamarck
,, fasciata, Reeve
Mytilus latus, Lamarck
Modiola nebulosa.
Pteria papilionacea, Lamarck
Diplodonta globularis, Lamarck
Solen vaginoides, Lamarck
Saxicava arctica, Linnaeus

Gastropoda.

Murex umbilicatus, T. Woods
,, triformis, Reeve
Lotorium verrucosum, Reeve
Fasciolaria coronata, Lamarck
Trophon paivae, Crosse
,, petterdi, Crosse
Cominella lineolata, Lamarck
,, costata, Quoy and Gaimard
Nassa fasciata, Lamarck

Nassa pauperata, Lamarck
,, labecula, A. Adams
,, rufocincta, A. Adams
Turricula scalariformis, T. Woods
Columbella lincolnensis, Reeve
Mangilia anomala, Angas
,, alucinans, Sowerby
Clathurella tincta, Reeve
Conus anemone, Lamarck
Natica plumbea, Lamarck
,, didyma, Chemnitz
,, conica, Lamarck
Eunaticina umbilicata, Quoy and Gaimard
Turbonilla spina, Crosse and Fischer
,, mariae, T. Woods
Obeliscus tasmanicus, T. Woods
Cerithium monachus, Crosse and Fischer
Bittium granarium, Kiener
,, cerithium, Quoy and Gaimard
,, lawleyanum, Crosse
,, minimum, T. Woods
Potamides australis, Quoy and Gaimard
Triforis angasi, Crosse and Fischer
Diala monile, A. Adams
,, lauta, A. Adams
,, pagodula, A. Adams
Risella melanostoma, Gmelin
Pseudoliotia micans, Adams
Phasianella australis, Gmelin
Astralium aureum, Jonas
Clanculus plebeius, Philippi
,, dunkeri, Koch
,, aloysii, T. Woods
Austrocochlea constricta, Lamarck
Diloma odontis, Wood
Phasianotrochus irisodontes, Quoy and Gaimard
Gibbula tiberiana, Crosse
Bulla australis, Gray
Cylichna arachis, Quoy

Haminea brevis, Quoy and Gaimard
Tornatina fusiformis, Adams
Siphonaria diemenensis, Quoy and Gaimard
Hipponyx australis, Lamarck
Calyptraea calyptraeformis, Lamarck
Haliotis naevosa, Martyn
Assiminea granum.
Amphibola fragilis, Lamarck
,, quoyana, Potiez
Ophicardelus australis, Quoy and Gaimard
Truncatella scalariana, Cox

Art. V.—*Further Notes on the River Yarra Improvement Sections, at the Botanical Gardens, Melbourne.*

By A. E. KITSON, F.G.S.

[Read 12th June, 1902.]

A former paper[1] on the Geology of this locality was read before this Society on 13th December, 1900. It was stated therein[2] that, at the eastern end of the new cutting on the northern side of the river, a stratum of "black fissile clay, with three thin laminae of comminuted shells, and lenticles of pure sand, 3 feet to 4 feet 6 inches" in thickness, overlay basalt, being separated from it by a bed of sandy clay. It was, also, mentioned that a small parcel of the shelly material, collected from this clay bed, had been mislaid. This collection has, fortunately, come to hand again, and careful examination of the material has enabled a few of the shells to be identified. I am indebted to Mr. J. H. Gatliff, and Mr. J. Dennant, F.G.S., F.C.S., for kindly determining them. The shells were so decomposed that even with the greatest care only a few specimens could be obtained in good order. These prove to be chiefly of lamellibranchs.

The list of those obtained is as follows :—

Nassa labecula, A. Adams.
Tatea rufilabris, A. Adams.
Sphaerium (= Cyclas) McGillivrayi, E. A. Smith.
Corbicula sp.
Mactra sp.

The greater number of the fragments consist apparently of those of Corbicula. Of the two gastropods, one entire specimen, and several fragments of Nassa were found ; while the small Tatea rufilabris occurred rather sparingly.

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1 Kitson, A. E.: Geological Notes on the River Yarra Improvement Sections at the Botanical Gardens and Vicinity, Melbourne—Proc. Roy. Soc. Victoria, vol. xiii., n.s., pt. ii., 1900.

2 *Loc. cit.* p. 247.

By reference to the list of shells given in the former paper as occurring in the shelly marl it will be noticed that neither Corbicula nor Tatea was included. These shells did not occur in the marl as far as observed. The black clay they were found in was then regarded as being probably the littoral portion of the estuarine deposits, and that opinion has now been confirmed as far as relates to this locality. The occurrence in this clay of Tatea and Corbicula, and their association with Nassa and Mactra prove that this spot was near the margin of the mouth of the old Yarra, in water greatly affected by the rise and fall of the tide.

Since the former paper was published, work of an intermittent character has been done in these Yarra Improvements. The cuttings have been carried about 165 yards past Punt Road footbridge, and deepened on the western side. The strata on the western side revealed up to the present time consist of 15 feet of alluvium, the lower portion being a yellowish-grey loamy clay with pieces of carbonised wood, overlying 6 feet of dark bluish-grey stiff clay with pieces of wood. No shells of any kind are observable.

[On the east of the bridge the cutting ends in grey indurated claystones and massive beds of grey mudstones. On the northern side these Silurian rocks are covered by 4 feet of alluvium at the eastern end, but at 50 yards west they disappear beneath about 20 feet of alluvium. On the southern side they show at the surface for 75 yards from the end. The beds dip 80° at 47°. The overlying beds consist of grey and brown loam, 12-16 feet, resting on 8 feet of dark and light coloured loam and clay, the lower portion of which contains a large number of angular fragments of the Silurian rocks. An interesting dyke occurs in the Silurian strata in the southern bank. It is from 16 inches to 2 feet wide, bears N.65°W., and runs parallel with the section. At the western end it shows at the surface, while at the eastern it is split into two prongs, one 3 inches, the other 8 inches thick. In the face here numerous thin bands and threads branch off and intersect the strata along the joint planes. About 20 feet west of this point a prong runs N. from the dyke. The rock is greatly decomposed, but is evidently of a granitic nature, and, as seen, consists of clay and large crystals of biotite up to 1 inch in breadth, and $\frac{1}{20}$ inch in thickness. No quartz was noticed in the material examined. This dyke is probably identical with that from which the micaceous material in the Anderson Street cutting was obtained, and belongs to the same series of intrusions as the smaller dyke near the old pumping station mentioned in the previous paper, and those revealed[1] by the sewerage works in South Yarra.—7.vi.02].

The evidence furnished by the shell-bearing dark clay by its occurrence above the basalt, settles the question of the relative positions of the volcanic and younger sedimentary rocks here. From the evidence of the deposits of sandy clays, sands and gravels, beneath the basalt in the Richmond and Clifton Hill quarries the basalt in those places has not flowed immediately over the marine marls, and it is very doubtful if this arm of the estuary ever extended up the valley to the latter place.

[Dr. Coates records[2] the occurrence of marine shells Foraminifera and Diatomaceae from "the mud of a swamp near the Yarra, where the Melbourne and suburban railway crosses that river." He says, that in some of the specimens of the deposit "marine shells, pieces of cuttle fish bone, and the debris of echini" occur. Also, that "from inquiries that have been instituted, it is estimated that the swamp has a depth of not less than 60 feet." He was, therefore, of the opinion that the waters of Port Phillip, at a time probably not very remote, covered this locality, and that after elevation of the land took place a lagoon or saltwater marsh was formed, and with further elevation a possible incoming of fresh water destroyed the organisms.

Accepting this record of marine fossils at South Yarra, the extension of the estuary deposits considerably further up the valley of the Yarra than Anderson Street bridge is clearly proved. The question, therefore, of the relation of the basalt to the shelly marls becomes a still more interesting one. It seems quite improbable for the latter to overlie the basalt, and the only alternatives are either that the basalt is of younger or of

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1 T. S. Hall, M.A., and G. B. Pritchard: A Contribution to our Knowledge of the Tertiaries in the Neighbourhood of Melbourne—Footnote p. 226, Proc. Roy. Soc. Victoria, vol. ix., n.s., 1896.

2 John Coates, M.R.C.S.L.: On a Deposit of Diatomaceae at South Yarra—Trans. Roy. Soc. Victoria, vol. v., 1860.

contemporaneous age. I am inclined to adopt the latter opinion, and to think that the basalt has flowed north-westward into the deep estuary, and filled it up almost completely except on the southern edge. It was probably prevented from occupying the indentations of the Botanical Gardens lagoon and South Yarra valley by the jutting points of Silurian rocks which occur at the eastern sides of their oulets, as may be seen by reference to the map with the former paper. These points have doubtless deflected the flow towards the north. The outlet to Port Phillip was probably not closed for some time later, and in the meantime brackish water fauna occupied the locality near the Anderson Street bridge, as shown by the shells specially mentioned herein. —7.vi.02].

Narrow arms of the estuary, similar to this of the Yarra, formerly existed along the Moonee Ponds Creek and the Saltwater River. In the former locality marine shells have been found,[1] and the estuarine deposits probably extended up to the vicinity of Flemington Road Railway Station. On the Saltwater River in all probability they reached the foot of and even beyond the semi-circular ridge in the Flemington Racecourse, occupying the whole of the "Flat" in this reserve.

At the Botanical Gardens the old estuary appears to have had fairly steep banks. For most of the way from its eastern side, and round its northern end past Kensington and to Footscray, the margin of the estuary consisted of more or less steep banks and cliffs, while on going to the south-west towards Williamstown these cliffs vanish, and the shore is low, and slopes gently inland.

In close proximity to the place where the marine shells occur, along the Moonee Ponds Creek, a portion of the jaw of Diprotodon australis, Owen, has been found, as recorded[2] by Mr. Pritchard, and though the nature of the deposits containing the shells, and their relation to the sandy clay in which the bone was found are not stated, yet it appears as if they are contemporaneous deposits. Mr. Pritchard has evidently so regarded them, and is of opinion that they are of Pleistocene age.

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1 Pritchard, G. B.: On the Occurrence of Diprotodon australis, Owen, near Melbourne—Proc. Roy. Soc. Victoria, vol. xii., n.s., pt. i., 1899.

2 *Loc. cit.*

In a recent paper[1] by Mr. J. F. Mulder, the basalt of the plains of the Moorabool River, near the viaduct on the Geelong-Ballarat Railway, is shown to be resting upon a deposit of sandy gravel, full of calcareous casts of Newer Pliocene fossil shells, thus proving the basalt to be not older than Newer Pliocene age. The upper volcanic rocks of the whole of the Western Plains coming eastwards to the Melbourne district are regarded as belonging to the one age. Therefore, the basalt in the Lower Yarra Valley must be Newer Pliocene or younger.

Evidence is present showing that the whole of the area bounding the Yarra Estuary was within late geological time beneath the waters of the Bay, and has since been slowly raised. Meanwhile the Yarra continued cutting its channel deeper, and extending its mouth till at the present time this is about 5 miles away in a straight line from its former mouth at the Botanical Gardens.

The occurrence of indentations in the eastern shores of Port Phillip, such as the areas occupied by the Elwood and Carrum Swamps, and the thin deposits containing recent shells which cover a large extent of the coast along the western shores of Port Phillip from Williamstown towards Geelong, also prove that the area bordering the northern part of Port Phillip is one of comparatively recent elevation.

Again, along the margin of Western Port, and in the valley of the Powlett River in South Gippsland, there also occurs what seems undoubted evidence of the existence of a large sheet of water in comparatively recent times, and of subsequent elevation of the land surface. In the Powlett Valley the country in some parts has the appearance of an area originally consisting of low mud banks, islands and promontories, separated by indentations with fairly deep channels having the character of those now visible in Western Port. [Further east, also, such as along the northern shores of Corner Inlet, evidence of elevation does not seem to be wanting. It seems, therefore, as if a considerable portion of the southern coast of Victoria has undergone some elevation during recent times. I am indebted to Messrs. T. S. Hall, M.A.,

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1 J. F. Mulder: Newer Pliocene Strata on the Moorabool River—Proc. Roy. Soc. Victoria, vol. xiv., part ii., 1901.

J. Barnard, and F. G. A. Barnard for information respecting the diatomaceous deposit. I was not familiar with the paper by Dr. Coates till considerably after this paper was read. I desire to thank Professor Gregory, D.Sc., F.R.S., for considerately allowing the new material referred to herein to be microscopically examined in the Geological Laboratory at the University, and also Mr. H. J. Grayson for kindly making the examination. Mr. Grayson has determined the occurrence of diatoms belonging to the genera Campylodiscus, Actinocyclus, Surirella, Navicula, and Inclosira in the material from the most easterly cutting, and also a few spicules of a sponge belonging to the genus Spongilla. In one of the beds here half of the material consists of diatoms, almost exclusively Actinocyclus with a few Campylodiscus. The shell-bearing clay above the basalt contains no diatoms except an occasional frustule of Campylodiscus. Mr. Grayson had himself collected some diatomaceous earth at a depth of 5 feet from the surface, close to the spot from which the collection examined by Dr. Coates was made. He found that the prevailing diatoms were those belonging to the first four mentioned genera, and that the material differs in no way from the Punt Road samples. He also says that diatoms are abundant at Coode Island and West Melbourne lagoon at a depth of about 5 feet, near the Corporation Freezing Works in Flinders Street, Melbourne, and in sewerage works on the southern side of the Yarra River on the Port Melbourne flat. It will thus be seen that they occur over a large area of the low land in the metropolis.—7.vi.02].

Art. VI.—*Description of some New Victorian Fresh-water Amphipoda, No. 2.*

By O. A. SAYCE.

(With Plates IV., V., VI., VII.).

[Read 12th June, 1902.]

In last year's Proceedings I described four new species of fresh-water Victorian Amphipoda.[1] Since then I have received additional material through the kindness of friendly collectors, and am now able to add four more hitherto undescribed species from our State. Amongst these one is of especial interest, inasmuch as, although an inhabitant of surface-waters, it is totally without eyes, and is comparable in this respect to another of our local species (Niphargus pulchellus) described by me in these Proceedings.[2]

In addition to the descriptions of the new species, I have given further information concerning some of those described in my last paper, and have adduced evidence of the migration of the genus Chiltonia.

Chiltonia australis, Sayce.

Hyalella australis, Sayce. Proc. Roy. Soc. Vict., xiii., pt. 2, pp. 226-230, pl. xxxvi.

Rev. T. R. R. Stebbing, F.R.S., recently[3] established the genus Chiltonia for Dr. Chilton's Hyalella mihiwaka, from New Zealand, and, although the characters of my H. australis are not quite in agreement with his generic description, notably in the terminal rudimentary uropods being two, not one-jointed, I think it bettter to unite it with the New Zealand form.

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1 Proc. Roy. Soc. Victoria, vol. xiii., pt. ii., pp. 225-242.
2 Proc. Roy. Soc. Victoria, vol. xii., pt. ii., pp. 152-159.
3 Trans. Linn. Soc. London, vii., pt. 8, p. 408.

The only marked differences between the several species of Hyalella and Chiltonia australis are that in the latter the first maxillae does not possess a minute rudimentary one-jointed palp, and the second pair of gnathopoda in the male is without a conspicuous lobe to the wrist; but this latter difference is only one of degree, for it has a minute unarmed one, as shown in my drawing.

In Chiltonia mihiwaka, besides the loss of the maxillary palp, the terminal uropoda are only one-jointed, and in Dr. Chilton's drawing the wrist of the second gnathopods is quite without any lobe.

Chiltonia australis therefore forms an interesting connecting link between the New Zealand and American forms, and affords good evidence of C. mihiwaka having migrated from America to New Zealand through Victoria, as some other forms of life appear to have done.

Through the kindness of Professor Baldwin Spencer, from whom I received some material collected from Lake Hindmarsh, I am now able to add another species to this genus.

Chiltonia subtenuis, sp. nov. (Pl. IV.).

Male.—Body comparatively slender, first four side-plates of subequal depth to their respective segments. Epimeral plates of last two segments of metasome with posterior angles a little produced acutely backwards, ventral margins evenly convex. Cephalon large, as long as first two segments of mesosome combined, lateral edges deeply excavated. Eyes large, slightly oval.

Mouth parts large and strong, possessing all the characteristics of the type. Maxillipedes relatively stouter, but of quite the same form and armature.

Upper antennae equal in length to cephalon, and first three segments of mesosome combined, peduncle with second and third joints of equal length, each shorter than the first; flagellum a little longer than peduncle with about nine rather long joints. Lower antennae a little shorter than the upper, gland cone prominent, following joint produced below distally to a conical spur tipped with setae; flagellum of about six joints.

First gnathopoda with anterior margin of side-plates slightly produced anteriorly, lower margin evenly convex, carpus with evenly rounded lobe bearing about eight stout faintly feathered setae; propodus a little longer than carpus, subtrigonal, widening distally, anterior margin strongly curved, palm nearly transverse, slightly convex and entire, meeting the posterior margin in an evenly rounded narrow curve bearing a little spine, posterior margin a little convex and free from setae. Second gnathopoda with propodus normally large, almost as broad as long, posterior margin equalling half the length of the anterior, both nearly straight, palm transverse, convex and setose, defined by a small rounded tubercle. Dactylus of equal length to the palm, inner margin entire, and on the outer margin a plumose setae.

First two pairs of pereiopoda equal in length and form, the third also of similar length, fourth longer, fifth of equal length to the fourth. In each of the last three pairs the basos is expanded, the last greatly so, being as wide as its length, with the hind margin strongly convex and deeply and irregularly serrated.

Uropods normal to the genus, terminal pair one-jointed. Telson subrectangular, lateral angles rounded, distal margin with a small rounded expansion medianly; armed distally above, on each side of the median line, with two spinules.

Female.—Similar in form to the male, except in the second gnathopoda which are, except for being rather longer, like the first pair.

Colour.—Spirit specimens uniformly yellowish.

Length.—♀ 4 mm. ♂ rather larger.

Occurrence.—From Lake Hindmarsh, North-Western Victoria (received from Professor Baldwin Spencer).

Remarks.—This species is easily distinguished from the New Zealand C. mihiwaka, by the much more slender body, and the larger head and eyes; and from C. australis, by the shorter urosome, one-jointed terminal uropoda, shape of the hands, and much shorter antennae. Amongst about twenty specimens there were only two males.

Atyloides fontana, sp. nov. (Pl. V.).

In general appearance very like A. gabrieli, but with deeper side-plates, the antennae not bearing fascicles of long setae, and the upper with shorter peduncle, also the mandibular palp has not the penultimate joint so widely expanded.

Body with short setae thinly scattered over the surface. First four pairs of side-plates considerably deeper than their respective segments, evenly rounded below and unclothed, the first not in the least expanded distally ; the fourth slightly deeper than wide. Last pair of epimeral plates of metasome with posterior angle minutely angularly produced, margin above entire and a little convex, ventral margin almost straight and unarmed, anterior angle narrowly rounded.

Cephalon equalling in length the first two segments of mesosome combined. Eyes circular, black.

Upper antennae less than half the length of the body, with few setae ; peduncle short, not longer than the cephalon and half of the first joint of mesosome combined, its ultimate joint rather more than half the length of the penultimate ; flagellum considerably longer than twice the length of peduncle, with 40-50 short articuli, secondary appendage, normal, one-jointed. Lower antennae of about equal length to the upper, with few setae ; peduncle extending to the limit of upper, flagellum more than twice the length of peduncle with 30-40 joints.

Gnathopoda subequal, the second with the basal joint a little longer than the first, hands small, not any larger than the first, and of identical form, carpus equal in length to the propodus, lobed posteriorly and thickly clothed with long spineform setae ; propodus oblong, subquadrate, palm oblique, very slightly concave, fringed with a few spinules, and at the limit a row of four or five stout spines ; forming with the hind margin a right-angle ; hind margin broken by two or three transverse ridges of long spineform setae, the distal one being the most prominent, anterior margin with four fascicles of setae, and on the outer face a single bunch near the palm. Dactylus as long as the palm, inner margin with about four equidistant fine spines, and on the outer margin a faintly pectinated one a little more proximally than the middle length.

First two pairs of pereiopoda much longer than the gnathopoda, of equal length and form ; last three pairs quite similar in form to each other, gradually increasing in length distally ;

freely spinulose; basos of each well expanded, the hind margin evenly curved and minutely serrate.

Uropoda with the peduncles of each extending to an even distance behind, first two pairs with outer ramus a little shorter than the inner, upper margins thickly fringed with little spines. Terminal uropoda extending to the limit of the lower pair, rami lanceolate, margins fringed with little spines and a few plumose setae.

Telson of even width to its length, deeply cleft, lateral edges almost straight, apex of each piece broadly rounded and bearing three setae, also a little below, one on each of the inner and outer sides.

Colour.—Spirit specimens uniformly yellow.

Length.—10 mm.

Occurrence.—From a rivulet near Wood's Point; altitude about 3000 feet (collected by Mr. S. W. Fulton).

Remarks.—This species agrees well in general characters with Atyloides gabrieli, described in my last paper; it is, however, more normal to the genus as instituted by Stebbing, notably in the inner lobe of the first maxillae bearing a lateral fringe of many plumose setae (not only tipped by three), also by the mandibular palp not being so widely expanded. The only notable feature of difference from the other known species of that genus appears to be in its possession of a distinctly lobed wrist in the gnathopods; in all other respects it is in close agreement. In the latter respect it agrees with *Calliopius*, but that genus has the telson entire, and the upper antennae have no accessory appendage. From Pontogeneia, with which Atyloides appears to be closely allied, it differs in possessing a secondary antennary appendage, as well as by the lobed wrists. In both Calliopius and Pontogeneia also the antennae, of at least the male, bear numerous large calceoli on the antennae, which does not appear to be the case in any of the Atyloides, certainly not in my two species.

Gammarus australis, Sayce.

Proc. Roy. Soc. Vict., xiii., n.s., pt. 2, pp. 233-237, pl. xxxix.

Since describing this species, I have received some further specimens of it, and am now able to define the sexual characters.

Also I find that some of the text in the supplementary description was left out in the printing; on page 235 under first maxillae, the description of the maxillipeds is given, and the first and second maxillae are omitted, I shall now add these.

First Maxillae.—Inner lobe apically pointed, inner margin straight, facing obliquely, fringed along its whole length with many plumose setae. Outer lobe stout, and apically bearing at least ten denticulated spines which are set in a double row, so that their number is difficult to determine, and there may possibly be one or two more of them. The palp is two-jointed, that of the right-hand side terminates in six teeth, that of the left bears ten apical spines, and on the outer face, at the base of these, three longer ones.

Second Maxillae.—Inner lobe extending almost to the extremity of the outer one, summit rounded and thickly clothed with fine spinules, inner margin sparsely fringed with spinules, and also having a submarginal oblique row of plumose setae. Outer lobe broadly rounded at the extremity and bearing many spinules, some of which, toward the outer margin, are longer than the others and faintly pectinated.

Body.—I find on further examination that in the last segment of the urosome the dorsum bears on each side of the median line a small spine, which is hidden by many long fine spinules, which also arm the other segments of the urosome and last two segments of the metasome.

Gnathopoda.—Dactyli bearing on the inner margin a secondary claw, and at its base two or three setae; on the outer margin near to the articulation a single setae.

Sexual Characters.—In the gnathopoda the first pair has no apparent difference in the two sexes, but the second has the propodus and carpus rather longer and more slender in the female than in the male. The palm also is set more obliquely in the male, but this is subject to variation.

The termination of the inner ramus of the last uropoda also shows a slight sexual difference. In the female the apex is narrowly rounded and bears about seven spinules, and just below these on the dorsal surface there are two spinules situated medianly, and a long stout spine on each side of them. In the male the corresponding part is rather broader and bears at the inner angle two stout spines, and the margin between them and the outer angle is fringed with long slender spinules ; also on the dorsal surface there is a row of eight long subapical spinules.

Occurrence.— Besides Dandenong Creek, near Bayswater, where the type specimens came from, I have three specimens found in association with Atyloides gabrieli, and a blind species (Gammarus haasei) described below, which Mr. Haase collected from a little rivulet in a fern gully at Monbulk, at an altitude of about 800ft.

Gammarus haasei, sp. nov. (Pl. VI.).

Body of similar form to G. australis, but rather deeper, appendages not so densely setose, and not possessing eyes. Segments of metasome dorsally possessing few, those of urosome with many long fine spinules, which, in the two last segments, almost obscure a small stout submarginal spine on each side of the median line. Cephalon of equal length to the first two segments of the mesosome combined. Coxal-plates more or less spinose and setose, fourth as wide as its depth. Last pair of epimeral plates of metasome with postero-lateral angle acute, slightly acuminate, margin above with a few minute hairs, ventral margin with two stout and two minute spines.

Peduncle of upper antennae extending beyond the limit of the penultimate joint of the lower, flagellum about two-thirds the length of the body with 40-50 joints, accessory appendage with 3-5 joints. Lower antannae with flagellum of about 19 joints; in the male with last joint of peduncle and about the first six joints of flagellum bearing calceoli.

Gnathopoda much more slender in female than in male. In the *female*, hands comparatively small, the second with carpus and propodus considerably longer than in the first pair, but of subequal form, carpus fully as long as propodus, propodus oblong, subquadrate, palm almost transverse and straight, fringed with spinules, and at the posterior angle, which is narrowly rounded, three conspicuous spines, posterior margins of the two mentioned joints with many transverse rows of setae, some of which are faintly feathered, also a few little fascicles of setae along the anterior margins, and, in the propodus, a few bunches scattered over the outer face. Dactyli at about the middle length bearing a secondary claw and three setae near to its base; on the outer margin a seta towards the proximal end. In the *male* the two pairs of gnathopoda are much more strongly built, the second compared with the first rather longer, and propodus a very little larger; the second, compared with the female with the basis shorter, carpus much shorter, being less than two-thirds the length of the propodus, and propodus much larger, in other respects they are subequal.

Pereiopoda with dactyli of each having a stout fine-pointed spinule on the inner margin at the base of the claw, and near to it on the side a seta, also on the outer margin more proximally one, and sometimes two plumose setae. Last three pairs of almost equal length, the penultimate a very little longer than the other two.

Terminal uropoda of medium length, differing in form in the two sexes. In the *female* with the outer ramus twice the length of the inner, terminating in a rudimentary joint, outer margin with four, inner with three ridges of spines, and a longitudinal series of plumose setae. Inner ramus lanceolate, outer margin with three equidistant spines, inner with about six plumose setae, apex with four long spinules. In the *male*, outer ramus subequal to the female, inner ramus rather longer and of different shape, its inner margin being almost straight and fringed with plumose setae, the outer margin straight for about two-thirds of its length when it is angularly deflected and runs straight to the narrowly rounded apex, and is fringed with about six long spinules. The apex carries a stout spine and a few spinules.

The telson is cleft to the base, each piece is broadly rounded at the end and furnished with numerous long spinules, also a few on the upper surface.

Colour.—Spirit specimens white.

Length.—Largest 10 mm.

Occurrence.—From a little runnel in a fern gully at Monbulk, near Lilydale, Victoria. Altitude about 800ft. In association with Gammarus australis and Atyloides gabrieli (collected by Mr. J. F. Haase).

Remarks.—This species agrees rather closely with G. australis, but, although inhabiting surface waters, is peculiarly characterized in being without the slightest trace of eyes. It is also more differentiated in the male, the hands of the gnathopoda being conspicuously stronger and the wrists shorter, also the lower antennae possess calceoli, which are not to be seen in G. australis.

I have had the opportunity through the kindness of Mr. G. M. Thomson, of New Zealand, of examining his Niphargus mortoni, from Tasmanian fresh-waters, which is certainly congeneric with the two species just mentioned, and is in rather close agreement with G. australis. He provisionally placed it in the genus Niphargus, and some may think it necessary to institute a fresh genus to receive these three forms, but the characters are so close to those of Gammarus, that it does not appear to me to be necessary. The number of dorsal spines on the urosome are certainly few, but in respect to the mouth parts and other features they are quite normal. Thomson's species has normal eyes like G. australis, and has the coxal-plates shallower than in that species, the dorsum is not clothed with nearly so many fine spinules, the inner branch of the terminal uropoda is shorter and inner ramus much shorter, the upper antennae have a smaller secondary appendage and relatively rather longer terminal peduncular joint, also the body and appendages are not nearly so setose.

The above new species is named in compliment to Mr. J. F. Haase, who collected it.

Supplementary description.—In all I received 11 specimens, and 4 of these are males.

Eyes.—There is not the slightest trace of any crystalline lense or pigment.

Mouth parts.—These agree very closely with those of G. australis and G. mortoni, and call for no special mention.

Upper Antennae.—The first antennae of the male compared with the female is rather longer, being about four-fifths the length of the body, while in the female it is not more than two-thirds, and the flagellum has respectively about 50 and 40 joints. In each sex the flagellum has, besides a large number of ordinary tactile setae, on the inner side of each joint, except above the first ten and the last three or four, a single "olfactory cylinder," also the peduncle bears on the first joint about five or six and the second and third joints, distally, two or three plumose sensory setae.

Lower Antennae.—The peduncle is a little longer than the flagellum, the two last joints subequal and clothed thickly with bunches of setae, and, at the distal end of each, two or three plumose sensory setae. There are about 19 joints in the flagellum, which are also thickly setose, but they are not so long or as dense as in G. australis. In the male the last joint of the peduncle, on the inner side, has a row of four calceoli, and one on each of the first six joints of the peduncle. In G. australis there are no calceoli, but G. mortoni, which has relatively shorter antennae, possesses one on each of the first six joints of the flagellum, but none on the peduncle. The former has longer and more numerous setae than the other two local species.

Coxal-plates.—The first three pairs are fringed with spineform setae as in G. australis, but they are not so numerous nor as long as in that species; each also bears three or four spines on the posterior margin. The fourth is of even depth to its length, and its ventral margin bears only a few setae.

Branchial and Incubatory Lamellae.—The former are simple and pedunculated, and the latter large and fringed with setae.

First and Second Pereiopoda.—The first is a little longer than the second, the latter compared with the third being about as long as from the proximal end of the basos to near the limit of the carpus.

Third, Fourth and Fifth Pereiopoda.—The third and fifth are of equal length and the fourth is a little longer. In G. australis it is relatively longer. The bases of each are expanded, that of the third being rather wider than the others, being in the proportion of three-quarters as wide as its length. In lateral outline it is oblong, subquadrate; the fourth has the posterior margin narrowing rather irregularly to the succeeding joint; the fifth also only differs in the hind margin which is concave, it is irregularly serrate, and besides a fringe of setules bears a rather stout spine at the distal extremity.

Pleopoda and Uropoda.—These are normal and call for no special mention, the terminal pair and the telson have already been described.

Neoniphargus fultoni, sp. nov. (Pl. VII.).

Similar in general features to N. spenceri, coxal-plates scarcely so deep, with only a few marginal setae and no spines, the first pair relatively shorter and distally narrower; legs rather longer and not so spinulose, eyes smaller and subspherical.

Last two segments of urosome dorsally bearing a spine on each side of the median line, and one or two little spinules on each of the four preceding segments. Last pair of epimeral plates of metasome with postero-lateral angles acute, but not produced, margins above with but one or two setae, ventral margins nearly straight and anteriorly bearing a conspicuous submarginal spine, anterior angles rather narrowly rounded. Cephalon scarcely as long as the two succeeding segments combined, lateral corners broadly rounded.

Upper antennae rather more than half the length of the body, peduncle with its last joint subequal in length to the preceding one, flagellum nearly twice the length of peduncle, of about 18 articuli; secondary appendage normal (two-jointed). Lower antennae with last joint of peduncle a little shorter than the preceding one, flagellum a little shorter than the two last joints of peduncle combined, of about nine articuli. In the male with upper and lower antennae bearing numerous calceoli.

Gnathopoda similar in form and armature to G. australis, but with hands relatively a little longer and the coxal-plates of first pair distinctly shorter than the second, also narrower at the apex.

Pereiopoda with last joint of each having a stout spine on the inner margin. Three last pairs long and slender, coxal-lobes not bearing any stout marginal spines, penultimate considerably longer than the other two, which are equal to each other; basal plates widely expanded, the last being two-thirds as wide as its length.

Terminal uropoda of similar length, but no so spinulose as in N. spenceri, the outer ramus with the terminal, rudimentary joint longer, and the minute scale-like inner ramus tipped with one plumose setae, also on the inner margin another one.

Telson long, deeply cleft, each piece narrow at the end, with two subapical spines, and on the upper surfaee a few little spinules.

Colour. Spirit specimens uniformly dark yellow.

Length.—6.5 m.m.

Occurrence.—From a spring at Collin's coach stage, near to Wood's Point. Altitude about 3000 feet. (Collected by Mr. S. W. Fulton.)

Remarks.—This species is easily distinguished from N. spenceri by its narrower side-plates (that of the first pair being distally much narrower and somewhat shorter than the succeeding one), by the penultimate segment of the metasome having its ventral margin not so curved, and furnished with a stout spine, by longer legs, and the dactyli only possessing one spine on the inner margin, not three, by the almost circular eyes, and by a much narrower telson. From N. thomsoni by the deeper side-plates, the much longer terminal uropods and antennae, which in the upper ones bear a longer terminal peduncular joint, by the character of the eyes and telson, as well as by several other features.

EXPLANATION OF PLATES.

Plate IV.

Chiltonia subtenuis, n. sp.

Plate V.

Atyloides fontana, n. sp.

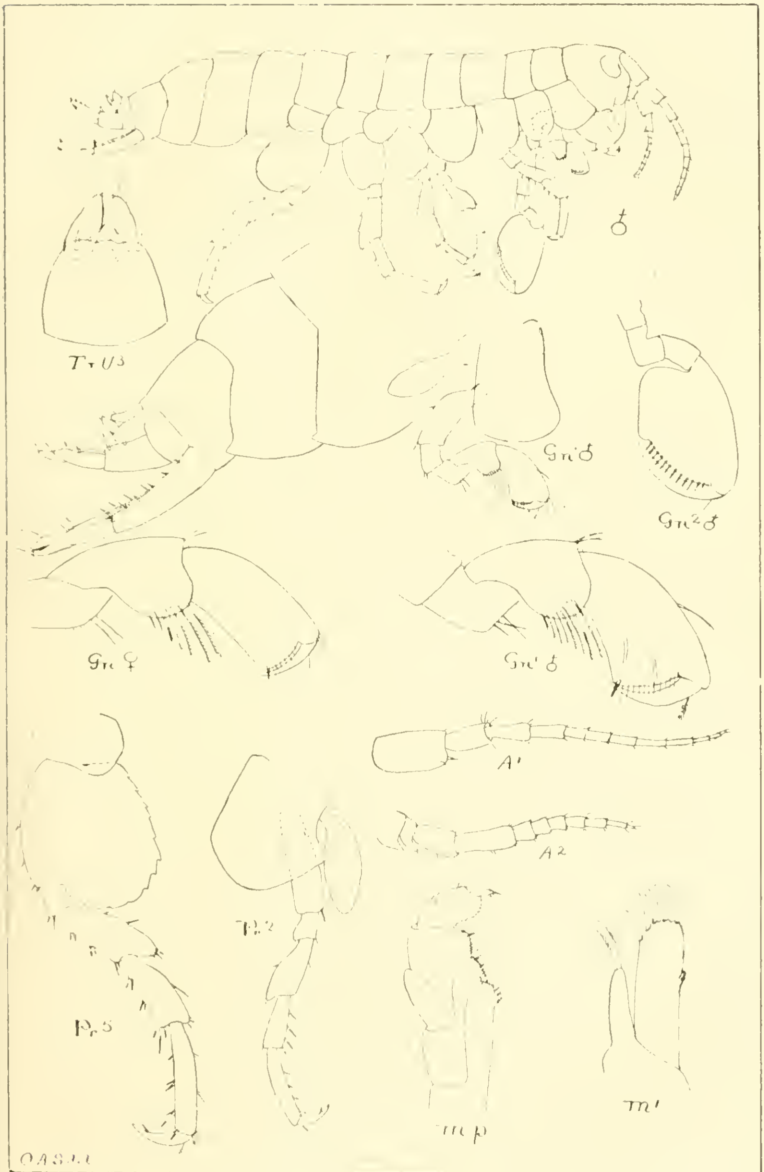
Plate VI.

Gammarus haasei, n. sp.

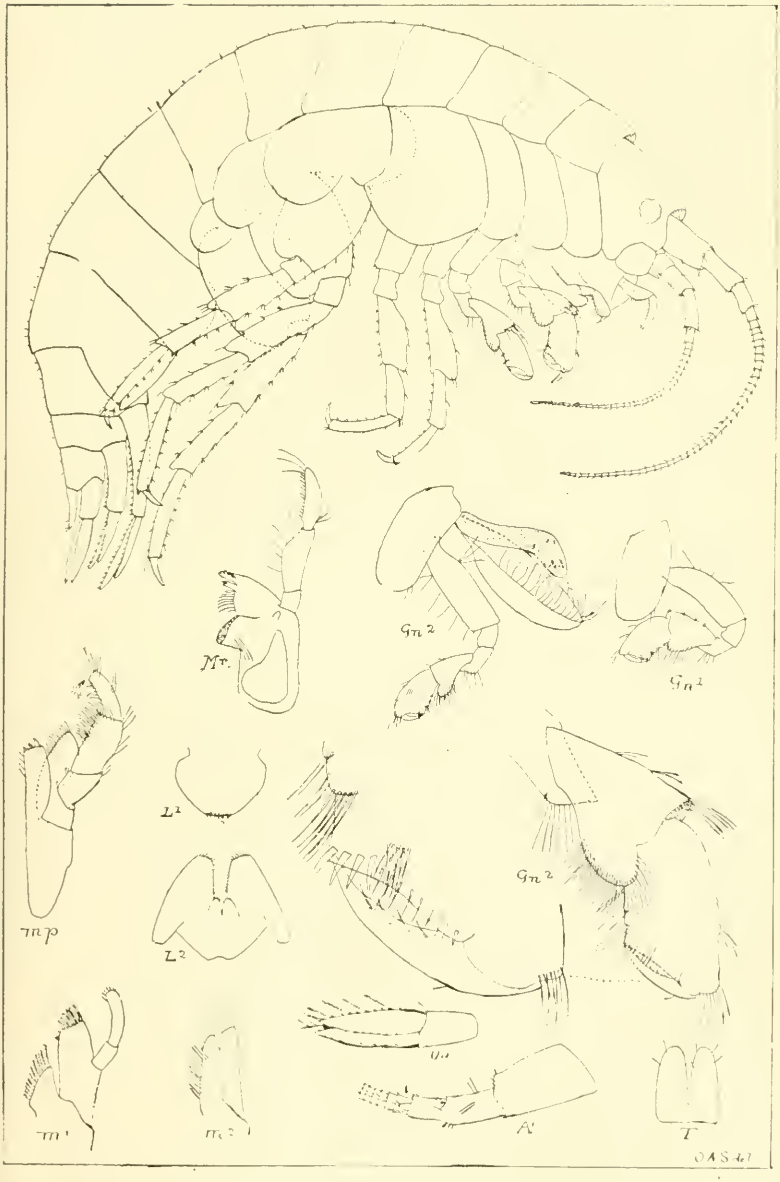
Plate VII.

Neoniphargus fultoni, n. sp.

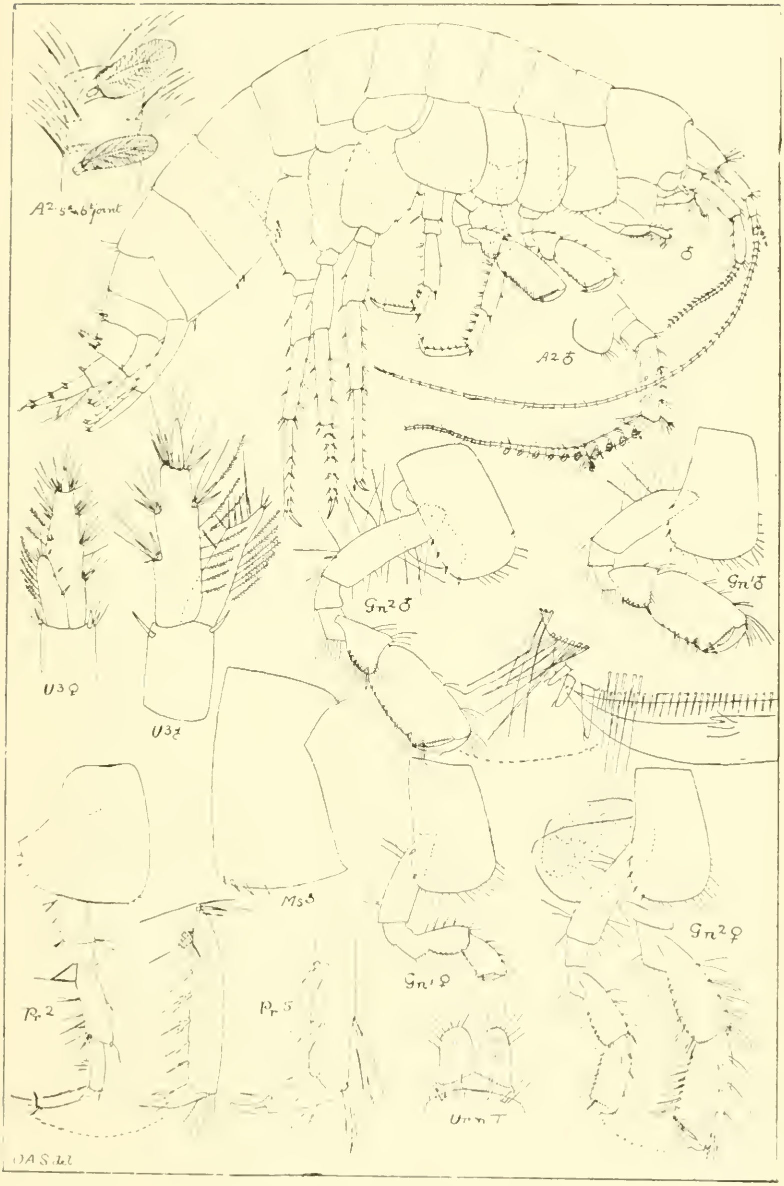
The following lettering is used to designate the corresponding parts :—C. cephalon; Ms., mesosome; Mts., metasome; Ur., urosome; A^1., superior antennae; A^2., inferior antennae; L^1., anterior lip; L^2., posterior lip; M., mandibles; m^1., first maxillae; m^2., second maxillae; mp., maxillipedes; Gn^1. and Gn^2., gnathopoda, first and second pairs; Pr^1.-Pr^5., pereiopoda, first to fifth pairs; U^1.-U^3., uropoda, first to third pairs; T., telson.



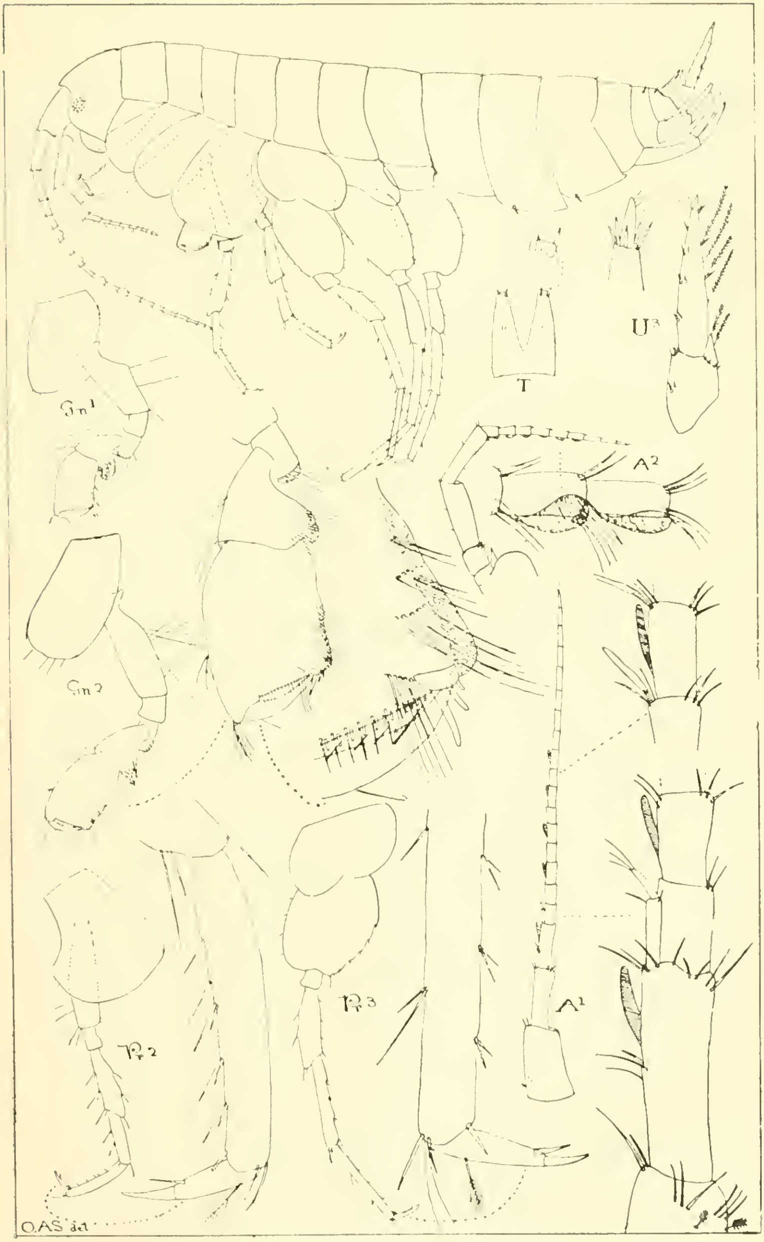
Chiltonia subtenuis, sp. n.



Atyloides fontana, sp. n.



Gammarus haasei, sp. n.



Neoniphargus fultoni, sp. n.

Art. VII.—*Some little known Victorian Decapod Crustacea with Descriptions of New Species, No. II.*

By S. W. FULTON and F. E. GRANT.

(With Plates VIII., IX., X.)

[Read 10th July, 1902.]

The paper which we have now the honour to submit is the second of a series of papers which we hope to continue dealing with our Victorian decapods.[1] Four of the species dealt with are new to science, whilst the remaining one is of considerable interest, and is new to the Victorian record. It is a fresh-water form found by us occurring in Lake Colac, and so near to kindred forms that at present we are not prepared to separate it from specimens with a similar habitat, which we have received from New Zealand and Norfolk Island through the kindness of Dr. Chilton, of Christchurch, and a further series from Mr. Wm. Lang, of Norfolk Island.

Of the new species three are shrimps living on a sandy bottom in Port Phillip and Western Port, the Australian analogues of the well-known English "Crangon," the common edible shrimp of Europe. The remaining new species is a form of crab dredged by the late J. Bracebridge Wilson, and which we found amongst the Royal Society's collection in the Biological Laboratory of the University.

Tribe—*Catametopa.*

Family—*Hymenosomidae.*

Hymenosoma lacustris. Chilton. (Pl. VIII.)

Elamena (?) lacustris. Chilton. Trans. N.Z. Inst., vol. xiv., p. 172, pl. 8, 1882.

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[1] In our previous paper (Proc. Roy. Soc. Victoria, vol. xiv.) on p. 62, line 7, for *first* joint read *fourth* joint. Also on p. 64 the figures were reduced in the process of reproduction, and consequently the magnifications given are not correct.

Hymenosoma lacustris. Chilton. Trans. N.Z. Inst., vol. xv., p. 69, 1883.

We have found this crab to be plentiful in the fresh waters of Lake Colac, Victoria, and a single specimen collected by Mr. T. S. Hall some years ago in the Moorabool River is undoubtedly a young female of this species. The species was described by Dr. Chilton in 1882 from specimens taken in Lake Pupuke—a fresh-water lake near Auckland, N.Z. The author has kindly furnished us with examples from the type locality and also with a small series from Norfolk Island. As to these we observe that those from the different localities differ slightly in the following characteristics:—

From New Zealand.—In addition to the points set out in the original description the following may be noted:

The carapace has two obsolescent teeth on the anterior lateral margins.

The chelipedes of the male have the hand with the lower posterior margin faintly tuberculate, the wrist with only a very small tubercle on its lower margin, and the arm with a small tubercle on its distal outer margin.

The specimens we have received from New Zealand are smaller than those from Lake Colac, and about the same size as those from Norfolk Island.

From Lake Colac, Victoria.—The carapace has one obsolescent tooth on the anterior lateral margins.

The chelipedes of the male have the hand with the lower posterior margin armed with 5-7 small rounded teeth and a rounded tubercle in the median line near its articulation with the wrist, the wrist with a prominent bifid tubercle on its lower margin (in some cases cut into two distinct teeth) and the arm without a tubercle on the distal outer margin. The specimens are as a rule more hairy than those from New Zealand.

The pleon of the male has a prominent tubercle on the outer margin of the first somite, and less prominent ones on the second and third.

The outer maxillipedes are more cordate than in the New Zealand form.

From Norfolk Island.—The carapace is more nearly circular, and is without marginal teeth. It is also generally more hairy than either of the above.

The chelipeds of the male have the hand with the teeth more prominent, and with the median tubercle well defined; the wrist with the tubercle prominent and bifid, the arm with the outer tubercle well defined. The hairs are stouter, shorter and straight.

On the pleon of the male the tubercles are absent on the first and second somites, the succeeding ones have a depression in the median line which is filled with hair.

The outer maxillipedes are similar to those from New Zealand.

In the examination of a number of specimens these features are not found to be constant, and a large series of adult males from each locality must be observed before we are prepared to divide them into distinct species. In the Norfolk Island examples the various points in which the species differs from others of the same genus are more clearly defined, and the hairs clothing the carapace are stronger, straighter and slightly more numerous than in those from the other localities—this may be due to its tropical habitat.

It is worthy of note that Lake Pupuke in New Zealand, although near the sea is cut off from it by sheets of recent basalt, while Lake Colac is also surrounded by tertiary basaltic flows, but is situate some 35 miles from the nearest sea, which is separated from it by a high range of hills.

We have refigured the species from Victorian examples.

Tribe—*Dromiidea.*

Family—*Dromiidae.*

Cryptodromia wilsoni, sp. nov. (Pl. IX.).

All parts, except the tips of the fingers and dactyli, thickly covered with a dense spongy tomentum, which on the dorsal surface of the carapace is markedly ridged and pitted, the ridges defining the regions.

Carapace much broader than long and deeply convex—on removal of the tomentum the surface is smooth, with the regions not so clearly defined.

Front cut into three teeth—the centre one, which is on a lower plane than the two upper ones, is small and acute, the two upper ones are larger and obtuse.

A flat obtuse tooth occurs near the middle of the upper border of the orbit—but there is no outer orbital spine. The suborbital lobe is well defined and dentiform.

The antero-lateral borders of the carapace are cut into four prominent acute teeth. The first, which is the smallest, is situate on the hepatic region, on the same level as the suborbital angle. The others are on the true lateral margin, the distance between the second and third being only about two-thirds of that between the third and fourth. The fourth is slightly nearer the median line of the carapace than the third. There is a small tooth or tubercle between the first of the above mentioned teeth and the endostome.

The hand is somewhat long and longitudinally ridged on its outer surface, but it is not nodular. There are two strong tubercles on the wrist.

The first two pairs of ambulatory legs bear strong nodulations on their carpus and propodos, the last two pairs are short and flattened, and only obscurely nodular, and alternating in length on either side. The dactyli are short and curved.

Dimensions of Type.

	♂	♀
Breadth of carapace - -	30 mm.	21 mm.
Length of carapace - - -	22 ,,	16 ,,
Length of chelipede - -	42 ,,	22 ,,
Length of 1st ambulatory limb	33 ,,	21 ,,

Locality.—Dredged off Port Phillip Heads (J. Bracebridge Wilson).

Type presented by the Royal Society to the National Museum. Co-types in the Biological Museum.

Tribe—*Caridea.*

Family—*Crangonidae.* Bates.

Genus **Pontophilus.** Leach.

This genus closely approximates to the well-known Genus Crangon, plentiful in European waters, and of which the edible shrimp of the English markets "Crangon crangon," Linn., forms so well known a type.

It may be readily distinguished from that genus by the possession of seven gills on each side (as against five in Crangon), and by the exceedingly short chelate second periopoda; the third periopoda also, although of greater length, are filiform as compared with the two remaining pairs, which are more robust.

So far the only species from Australasian waters which have been described are P. australis,[1] Thomson, from New Zealand; and P. intermedius,[2] Bates, from St. Vincent's Gulf; and P. challengeri,[3] Ortmann.

The three forms now described bring the Australian representatives of the genus up to six.

Pontophilus obliquus, sp. nov. (Pl. X., Fig. 1).

The cephalothorax, which is about one-third the total length of the body is subquadrate when viewed from above, and is furnished with a broad, flattened, and somewhat concave rostrum, obscurely trifid at its extremity. The posterior angle is well defined, and the antero-lateral margins are prominently extended as spines, but there are no further spines on the borders anterior to this.

Two long pointed spines occur on the median line; these are pointed forward, and give to the cephalothorax the aspect of having a median carina. On each side of the foremost of these there are two long pointed spines turned obliquely inwards, from which the species takes its name.

The regions of the carapace are well defined and are delineated by distinct rugae.

The *abdomen* is short and broad, narrowing somewhat abruptly from the third to the fifth segment. It is geniculate at about right angles at the third segment, the segments from the first to the fourth are smooth, whilst the fifth and sixth are strongly carinate. The first segment slightly overlaps the cephalothorax

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1 Thomson: Trans. and Proc. New Zealand Institute XI., 1878, pl. 10, fig. A1.

2 Bates: Proc. Zool. Soc. London, 1863, p. 503, pl. 41, fig. 6.

3 Ortmann: Decapod. Schizopod. Plankton Exped., 1893, and Proc. Acad. Nat. Sci. Philad., p. 185, 1895.

at the margins, whilst in the centre there is a long oval space, in which the integument is not calcified. A similar, but smaller, space occurs between it and the following segment.

The *second segment* is narrow in the centre and expanded at each side into two rounded lobes, which overlap the preceding and succeeding segments.

The *third segment* the longest and is sinuate posteriorly.

The *fourth* is short and smooth.

The *fifth* is narrow, and bears a strong median ridge.

The *sixth* is somewhat long and exceedingly narrow, and is hollowed on each side, thus throwing the centre up into a strong ridge, which bifurcates at its posterior end.

The *telson* is of the same length as the sixth segment, is strongly ridged, and is fringed at the end with stiff hairs.

The *uropods* are narrow and slightly longer than the telson, and are fringed with strong hairs.

The *first antennae* are robust and furnished with two flagella, which reach only slightly beyond the squames of the second pair. The basal joints are short, reaching little beyond the margin of the carapace.

The *second antennae* are long, and furnished with short, broad basal squames.

The *chelipedes* are robust, and reach to the level of the distal end of the antennal squamae; they are furnished with a long, curved dactylos, between the base of which and the short mobile finger there is a short fringe of hair. The mobile finger is situate about midway between the base of the dactylos and the next joint.

The *second pereiopod* reach only to the carpus of the first pair, and are clothed with hair.

The *third pair* are of normal length and filiform.

The *fourth and fifth pairs* are more robust, and with the third pair terminate in a simple styliform dactylos.

Dimensions of Type. ♂.

Length (entire) - - -	23 mm.
Length of carapace - -	8 ,,
Length of abdomen - -	12 ,,
Length of telson - - -	5 ,,
Length of 1st pereiopod - -	9 ,,

Habitat.—Dredged off Shoreham, Western Port, in about five fathoms on a sandy bottom.

Observations.—This species is readily distinguished from the next two hereunder described principally by its broader form, by the disposition of the dorsal spines on the cephalothorax and by the form of the abdomen.

It does not appear to have close affinity to any member of the genus as set out by Ortmann in his revision of the Family Crangonidae.[1]

The type has been deposited with the National Museum.

Pontophilus victoriensis, sp. nov. (Pl. X., Fig. 2.)

The *cephalothorax* is nearly one-quarter the total length measured from the base of the rostrum to the tip of the telson. The anterior margin is furnished with an obtuse concave rostrum scarcely as long as the eye stalks. A prominent tooth occurs at the outer angle of the orbit, and another forms the apex of the antero-lateral angle, behind which there are two other teeth on each lateral margin.

There is a marked depression at the base of the rostrum and behind the eyes. In the median line immediately behind the base of the rostrum there are three strong teeth projecting forward, which make the carapace appear strongly carinate when viewed from above. Behind each of the external orbital teeth there are five more spines in a longitudal line reaching about three-fourths the length of the carapace, and half way between the third of these spines and the lateral margin there is another single prominent spine on either side.

The *abdomen* is about three times the length of the cephalothorax and tapers gradually and regularly to the telson.

The *first segment* is the shortest and slightly overlaps the cephalothorax on its lateral margin. It is bordered in the centre both anteriorly and posteriorly by a small uncalcified area, and is without any carina on its surface.

The *second segment* is about twice the length of the first, and carries a prominent median carina for two-thirds of its posterior length, which is continuous through the next two segments.

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1 Ortmann: Proc. Acad. Nat. Sci. Philadelphia, 1895, pp. 173-197.

The *third segment* is three times the length of the first, and slightly sinuous at its posterior margin, where the abdomen becomes steeply geniculate.

The *fourth segment* about equals the second in length.

On the *fifth segment* which is short the median carina bifurcates and terminates in its posterior margin.

The *sixth segment* equals the third in length, and its posterior lateral angles at its articulation with the telson are dentiform.

The *telson* is as long as the two anterior segments, and slightly longer than the uropods and terminates in a small tooth, which is supported on either side by two long fine spines, and is somewhat longitudinally ridged and distally fringed with stiff hairs.

The *uropods* are narrow and fringed with hairs.

The *first antennae* are biflagellate and longer than the squamae of the second pair.

The *second antennae* are long and fine, and furnished with the characteristic broad basal squames.

The *chelipedes* have the propodos somewhat long and slender, the immobile finger is situate at about one-third the distance between the base of the daotylos and the next joint. The carpos is somewhat globular in outline, and is furnished with a prominent tooth on its inner margin.

The *second pereiopod* are short and chelate, reaching only to the carpos of the first pair, and are not clothed with hairs.

The remaining three pairs have the normal characters of the genus.

Dimensions of Type.

Length (entire) - - -	24 mm.
Length of carapace - -	6 ,,
Length of abdomen - -	13 ,,
Length of telson - - -	5 ,,
Length of 1st pereiopod - -	8 ,,

Habitat.—Altona Bay and Beaumaris, Port Phillip. Dredged in about five fathoms on a sandy bottom.

Observations.—This species has some affinity with P. australis, Thomson. By the kindness of the author we have been furnished with specimens of his species, from which ours may be distinguished by the presence of three dorsal median spines, and by its more slender form.

The type has been deposited with the National Museum.

Pontophilus flindersi, sp. nov. (Pl. X., Fig. 3.)

This species somewhat resembles P. victoriensis (described above) in its general form and proportions.

The *cephalothorax* is bounded anteriorly by a rounded concave rostrum of equal length to the eye stalks. The post-orbital angles are well defined, and the lateral marginal angles form distinct teeth, behind which the margins are cut into three large forwardly directed spines.

The upper surface forms a raised platform terminated anteriorly by a curved ridge, which is continuous with the anterior half of the orbital margins and the margin of the rostrum. This ridge extends backward on the dorsal surface parallel with the lateral margins, behind the eyes it is cut into four small fine teeth. In the median line, at its anterior fourth, there is a strong forwardly directed tooth or spine, slightly behind which on each side between the ridge above mentioned and the lateral margin there is another prominent spine.

The *abdomen* is smooth and without distinctive features, except that the last two segments are laterally compressed, giving them a somewhat carinate appearance.

The *telson* is dorsally ridged and terminates in a brush of stiff hairs. It only slightly exceeds in length the *uropods*, which are also fringed.

The *first antennae* have the basal joints considerably lengthened, reaching to half the length of the squamae of the second pair, beyond the end of which the two flagella scarcely pass.

The *second antennae* are furnished with very long and fine flagella.

The *pereiopods* in all their characters closely resemble those of P. victoriensis.

Dimensions of Type.

Length (entire)	- - -	22 mm.
Length of carapace	- -	6.5 ,,
Length of abdomen	- -	11 ,,
Length of telson	- - -	3.5 ,,
Length of 1st pereiopod	- -	8 ,,

Habitat.—Dredged on a sandy bottom in about four fathoms off Shoreham, Western Port.

Observations.—This species appears to have its closest affinities with P. intermedius, Bates. We have not seen specimens of this species, but judging from the figure given[1] there can be no question as to validity of our species.

The type has been deposited with the National Museum.

DESCRIPTION OF PLATES.

Plate VIII.

Hymenosoma lacustris, Chilton.

a♂. Dorsal view of male.
b♂. Pleon of male.
c♀. Pleon of female.
d♀. Dorsal view of posterior portion of carapace of female.
e. Front.
f. Second maxillipede.
g. Mandible.
h. First maxillipede.
i. Chela.
k. Last two joints of ambulatory legs.

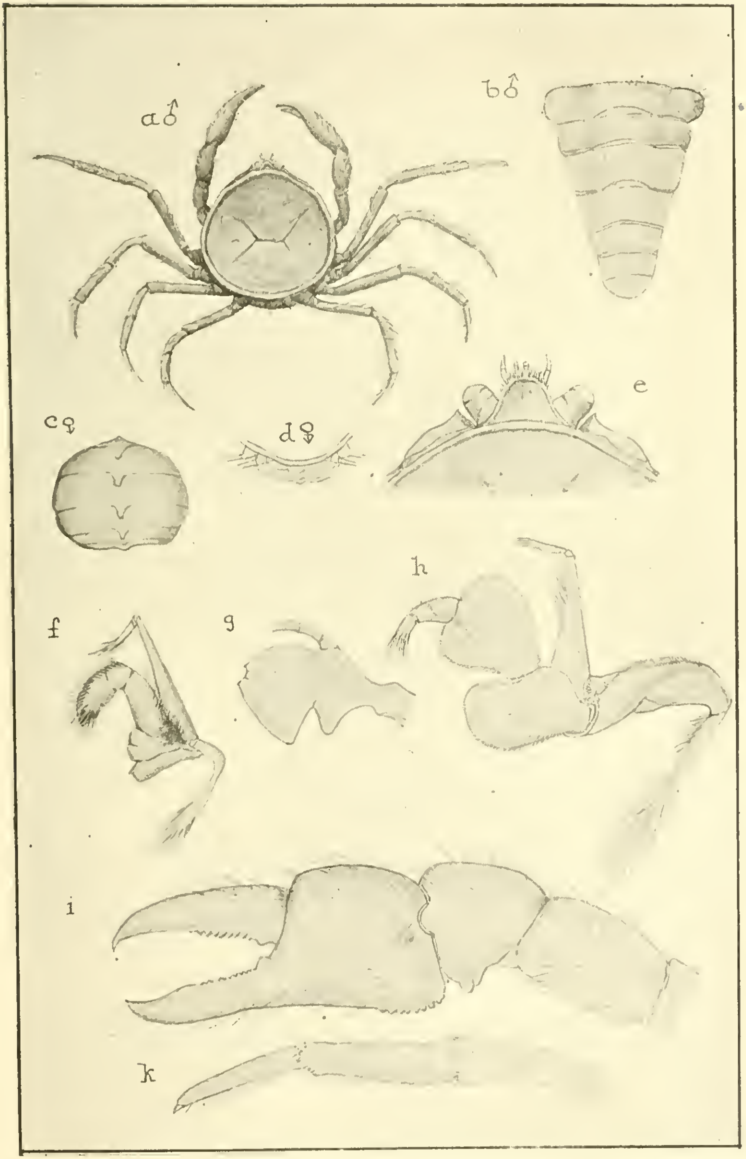
Plate IX.

Dromia wilsoni.

Plate X.

Fig. 1.—Pontophilus obliquus.
,, 2. ,, victoriensis.
,, 3. ,, flindersi.

[1] Proc. Zool. Soc. London, 1863, p. 503, pl. 41, fig. 6.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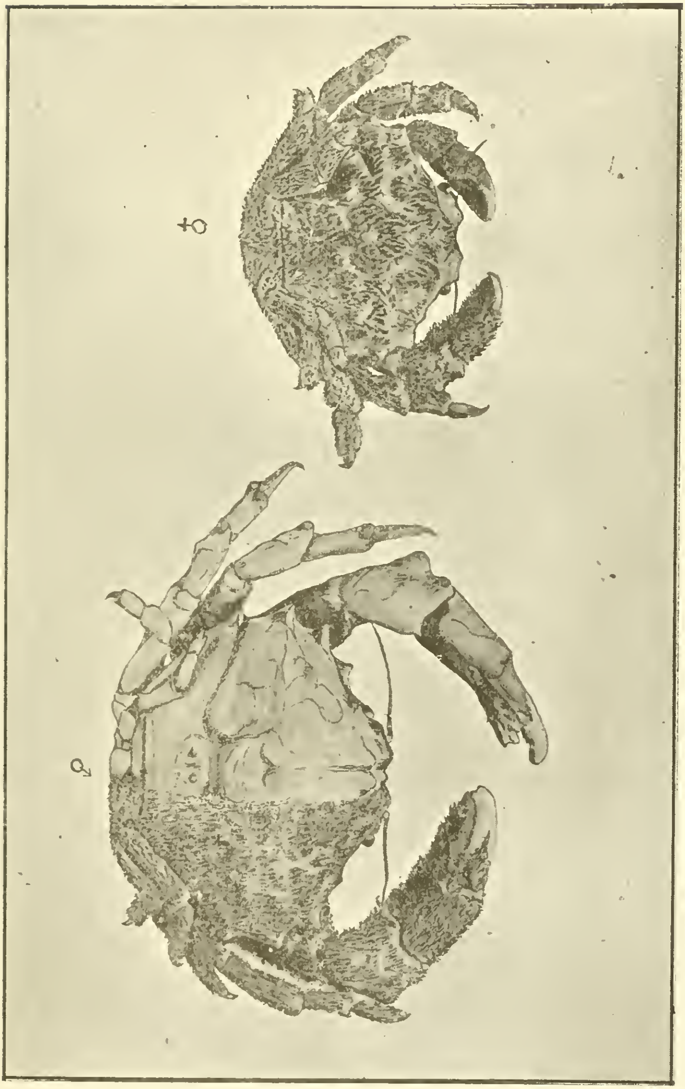

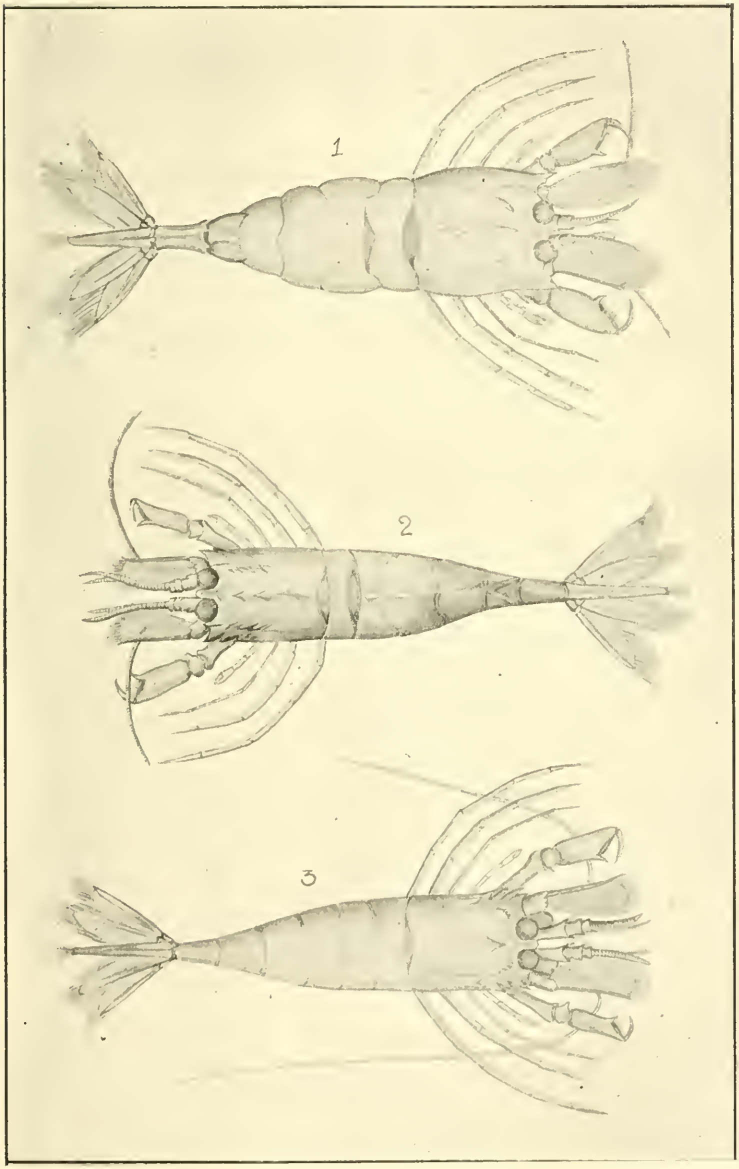
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Art. VIII.—*Six Months' Daily Examination of Melbourne Tap Water.*

By THOMAS CHERRY, M.D., M.S.,

Lecturer in Bacteriology, The University of Melbourne, Bacteriologist to the Department of Agriculture.

[Read 8th May, 1902.]

Before giving the results of the examinations of the Melbourne Water Supply, a short description of the sources of the water and of the reticulation is necessary in order to explain the results obtained.

Melbourne is probably unique among the large cities of the world in being supplied with water which comes from uninhabited catchment areas. The water supply consists of two systems—the Yan Yean and the Maroondah. The Yan Yean system collects the water from the northern slopes of the Dividing Range in the neighbourhood of Mount Disappointment, about 30 miles north of the city. This catchment comprises 26,500 acres. The most distant source is the Silver Creek, the water of which is conveyed in an open aqueduct, 8 miles long, to the Wallaby Creek Weir. From this point the combined waters of the Wallaby and Silver Creeks are conveyed by a similar aqueduct for 5 miles to the southern crest of the Dividing Range, at a height of 1700 feet above sea level. The water is then dropped by a series of cascades into the bed of Jack's Creek, one of the branches of the Plenty River. Jack's Creek leads to Toorourong Reservoir, with a storage capacity of 60 million gallons, whence a clear water channel nearly 5 miles long leads to the Yan Yean Reservoir. The average flow from Silver Creek is five, and from Wallaby Creek seven million gallons a day.

The Yan Yean Reservoir is 600 feet above sea level. It covers an area of 1360 acres, with an available depth of 18 feet, and a storage capacity of 6400 million gallons. The face of the embankment and a considerable extent of the shores of the reservoir have been pitched in order to prevent discolouring of the water with the action of the waves upon the banks. From the Yan Yean Reservoir to the pipe head dam at Morang the water is conveyed in an open aqueduct, 7 miles long, and capable of delivering 33 million gallons a day. From this point the water is conveyed by pipes to the local distributing and storage reservoirs. The chief of these is at Preston, 7 miles from Morang.

The Maroondah system is supplied by the Watts River and its tributaries at a point 45 miles to the N.E. of Melbourne, and 3 miles beyond Healesville Railway Station. An aqueduct, 41 miles long, capable (as at present completed) of delivering 25 million gallons a day, conveys the water to Preston Reservoir. As will be seen from the results of our examinations, the bacterial content of this water is practically identical with that from the Yan Yean catchment, but it reaches the consumer direct, while that from the Yan Yean system has the advantage of sedimentation during its storage in the large reservoir.

All the aqueducts are built of stone set in cement, or of concrete, and elaborate precautions are taken to prevent the washing away of the banks or the entry of storm water into the channels. The catchment areas are uninhabited except by the caretakers, all the settlers having been bought out prior to 1887. There is very little animal life of any kind in the forests, and steps are taken to restrict the ingress of tourists. No public road enters the Yan Yean catchment, but the Maroondah catchment is traversed for 6 miles by the road from Healesville to Marysville. At the point where this road crosses the Watts River the village of Fernshaw formerly stood, but all the houses have been removed, and the gardens and orchards allowed to return to a state of nature. The neighbourhood of this bridge is the only place where contamination of the water is likely to occur, and, as a matter of fact, the water below the bridge nearly always shows a few more organisms per cubic centimetre than that taken from the river above the former site of the houses. Whether this is to be accounted for by the drainage from the road or from the old cultivated grounds is a point on which I am not at present prepared to express an opinion. The whole of both catchments is covered with dense forest and undergrowth, and the annual rainfall varies at different points from 40 to 60 inches.

METHODS.

All the samples of water were taken from one of the laboratory taps which is in constant use. The nearest large pipe is a 30 inch main which runs from the Preston Reservoir along the Sydney Road. From this about half-a-mile of 6 inch and 4 inch pipes along Grattan and Madeline Streets lead to the branch which supplies the laboratory.

The water was obtained as nearly as possible at 4 p.m., except on Saturdays and Sundays, when it was taken at noon. 5 c.c. were mixed in a flat glass dish, 7 inches in diameter, with 50 c.c. of nutrient gelatine. The plates were kept at 18°-20° C., and examined after 48 and 72 hours. As far as possible the results of the last count of the colonies were taken, but in some cases the plates became liquefied in less than 48 hours. The average number of bacteria per c.c. was found by dividing the total number of colonies on the plate by 5. The observations extended from 4th July, 1901, to 29th January, 1902.

RESULTS.

Table I.

Average of Each Month.

——	No. of Examinations.	Total Number of Colonies.	Average per c.c.
July - - - -	25	7975	319
August - - -	30	8887	296
September - - -	30	2294	76
October - - -	31	2586	83
November - - -	29	1757	60
December - - -	31	2219	71
January - - -	23	4841	210

Total number of observations - - 199

Average of organisms per c.c. - - 154

TABLE II.

NUMBER OF BACTERIA PER CUBIC CENTIMETRE OF TAP WATER.

Day.	July.	August.	September.	October.	November.	December.	January.
1	—	316	53	35	24	56	60
2	—	200	24	12	40	82	86
3	—	6000	87	8	24	94	44
4	90	21	80	120	3	77	40
5	138	480	96	131	6	88	24
6	40	64	7	20	20	168	—
7	93	190	37	90	32	116	10
8	72	117	30	82	40	39	48
9	144	140	106	94	31	72	41
10	190	50	87	95	10	72	55
11	160	12	57	98	56	124	6
12	190	144	186	82	96	94	54
13	128	112	193	128	25	75	50
14	31	78	78	150	95	160	60
15	4800	88	16	101	48	3	141
16	76	55	99	156	78	3	124
17	147	44	48	128	57	64	11
18	90	43	150	121	73	86	—
19	—	72	76	57	41	72	21
20	84	89	67	150	80	60	116
21	30	94	38	73	76	40	112
22	108	44	30	52	80	51	—
23	600	86	100	100	74	80	—
24	124	101	288	112	—	62	23
25	124	28	46	68	179	41	3600
26	—	33	69	52	96	32	—
27	—	36	54	43	80	84	43
28	6	—	31	56	61	50	72
29	200	125	22	52	50	62	—
30	120	56	39	50	152	49	—
31	200	80	—	70	—	43	—

REMARKS.

It will be observed that on three occasions the average number of organisms rose to 4800, 6000 and 3600 per c.c. respectively. If these three are omitted the average for the 196 observations falls to 83 per c.c. Taking its average at 154 per c.c. the results are undoubtedly good for an unfiltered water supply; at 83 per c.c. they approach the best average results obtained by sand filtration. It will be seen that two of the three abnormal results occurred in the winter months, and the rainfall in the last half of July was unusually heavy. The consequence is that more sediment is washed down the creeks, and the average number of organisms is raised. I am inclined to attribute the three large numbers to a little particle of mud being taken up with the sample, but on the other hand the third case happened in January, when the rainfall and amount of sediment are both at the minimum. So far as we could ascertain there was no interference with the mains or reticulation pipes on these occasions. Leaving out of account the three anomalous results it will be seen that the number of organisms steadily fell from July to January thus:—

July - - -	132
August - - -	99
September - -	76
October - - -	83
November - -	60
December - -	71
January - -	54

As will be seen from the following tables the tap water contains a smaller number of organisms than the mountain creeks. It is considerably higher than the average of the outlet of the Yan Yean Reservoir, or of the Surrey Hills and Caulfield local reservoirs, which are supplied direct from the Yan Yean. As previously explained nearly half the water supplied to Melbourne does not pass through the Yan Yean Reservoir, and therefore loses the advantage of sedimentation. Moreover, the Maroondah water is supplied chiefly in the winter, so as to allow of the large reservoir to be filled ready for summer consumption. This probably accounts for the average improvement as the summer approaches, the results of the examinations of the creeks showing little variation in summer and winter, unless the water was actually discoloured by recent heavy rain. For the same reason the number of micro-organisms bears no direct relation to the temperature of the water. For purposes of comparison the results of the examination of London water are appended.

Table III.

Results of Examinations of Creeks in Catchment Area during 1901.

——	March.	April.	June.	December.
Yan Yean Catchment—				
Silver - - - -	200	112	—	200
Wallaby - - - -	40	196	—	256
Jack's - - - -	160	190	—	205
Maroondah Catchment—				
Watt's, above Fernshaw -	—	—	191	126
Watt's, below Fernshaw -	—	—	187	141
Graceburn - - -	—	—	195	160
Donelly's - - - -	—	—	—	120
Intake at Maroondah Weir	—	—	220	175

Table IV.

Results of Examinations of Reservoirs during 1901.

——	March.	April.	June.	Oct'ber.	Dec'ber.
Yan Yean outlet - - -	49	28	—	—	14
Surrey Hills Local Reservoir -	80	—	52	90	31
Caulfield ,, ,, -	25	—	75	41	42
Essendon ,, ,, -	54	—	100	20	40

TABLE V.

LONDON WATER.—AVERAGE MONTHLY BACTERIAL CONTENT IN 1901.

From the Official Reports on the Condition of the Metropolitan Water Supply during the month of December, 1901.

Month.	Thames, unfiltered.	Thames derived, Companies' filtered.	New River, unfiltered.	New River, filtered.	River Lee, unfiltered.	River Lee, filtered.
January -	4069	49	671	28	450	16
February -	5310	26	800	5	172	18
March -	2303	27	593	10	315	43
April -	2076	15	176	6	177	15
May -	852	9	106	6	209	13
June -	1371	26	204	8	488	56
July -	5560	35	383	13	837	40
August -	1646	22	284	13	223	16
September -	873	19	215	7	266	17
October -	865	13	173	4	155	12
November -	1909	55	280	10	202	13
December -	4065	31	387	18	446	14
Average -	2575	24	356	10	328	22

[NOTE.—The above are the results of 6893 examinations. The samples of the filtered water were taken from the clear-water wells of the various Companies.—T.C.]

Art. IX.—*Descriptions of some New Lizards from Western Australia.*

By A. H. S. LUCAS, M.A., B.Sc., and C. FROST, F.L.S.

[Read 10th July, 1902.]

The Lizards described in the following pages formed part of a collection of reptiles sent to the National Museum, Melbourne, for identification by Bernard H. Woodward, Esq., from the Perth Museum, Western Australia.

Besides the specimens here described, the collection contained 38 species, all of which have been previously recorded for Western or Central Australia.

Diporophora amphiboluroides, sp. n.

Description.—Habit moderate; head oval, elongate; snout anterior to nostril as long as diameter of orbit, with angular canthus rostralis; nostril moderate, directed backwards, midway between the orbit and the tip of the snout; tympanum measuring nearly half the diameter of the orbit. Upper head scales obtusely keeled; all the head scales larger than the dorsal; a short series of spinose scales above the tympanum, more marked immediately behind it on a well-marked dorso-lateral fold; a distinct nuchal crest of about a dozen compressed spines; scales on side of neck, and gular scales small, smooth, tessellated; a distinct gular fold. Body moderately depressed; a very low dorsal ridge, especially in the anterior half; dorsal scales slightly keeled, as large as the ventral; an irregular longitudinal series of enlarged scales on each side of the vertebral ridge; a regular series of enlarged keeled scales above the dorso-lateral fold; ventral scales smooth, scales on sides smaller, slightly keeled. Limbs short; adpressed hind limb does not reach the axilla. Two praeanal pores on each side; no femoral pores. Tail rounded, somewhat depressed at the base, gradually tapering, but never filiform, nearly one and a-half times as long as the head and body; all scales keeled.

Colour (spirit specimen).—Brown above, lighter on the head, which has three pairs of short black longitudinal streaks, one from the nostril to the orbit, one from the orbit to the tympanum, and one behind the supraorbital eminences. Apparently others on the body and tail, under surfaces, throat and thorax light brown, abdomen much darker, all lighter than the corresponding dorsal surfaces.

DIMENSIONS.

Total length - - -	247 mm.
Head - - - -	29 „
Width of head - - -	17.5 „
Body - - - - -	68 „
Fore-limb - - - -	34 „
Hind-limb - - - -	50 „
Tail - - - - -	150 „

Habitat.—Western Australia. Type in the National Museum.

This species agrees with the generic definition of *Diporophora* in the arrangement of its pores, but differs totally in habit. It has the head almost of *Physignathus*, but in general habit more closely resembles *Amphibolurus*. It is perhaps best at present to avoid establishing a new genus, especially as we have but a single specimen, but it may become necessary to do so in the future.

Hemiergis woodwardi, sp. n.

Description.—Body much elongate; limbs very weak, with four fingers, three toes; the distance between the tip of the snout and fore-limb is contained twice in the distance between axilla and groin; snout short, obtuse; lower eyelid with an undivided transparent disc; nostril pierced in the nasal; no supranasals; frontonasal broader than long, forming a suture with the rostral, and a broader one with the frontal; praefrontals small; frontal not larger than the interparietal, nor broader than the supra-ocular region, in contact with first and second supraoculars; four large supraoculars, the second largest; seven or eight supraciliaries; frontoparietals distinct, as long as the interparietal; parietals larger, forming a suture behind the interparietal; two or three pairs of enlarged nuchals; fifth upper labial below the centre of the eye, separated by a series of suboculars; sixth and seventh upper labials largest. Ear covered with scales, indicated by a depression. Twenty smooth scales round the middle of the body, subequal; a pair of enlarged praeanals; the length of the hind-limb equals the distance between the centre of the eye and the fore-limb. Two middle fingers much the longest, equal; third toe longest, three times as long as first.

Colour (spirit specimen).—Pale brown above, with four longitudinal series of black dots on the back; a black dorso-lateral line; sides and lower surfaces darker; each scale on the under surfaces with a broad yellowish margin.

DIMENSIONS.

Total length - - -	145 mm.
Head - - - - -	9 ,,
Width of head - - -	6.5 ,,
Body - - - - -	43 ,,
Fore-limb - - - -	8 ,,
Hind-limb - - - -	12 ,,
Tail - - - - -	93 ,,

Habitat.—Western Australia. Type in the National Museum.

Rhodona planiventralis, sp. n.

Description.—Snout cuneiform, with projecting labial edge. Eye small; lower eyelid with an undivided transparent disk. Nostril pierced in a large nasal. Rostral large, nearly as long as the frontonasal; frontonasal broader than long, forming a moderate suture with the rostral and a broader one with the frontal; praefrontals moderate; frontal a little broader than the supraocular region, as long as its distance from the end of the snout, in contact with the first and second supraoculars; three supraoculars; six supraciliaries; frontoparietals small, a little smaller than the interparietal; parietals forming a suture behind the interparietal. Two pairs of enlarged nuchals; fourth upper labial below the orbit. Ear hidden, indicated by a depression. Twenty-two smooth scales round the middle of the body, smallest on the sides. A pair of enlarged praeanals. Ventral surfaces flat, with keeled ventro-lateral margins. Fore-limb didactyle, as long as the distance from the end of the snout to the posterior margin of the eye; hind-limb tridactyle, three times as long as the fore-limb; third toe very long, thrice the length of the first.

Colour.—Greyish-brown above, with four faint, narrow, dark brown lines, a dark brown dorso-lateral line from the eye to the base of the tail. Tail brownish-yellow, with faint, less continuous, brownish lines. Undersurfaces and sides uniform pale brownish-yellow.

Dimensions.

Total length - - -	121	mm.
Head - - - -	7	,,
Width of head - - -	5	,,
Body - - - - -	53	,,
Fore-limb - - - -	5	,,
Hind-limb - - - -	15	,,
Tail - - - - -	61	,,

Habitat.—Western Australia. Locality not known. Type in National Museum.

Art. X.—*New or little known Fossils from the Tertiaries of Victoria.*

By T. S. HALL, M.A.

(With Plate XI.)

[Read 10th July, 1902.]

In the present communication I figure and remark upon some fossils which have come into my hands from time to time from the Victorian Tertiaries. The presence of some of the genera has already been indicated in various lists which have been published, but the evidence of their correct identification afforded by descriptions and illustrations has not been given. In only two instances have I ventured to attach specific names, as I am unable in the case of the remainder to point to differences from other forms. It so happens that all the forms referred to have modern analogues, but it must be borne in mind that they are associated with others whose facies is far older, a fact to be bore in mind when attempts to correlate our formations with those elsewhere are made by those unfamiliar with the fauna as a whole.

The following fossils are treated :—

Melitodes (?) sp.
Pentagonaster, sp.
cf. Sigsbeia, sp.
Chirodota, sp.
Salmacina (?) tereta, n. sp.
Lepas pritchardi, n. sp.

Alcyonaria.

Gorgonidae.

Melitodes (?) sp. (Pl. XI., Figs. 1, 2, 3).

Several specimens of the calcified segments of an Alcyonian stem from "Forsyth's" appears identical with those of a specimen of Melitodes in the Museum of the Biological department from an unknown locality. The generic identification of the Gorgonidae rests more on the characters of the spicules than of the stem segments, but in the case of our fossils we have not this important aid at our command. Still the resemblance of the specimens to the recent species is so great that, provided any reliability can be placed on the characters afforded by stem joints, there seems no reason why they should not be referred to this genus.

Associated with these forms at "Forsyth's" is a number of joints of quite different characters, but in the absence of recent material as a guide I shall not attempt to place them. Stem segments from our beds have been referred by Duncan to Isis, but for no very apparent reason. Microscopic spicules apparently of Alcyonaria are abundant in some of our Older Tertiary clays.

Locality and Age.—Grange Burn ("Forsyth's"). Kalimnan (? Miocene).

Asteroidea.

PENTAGONASTER, sp. (Pl. XI., Figs. 4, 5.)

Marginal plates of Phanerozonic Starfish are not uncommon in our Older Tertiary beds, but as they are not very striking in appearance, are apt to be passed over as worn fragments. I had collected a good many, and from their calcitic cleavage had recognised that they belonged to Echinodermata, but got no further till I showed them to Prof. J. W. Gregory, and he pointed out their nature. Similar plates are figured in Eastman's translation of Zittel's Handbook of Palaeontology. Compared with plates from the recent Pentagonaster australis of our coasts, we find the fossils are for the most part more compressed laterally, or are more elongate in the dorsiventral line. In shape they are, roughly speaking, quadrants of a thick disc. The greatest diameter of an average specimen is about 5 mm. The largest I have seen is 13 mm., and the smallest about 2 mm. in diameter. It seems hardly worth while attempting to fix a name to such fragments, as their distinguishing characters are so few and perhaps more than one species is represented.

Localities and Age.—Muddy Creek (upper and lower beds), Spring Creek, Waurn Ponds and Batesford (Jan Jukian, Balcombian and Kalimnan). Prof. Tate has recorded Astrogonium[1] from our Older Tertiary beds, and possibly my specimens are similar to those he collected.

Ophiuroidea.

cf. SIGSBEIA. (Pl. XI., Figs. 6, 7.)

A single vertebral ossicle is all I have found to show the presence of the order in our tertiaries. Its articular faces somewhat resemble those of Sigsbeia, as figured by Lyman,[2] but there is a rather closer approach to the hour-glass shaped articulations of the Cladophiurae than is shown by Sigsbeia, besides which, it differs from the latter genus in being wider above than below. The podial canals open on the distal face. Greatest width, 1.5 mm. The only specimen is somewhat corroded.

Locality and Age.—Grange Burn ("Forsyth's"), near Hamilton. Kalimnan (? Miocene).

Holothuroidea.

CHIRODOTA, sp. (Pl. XI., Fig. 8).

The spicules of holothures are not as a rule reliable guides to generic position, but wheels with six rays are in recent forms confined to the genus Chirodota,[3] so I have referred the fossil to that genus.

The wheel figured measures 0.27 mm. in diameter, and was obtained by Mr. C. M. Maplestone in some material supplied to him by myself from the beds at Spring Creek. I believe that this is the first record of fossil holothurians from Australia. The genus is world wide in recent seas, and on this account we should be justified in assuming its backward range in time.

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1 Jour. Roy. Soc. New South Wales, v. 22 (1889), p. 252.

2 Challenger Rep., v. 5, pl. 43, figs. 5, 6.

3 Theel, H.: Report on the Holothuroidea dredged by H.M.S. Challenger, pt. ii.; Challenger Reports, Zoology, vol. 14, p. 33. Ludwig, Dr. H.: In Bronn's Klassen und Ordnungen des Thierreichs, Bd. 2, Abth. 3, p. 39.

Locality and Age.—Spring Creek (Bird Rock Zone). Jan Jukian (? Eocene).

Chaetopoda.

Serpulidae.

Salmacina (?) tereta, n. sp. (Pl. XI., Fig. 9).

Numerous examples of almost straight intertwining calcareous tubes occur in the Kalimnan beds at "Forsyth's," on the Grange Burn, near Hamilton. They closely resemble in size and habit the tubes of Salmacina australis, Haswell, which is common in Port Phillip and Port Jackson. The tubes have an external diameter of 0.4 mm., and are marked by rounded lines of growth and an occasional funnel-shaped expansion where the mouth of tube formerly lay. In the recent species there is occasional dichotomous division of the tube, as shown in Fig. 10. I have not seen any trace of this in the fossil specimens, but the latter occur as small fragments, and are usually somewhat rolled. It is, of course, impossible to refer tubes of this nature to any particular genus with absolute certainty, nor indeed cylindical tubes to any particular part of the animal kingdom. Very similar objects have been referred to Serpula, but with Salmacina actually living on our coasts, we may perhaps have some slight justification in regarding our fossil as belonging to the same genus. I have to thank Mr. R. Etheridge, jun., for a specimen of S. australis, from Port Jackson, which enabled me to determine our Port Phillip examples as belonging to the same genus if not indeed to the same species.

Locality and Age.—Fairly common, but much broken, in the beds at "Forsyth's," on the Grange Burn, Hamilton. Kalimnan (? Miocene).

Crustacea.

Lepas pritchardi, n. sp. (Pl. XI., Figs. 11, 12, 13.)

The only two specimens I have seen are right scuta, which differ only in size. Viewed from the side, the occludent margin is slightly concave. The basal margin is almost straight, but has a slight convexity. The tergolateral margin is boldly curved, so that the part near the basal margin is almost at right angles to that near the occludent one. The basal margin bears a slightly thickened ridge within, and there is no umbonal tooth. Seen from the peduncular side, the basal margin is moderately curved. The lines of growth show that a slight addition was made to the basal margin throughout life. Radial markings are absent. Length of occludent margin of type, 30 mm.; greatest width of valve at right angles to this line, 27 mm. A specimen from Spring Creek, collected by Mr. G. B. Pritchard, measures 38 mm. in its greatest breath.

Locality and Age.—Waurn Ponds, quarry below the school (type). Spring Creek (G. B. Pritchard). Jan Jukian (? Eocene).

I think there can be no doubt of the correctness of the generic position to which I have referred this fossil, though in shape it differs somewhat from the corresponding valve in all the recent species. The absence of an umbonal tooth may be due to corrosion, which is a fault many of our fossils from the polyzoal rocks exhibit. Still, if originally present, the tooth must have been small, and it is of course absent in some recent species.

Another peculiarity is the bending of the growth lines along the basal margin, a feature which Darwin says is not shown by any of the species known to him, for no addition by growth is made in this position by recent forms.

As regards the age of the specimens, no one apparently would suggest that the Waurn Ponds beds are younger than Miocene, while some Australian authors call them Eocene. Even if we take the youngest estimate, namely Miocene, the fossil is the oldest member of the genus yet discovered.

EXPLANATION OF PLATE XI.

Figs. 1, 2, 3.—Melitodes (?). Stem-joints. Grange Burn.

,, 4, 5.—Pentagonaster, sp. Marginal plates seen from from two directions. Waurn Ponds.

Figs. 6, 7.—cf. Sigsbeia, sp. Vertebral ossicle, distal and proximal faces. Grange Burn.

,, 8.—Chirodota, sp. Wheel spicule. Spring Creek.

,, 9.—Salmacina (?) tereta, n. sp. Grange Burn.

,, 10.—Salmacina australis, Haswell. Recent. Port Jackson.

,, 11.—Lepas pritchardi, n. sp. Waurn Ponds. Side view.

,, 12.—The same, seen from peduncular side.

,, 13.—The same. Umbonal angle, seen from within, showing thickening of basal margin.

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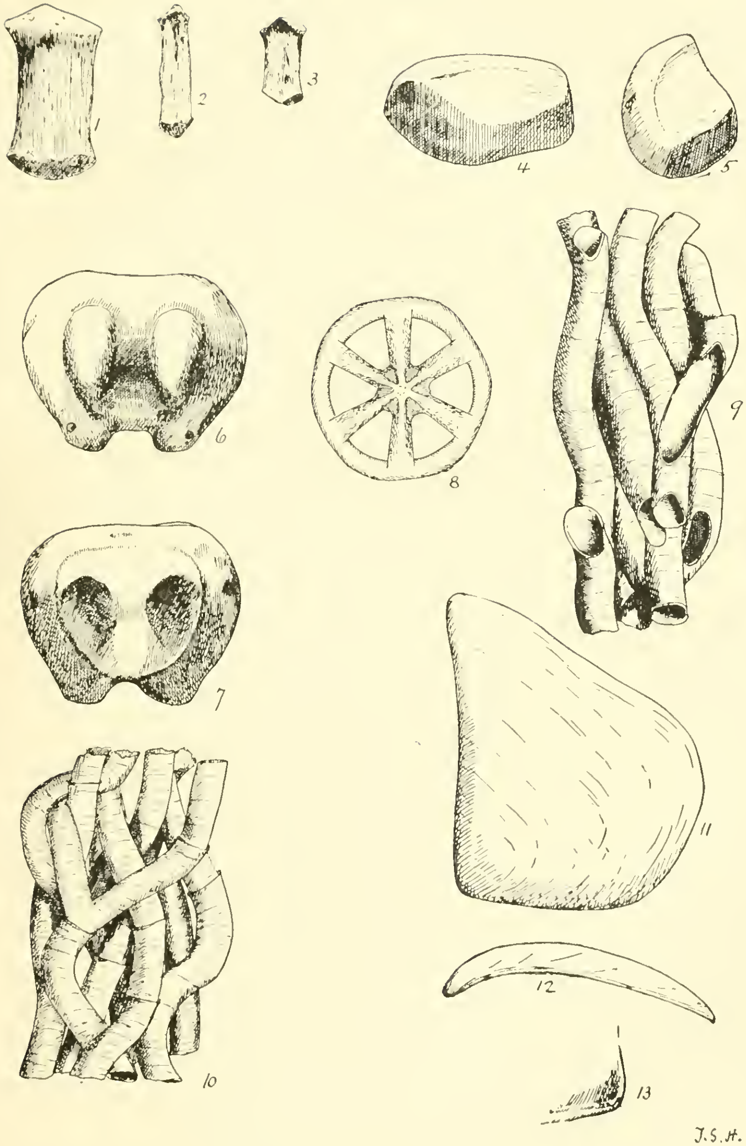
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Art. XI.—*Contributions to the Palaeontology of the Older Tertiary of Victoria.*

Lamellibranchs.—Part III.

By G. B. PRITCHARD,

Lecturer on Geology, etc., Working Men's College, Melbourne.

(With Plates XII., XIII., XIV. and XV).

[Read 11th September, 1902].

The present paper includes a number of species that it has been found necessary to diagnose, as the majority are undoubtedly new, but some have been included under described species which I shall endeavour to show are quite distinct from them.

The following are the species included:—

Lithophagus latecaudatus, sp. nov.
Mytilus mooraboolensis, sp. nov.
Glycimeris halli, sp. nov.
  var. intermedius, var. nov.
  var. paucicostatus, var. nov.
Trigonia semiundulata, Jenkins.
  var. granosa, var. nov.
  var. lutosa, var. nov.
Crassatellites maudensis, sp. nov.
Crassatellites kingicoloides, sp. nov.
Crassatellites camurus, sp. nov.
Mytilicardia kalimnae, sp. nov.
Cardita excrescens, sp. nov.
Lucina gunyoungensis, sp. nov.
Chione etheridgei, sp. nov.
Chione cognata, sp. nov.

Many of the species are particularly interesting, as their occurrences tend materially to strengthen the views held by Mr. T. S. Hall and myself on the stratigraphical relationships of some of our Tertiary beds.

Lithophagus latecaudatus, sp. nov. (Pl. XIV., Fig. 4).

Description.—Shell smooth, thin and fragile, digitiform, narrow and tumid at the anterior end, but remarkably broad and depressed at the posterior end, the posterior being more than twice as broad as the anterior. Umbo incurved anteriorly and depressed dorsally. Anterior end very short, but strongly convexly rounded, ventral margin sloping downwards to the posterior; dorsum immediately behind the umbo slightly concave, thence ascending to the posterior, posterior margin broadly convex. Surface smooth and shining, showing faint irregular undulations or ridges conforming to the lines of growth, and very faint finer parallel striations, very close radial striations may also be detected, particularly on the upturn towards the post-dorsal margin forming a microscopic reticulation. The nacreous interior shows where the shells are decorticated or worn, especially on the umbonal region.

Dimensions.—Antero-posterior diameter, 42 mm.; width at umbo, 11 mm.; median width, 17 mm.; greatest posterior width, 22 mm.; thickness through one valve, about 6 mm.

Locality.—Lower beds of the Spring Creek series, or Bird Rock Bluff, near Geelong. Jan Jukian,—Eocene.

Observations.—The genus Lithodomus has previously been recorded from "casts and crypts" in a coral from the Miocene beds of Hallett's Cove, by Professor R. Tate[1] in 1885, but the species was not described till 1886,[2] under the name of L. brevis. The present species is evidently distinct from the above-mentioned representative as judged by the dimensions and the few brief particulars given.

Mytilus mooraboolensis, sp. nov. (Plate XIV., Fig. 1).

Description.—Shell small, elongately triangular, umbo somewhat twisted, incurved, and terminal, strongly keeled from the umbo to the posterior margin, posterior area much expanded and depressed, sculpture on the anterior portion of the shell strongly marked off, and distinct from that on the posterior.

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1 Trans. Roy. Soc. South Australia, 1886, vol. viii., Lam., pt. i., p. 124.

2 *Op. cit.*, 1887, vol. ix., Lam., pt. ii., p. 186 (45 in author's reprint).

Ventral side flattened, and nearly straight, making an abrupt ascent to the umbonal keel. Umbo to posterior convex, becoming flattened towards the posterior margin, the depression being so marked towards the dorsal margin as to appear slightly concave. Dorsal margin straight, and making an angle of about 100 degrees with the slightly concave posterior, thence angled again, and nearly straight to join the ventral margin. Surface posterior to the umbonal keel sculptured by strong broad dichotomising ribs, numbering about eight at the umbo, and increasing to twelve or fourteen at the margin; on the flattened area below the keel the ribbing is of a much finer and more regular character, there being about twelve flat ribs, with much narrower interspaces on the hinder half of this area, while the forward half is still finer in its ribbing, and the ribs are more arched towards the umbo, instead of running up briefly to the keel. The shell also shows strong irregular concentric growth stoppages, which are inclined to frill the ribs at their intersection, finer concentric lines of growth are also present. Left valve furnished with a relatively strong tooth just below the beak, and a strong pad within for the anterior adductor.

Dimensions.—Type, length 19 mm.; extreme breadth, 12 mm.; breadth at posterior end, 7 mm.; others have a length of 14 mm. by a breadth of 7 mm., and some have length 12 mm. by breadth 7 mm.

Localities.—Lower beds of the Spring Creek series, or Bird Rock Bluff, near Geelong. Lower limestone beds of the Maude section, Moorabool Valley. Jan Jukian,—Eocene.

Observations.—This species at once recalls our living species M. menkeanus, Philippi, but is a much smaller and less solid species, with a more marked keel, and characteristic post-dorsal depression, different outline, and a more twisted umbo. It is equally distinct from the Miocene species, M. submenkeanus, Tate, from Hallett's Cove.

Glycimeris halli, sp. nov. (Pl. XIV., Figs. 10, 11, 12; Pl. XV., Figs. 1, 2, 8, 9).

Description.—Shell orbicular, tumid, thick and strong, equilateral, with a prominent convex umbo, and closely radially ribbed surface. Umbo incurved and overhanging the ligamental area, which is a well-defined isosceles triangular space, the base of which is just about half the width of the hinge. Hinge furnished with from 22 to 26 oblique and angular teeth, most usually 12 on each side, with a tendency for the medial ones to become obsolete in the extreme adult. Surface closely covered with broad radial ribs, ranging from about 30 to 35 in small specimens, up to about 50 in the adult, ribs slightly convex, with very narrow, almost lineal, interspaces in young shells, but in the adult the ribs are decidedly flattened; the ribs are closely, finely, and regularly radially striate, each rib bearing near the ventral margin ten striae, anteriorly and posteriorly the ribs become obsolete, but the radial striae are present, and much stronger than on the ribs. The radial sculpture is crossed by fine concentric lines of growth. Interior of valves strongly denticulate along the ventral margin, bearing about 25 strong denticles, running about 8 to 10 in 10 mm., thence both anteriorly and posteriorly diminishing in size, but extending right up to the hinge.

Variety, **intermedius**, var. nov. (Pl. XIV., Figs, 10, 11).

A variation of the above shows a less orbicular outline with sloping shoulders and consequently an apparently more prominent umbonal region, and with coaser radial ribbing, 25 to 28 being about the average number.

Variety, **paucicostatus**, var. nov. (Pl. XIV., Fig. 12, and Pl. XV., Fig. 9.

Another form which appears but a variation of the above species, is intermediate in shape between it and the foregoing variety, but rather closer related to the latter, being distinguished most readily by the still coarser radial ribbing, as it bears only about 20 strong, convex ribs, neglecting the obscure and ill-defined ones on the anterior and posterior slopes.

Dimensions.—Type, antero-posterior diameter, 42 mm.; umbo-ventral diameter, 44 mm.; thickness through one valve, 18 mm. Others range from 24 by 22, 21 by 20, 18 by 17, 17 by 16, 12 by 11, to 9 by 9 and 8 by 8, and smaller. Var. intermedius, antero-posterior diameter, 21 mm., umbo-ventral diameter, 20 mm., and 19 by 19. Var. paucicostatus, antero-posterior diameter, 22 mm.; umbo-ventral diameter, 21 mm.; others range about 18 by 17, and 15 by 14·5.

Localities.—Grange Burn, between Forsyth's and Henty's, from the clays and sandy beds of the upper series; Muddy Creek, from the upper beds below the State School; sandy clays of Jimmy's Point, Gippsland, variety paucicostata seems fairly common at this locality. Kalimnan,—Miocene.

Observations.—This species has usually been confused with Pectunculus cainozoicus, T. Woods, but Mr. T. S. Hall was the first to draw my attention to the fact that it was distinct. The type locality for P. cainozoicus is Table Cape, and compared with specimens from that locality, our present forms are much thicker and stronger, more convex, with coarser radial ribbing, but much finer radial striations. Here again, as regards the genus, it appears we must lose another old friend in Pectunculus, for, according to Professor Tate and others, *Axinaea* should replace it, but, according to Dall, *Glycimeris* appears to have the best claims.

Trigonia semiundulata, Jenkins. (Plate XV., Figs. 3–7).

This species is a well known and characteristic form, described by McCoy as from Bird Rock Bluff, and the specimens described and figured by Mr. Jenkins are indicated by McCoy as having been forwarded by him to an exhibition in London, and therefore presumably from the same locality. This Bird Rock Bluff or Spring Creek form is very consistent in shape and in the closeness of the undulating anterior ridges. McCoy describes the undulating ridges as being "crossed, except on the anterior portion, by rather faint impressed sulci radiating from the beak to the ventral margin, nearly the same distance apart as the ridges of the posterior slope." This faint impression of the sulci is not a constant feature; in some few specimens it is so extremely faint as to be scarcely visible for a greater distance than half the umbo-ventral diameter of the shell, and then only close to the posterior radiation, whilst in others the impression is so deep as to break up the undulating ridges into triangular nodes for about a third of the antero-posterior diameter. From the latter form it seems to me that we can proceed to an extreme form, for which it seems advisable to propose at least a varietal name.

Variety, **granosa**, var. nov. (Pl. XV., Fig. 5).

In shape similar to T. semiundulata, but proportionately a little shorter in its antero-posterior diameter, with eight distinct radial ribs on the posterior slope and three fainter spinose beginnings post-dorsally, anteriorly the undulating ridges are completely broken up into triangular nodes right up to the anterior margin, and so deeply impressed are the sulci that the shell has rather the appearance of being radially nodosely ribbed here also, there being 18 radiations on this portion, while looking at it from the point of view of undulations the number is about 25, and further apart than in the usual type, hence the granules or nodes are rather coarser than those usually developed.

Dimensions. — Antero-posterior diameter, 25 mm.; umbo-ventral diameter, 23 mm.; thickness through one valve, 7 mm.

Locality.—Lower beds of the Spring Creek series or Bird Rock Bluff, near Geelong. Jan Jukian,—Eocene.

Variety, **lutosa**, var. nov. (Pl. XV., Figs. 6, 7).

The next form for consideration is that commonly occurring at Muddy Creek, which is a very distinct variation from the typical form of the species. The shell is more oblong owing to a greater posterior attenuation, and is much narrower at the posterior end, the posterior area is more depressed, and the anterior area is rather more tumid and more regularly convex; the anterior undulations are coarser, less numerous, more regular, and do not ascend so rapidly; while the radial sulci are usually very faint, sometimes almost absent, or showing somewhat as a fimbriation of the ventral aspect of the concentric undulations, occasionally distinct on the upper half of the shell, and then very closely packed, considerably closer than in T. undulata, and then also apparently restricted to portion of the ventral slope and the interspace between the undulations.

Dimensions.—Antero-posterior diameter, 40 mm.; umbo-ventral diameter, 33 mm.; length of posterior, 22 mm. Other specimens range about 38 by 31·5 by 20; 36 by 30 by 18; 35 by

30 by 17; 34 by 30 by 18; 33 by 28 by 18, for the above measurements respectively.

Locality.—Lower beds of Muddy Creek, Western Victoria. Balcombian,—Eocene.

Observations.—Mr. R. Etheridge, jun.,[1] in his paper on a representative of this species from a depth of about six hundred and forty-seven feet from the Arumpo bore, east of the Darling, in the County of Wentworth, New South Wales, draws attention to some important points in some Muddy Creek examples of this species which he examined, and remarks on some discrepancies with McCoy's description. It must be borne in mind, however, that McCoy figured and described his specimens from the Spring Creek section. McCoy speaks of "faint impressed sulci radiating from the beak to the ventral margin," and it would be difficult to otherwise describe the Spring Creek forms. Etheridge, however, states, "but in the specimens examined by me, these are not sulci, nor are they continuous, but rather a fimbriation of the lower margin of each concentric ruga, and these being placed directly under and above one another in line, give rise to the appearance of sulci, until closely examined." This offers rather good independent confirmation of my treatment of the above, and so strengthens the case that the Muddy Creek examples might almost be regarded as a distinct species, but for the present a varietal distinction appears to me to meet requirements. The Arumpo bore specimen, judging from Mr. Etheridge's particulars, would appear to represent the Spring Creek form.

The Table Cape specimens represent the typical Spring Creek form.

From Wilkinson's No. 4 locality, Aire Costal sections, the specimens are of the Spring Creek type.

From Lake Bullen Merri, near Camperdown, the specimens are of the Muddy Creek type, var. lutosa.

Crassatellites maudensis, sp. nov. (Pl. XIV., Figs. 2, 3).

Description.—Shell elongate, oblong ovate, somewhat depressed, and bearing a strong angulation from the umbo to the post-ventral margin, the posterior area thus marked off being much

[1] Records Geo. Surv. N.S.W., vol. iii., pt. iv., p. 117, 1893.

flattened, and being devoid of the strong corrugations characteristic of the remainder of the shell.

Anterior margin convexly rounded, ventral margin slightly convex to almost straight, posterior truncation strongly marked, and post-dorsal margin usually very straight, sometimes slightly concave. Umbos strong and very acute and well incurved. Lunule long, narrow, and somewhat impressed. Surface closely set with very fine concentric lines of growth, most distinct on the posterior slope and towards the anterior of the shell, the median portion being occupied by strong concentric corrugations. Umbo very closely and regularly corrugate, in 3 mm. from the beak there are 14 corrugations, the corrugations here extending also on to the posterior slope; from the umbonal region towards the ventral margin the corrugations become broader, with shallow interspaces, flattening and thinning out towards both the anterior and posterior. Hinge teeth large and strong for the size of the shell, with a large deep cartilage or resilium pit, inner margin of the valves smooth.

Dimensions.—Type, antero-posterior diameter, 56 mm.; umbo-ventral diameter, 36 mm.; an example of the paired valves measuring 55 by 33 gave a thickness through both valves of 25 mm. Other examples range 60 by 36, 58 by 36, 59 by 35, 52 by 32, 47 by 30, and 39 by 25.

Localities.—Lower and Middle beds of the Spring Creek series, or Bird Rock Bluff, near Geelong; Lower beds at Maude, Moorabool Valley. Jan Jukian,—Eocene.

Observations.—This is a well-marked and distinctive species which shows some relationship to C. dennanti, Tate. Its characters are usually fairly constant, but some specimens are so straight along the ventral margin as to intensify the posterior angulation to a marked degree, and in some again the concentric corrugations are more persistent towards and up to the anterior end.

Crassatellites kingicoloides, sp. nov. (Pl. XIII., Figs. 1, 2, 3).

Description.—Shell large, strong and solid, broadly ovate, with prominent and large umbos, and rather a strongly marked and rapid attenuation posteriorly, rather inflated in the neighbourhood of the umbos but becoming depressed ventrally and posteriorly.

Umbo-post-ventral keel not always well defined, but when present, concavely curved to the posterior margin, sometimes an intermediate faint keel shows between the posterior depression for the ligament and the umbo-ventral keel. Post-dorsal margin deeply concave to a short straight posterior truncation, thence regularly convex to the anterior and thence somewhat straight to the umbo. Umbos strong and very tumid, to flat and depressed at the crest, incurved anteriorly, and strongly but not very closely corrugated, the first 4 millimetres of the beak bearing from 9 to 11 corrugations. Lunule very large, deep and broad, being in length nearly one-half the umbo-ventral diameter; posterior to the beaks deeply and broadly excavated.

Surface covered with fine, close, but irregular concentric lines of growth very closely packed anteriorly and posteriorly, about one-third of the shell from the umbo regularly concentrically corrugated with narrow ridges, and broader and shallow interspaces; the remainder of the shell is usually devoid of regular corrugations, but frequently shows irregular concentric undulations. Hinge very thick and solid, and with teeth strongly developed. Inner margin of the valves smooth and bevelled off to a sharp edge. Internally the shell is relatively shallow and of small capacity.

Dimensions.—Type specimen, antero-posterior diameter, 69 mm.; umbo-ventral diameter, 54 mm.; thickness through both valves, 36 mm.; the slight variation from this may be indicated by the following specimens—67 mm. by 53 mm., and 66 mm. by 53 mm.

Locality.—Jimmy's Point, Kalimna, Gippsland Lakes. Kalimnan,—Miocene.

Observations.—This is a fairly common and well-preserved species from the above locality, and at once recalls the living C. kingicola, Lamarck; it may, however, be distinguished by its greater inflation, its marked posterior attenuation, its shorter anterior, its umbos much nearer the anterior, and the closer and more numerous umbonal corrugations. Compared with C.

oblonga, T. Woods, from the Eocene beds of Table Cape, Tasmania, it may be noted that T. Woods' species is proportionately longer and of much more uniform breadth, is a more depressed shell with a more incurved umbo, and still finer and closer umbonal corrugations, numbering (15) fifteen in the first 4 millimetres of the beak. With the recent species there is also another analogy of some interest, in that a species of Myochama is not infrequently found adherent to the shell, the present fossil species has Myochama plana, Tate, adherent to it.

Crassatellites camurus, sp. nov. (Plate XIV., Figs. 5–9).

Description.—Shell ovate, thick and solid, of medium size, with a very short anterior, and a somewhat attenuate posterior; strong, broad, and prominent umbos medially depressed. Slightly concave anterior to the beaks, slightly to deeply concave posterior to the beaks, ventral margin very slightly convex, medial portion usually straight. Umbos strongly incurved and rather coarsely corrugated, the first 4 millimetres of the beak bearing from 8 to 10 corrugations, the umbonal region rapidly broadens and becomes depressed. Umbo-post-ventral keel only moderately developed and convexly rounded.

The surface shows fine but irregular concentric lines of growth, with occasional irregular undulations, from a little less than half the umbo-ventral diameter of the shell to about one-third of the same the more regular corrugations make their appearance, and here they are about a millimetre apart, with broad shallow interspaces. Internal edge of shell smooth and bevelled off sharp. Young examples of this species are rather more wedge-shaped posteriorly than in the adult.

Dimensions.—Type specimens, left valve, antero-posterior diameter, 54 mm.; umbo-ventral diameter, 41 mm.; depth through the one valve, 14 mm.; right valve, antero-posterior diameter, 55 mm.; umbo-ventral diameter, 37 mm.; depth, 12 mm. The following antero-posterior and umbo-ventral diameters will serve to indicate the usual range and average variations:—64 by 42; 61 by 43; 60 by 40; 54 by 37; 52 by 36; 31 by 21; 25 by 18; 21 by 16; 13 by 10.

Localities.—Grange Burn, between Forsyth's and Henty's, and

Muddy Creek, near the State School, Western Victoria. Kalimnan,—Miocene.

Observations.—As I have previously indicated,[1] this species was regarded by Professor Tate as C. oblonga, T. Woods, but that conclusion I could not agree with when dealing with a collection of Table Cape fossils. Since then I have been able to examine the type of T. Woods' species in the Hobart Museum, and to collect a large series of specimens from the type locality, and I think there can be very little doubt about the utility of regarding our Victorian form as a distinct species. C. camurus may be distinguished from C. oblonga by its different outline, more striking umbo, by not being so generally depressed, and not so flattened at the crest of the incurvature of the beak, being more attenuate posteriorly, and by possessing a more coarsely corrugated beak; there are 8 to 10 corrugations in the first 4 millimetres in the former, as against at least 15 in the latter.

Mytilicardia kalimnae, sp. nov. (Plate XII., Fig. 4).

Description.—Shell thin, almost elliptical in outline, and rather depressed, so that from the internal aspect it appears shallow, externally strongly radiately ribbed, the ribs bearing erect scales. Faintly concave anterior to the beak, showing an extremely narrow but elongated lunule, anterior end convexly rounded and well-developed, post-dorsal margin ascends only a little, thence to the extreme posterior, convexly curved rather than truncated, and from the extreme posterior to the ventral margin more sharply curved, the greater part of the margin undulatory on account of the protrusion of the radial ribs.

Surface bearing 19 radiate ribs, with deep interspaces of about the same width; the ribs on the posterior slope are furnished with distant (that is from 1.5 to 2 mm. apart) erect hollow scales or spines, while on the anterior of the shell the scales are packed much more closely, and appear rather as a granulation or irregular oblong beading; ribs also radiately striate, and both interspaces and ribs transversely crossed by lines of growth. Internally strongly denticulate, and owing to the thinness of the shell it is internally grooved, corresponding to the external ribbing.

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1 P.R.S. Vic., vol. viii., n.s., p. 131.

Dimensions.—Antero-posterior diameter, 19 mm.; greatest breadth, 12·5 mm.; umbo-ventral diameter, 11 mm.; thickness through one valve, about 4 mm.

Locality.—Jimmy's Point, Kalimna, Gippsland Lakes. Kalimnan,—Miocene.

Cardita excrescens, sp. nov. (Pl. XII., Figs. 2, 3).

Description.—Shell large, thick and strong, rotund, with a remarkably prominent umbonal region, and bearing coarse radial costae, which are granulosely ornate.

Anterior side extremely short, slightly concave anterior to the umbo, with a relatively small lunule; post dorsal slope long and faintly convex, remainder of the margin regularly rounded. Umbo strong and incurved anteriorly, and rising high so as to give a strong hump to the shell.

Surface sculptured by 19 strong radial ribs, with broader interspaces, except at the ventral margin; both ribs and interspaces increasing in breadth towards the ventral margin; at the medial portion of the ventral margin the distance from centre to centre of two adjoining ribs being (2) two millimetres; the ribs bear a rather strong beading, the beads are irregularly sized, but run about eight in 5 millimetres, becoming more crowded anteriorly, towards the ventral margin for about the last 5 millimetres the beads are replaced by closer imbricating frills. Concentric lamellae show in the interspaces corresponding to the lines of growth, most prominently seen towards the anterior and posterior portions of the shell. Inner margin undulatory and coarsely denticulate, the teeth corresponding to the interspaces.

Dimensions.—Antero-posterior diameter, 21 mm.; umbo-ventral diameter, 22 mm.; thickness through one valve, about 9 mm.

Locality.—Shores of Lake Bullen Merri, near Camperdown. Balcombian,—Eocene.

Lucina gunyoungensis, sp. nov. (Pl. XIV., Fig. 13).

Description.—Shell small, thin, orbicular to quadrately orbicular, somewhat depressed, with a prominent pointed beak, greatest convexity of shell in the umbonal half, thence ventrally rather flattened.

Umbo acute, incurved a little to the front of the medial line, with a very small, deep, but relatively broad, cordate lunule, and further down two faint curved grooves radiating from the umbo to the anterior margin ; shell much depressed anterior to the lunule and inclined to shouldering or angulation at the downward curve of the anterior margin ; dorsal margin straight, downwardly inclined, and somewhat angulate with the posterior margin ; a change in the convex curvature of the ventral margin can be noted from that of the anterior and posterior margins, and this, together with the shouldering, gives rise to the quadrate appearance of the shell.

Surface sculptured by fine close concentric ridges which tend to become lamellose anteriorly and posteriorly, numbering about 20 in 5 millimetres from the ventral margin in average sized specimens, but running closer and finer towards the umbo. No radial sculpture present externally, but internally there is a faint radial striation terminating at the margin in faint crenulations.

Dimensions.—Type specimen, antero-posterior diameter, 13 mm.; umbo-ventral diameter, 12 mm.; others range from 12 mm. by 11 mm., 12·5 mm. by 12 mm. to 14·5 mm. by 14·5 mm.; thickness through both valves of specimen 12·5 by 12 is 6 mm.

Localities.—Grey clays of Grice's Creek or Gunyoung Creek, Mornington. Balcombian,—Eocene. Lower beds of the Spring Creek series or Bird Rock Bluff, near Geelong. Jan Jukian,—Eocene.

Observations.—This species is apparently most closely related to L. leucomomorpha, Tate, but is more depressed, with the umbos more anterior, more deeply excavated anterior to the umbos, and differently sculptured.

Chione etheridgei, sp. nov. (Plate XII., Fig. 1).

Description.—Shell large, transversely oval, thick, and only moderately convex ; greatest convexity near the umbo, and with a marked flattening towards the ventral margin ; deeply concavely excavated anterior to the umbo.

Umbo very prominent, incurved anteriorly, and situated about one-third the length of the shell from the anterior margin. Lunule distinct, elongate cordate, and slightly raised to a medial ridge along the junction of the valves. Dorsally immediately posterior to the umbo the ligamental groove is long and narrow, and is margined by a much more elongate but relatively broad, smooth, flattened, or slightly concave area, which is well defined from the remainder of the shell by an angulation running from the umbo to the posterior margin. The post-dorsal margin is slightly arched, and joins the posterior margin somewhat suddenly; the junction is usually convexly rounded, but occasionally a distinct angulation is noticeable giving rise to a posterior truncation.

Ventral margin regularly and gently convexly rounded to the more strongly convex anterior margin. The surface of the valves is strongly marked by closely packed radial ridges, which are broader than the interspaces umbonally, but the latter become as broad at the ventral margin; the radial ridges show a tendency to subdivision by a minor radial groove, and this is more especially noticeable on the anterior half of the shell; concentric lines of growth are also present and in conformity with some of these, are thin erect frills which are corrugated on their ventral aspect, the ridge on the frill corresponding in position to the interspaces between the radial ridges. The frills become more crowded towards the ventral margin. Inner margin denticulated, anterior denticles at first very fine, gradually increasing in size to the anterior portion of the ventral margin, then along the median portion finer and fairly regular, thence to the posterior a few very strong ones, then gradually fading away.

Dimensions.—Type shell, antero-posterior diameter, 65 mm.; umbo-ventral diameter, 51 mm.; greatest thickness through one valve about 18 mm. Other specimens range 65 mm. by 52 mm.; 63 by 49, 56 by 46, 53 by 42, 52 by 45, and a smaller specimen with both valves in contact gives 44 by 35 and a thickness through both valves of 24 mm.

Locality.—Lower beds of the Spring Creek series or Bird Rock Bluff, near Geelong. Jan Jukian,—Eocene.

Observations.—Two species of this genus of a very similar type of shell have already been described by Professor Tate, namely—C. hormophora, and C. dimorphophylla. The former, however, is of different shape, is strongly inflated, and shows many distinctive features in the surface sculpture; the description of the latter is of the most meagre order, and but for possessing well authenticated examples of the species, it would be difficult to be certain on many points, but by actual comparison the following points may be noted :—C. dimorphophylla is more regularly tumid and not depressed as in the present new species, and shows a marked posterior truncation, and a shorter anterior end, the umbos being much further forward, and the radial ribbing is of a much closer and finer character.

This type of shell is also represented amongst living Australian mollusca, and the species that appears most closely related is C. laqueata, Sowerby, which can be obtained living from the Paramatta River, New South Wales, right up along the Queensland coast. This living species is, however, a strongly inflated and rather coarsely ornate form, as compared with our fossil species.

Chione cognata, sp. nov. (Pl. XII., Fig. 5).

Description.—Shell large, thick, and solid, broadly ovate, regularly convex but not strikingly tumid, with a shallow but broad lunule, and not deeply concave anterior to the umbo.

Umbo broad and strong, incurved anteriorly, and situated about one-fourth the length of the shell from the anterior margin. Anterior margin for the length of the lunule straight, thence to and along the ventral margin regularly convex to the posterior, where the shell shows an evident truncation from the post-dorsal region, dorsal margin gently arched to the posterior truncation. The ligamental groove is deep and very long, being about one-half the length of the shell, and is margined by a broad, but concave dorsal area which only shows lines of growth.

The surface of the valves is crowded with very close and fine radial riblets, which are broader than the interspaces, the riblets thicken somewhat towards the ventral margin but still remain broader than the interspaces ; the radial sculpture is crossed by very fine lines of growth, and by strong regular concentric frills, the frills at first are thin and delicate and usually the bases only are preserved, but towards the ventral margin they become very thick and strong ridges medially, tapering to thinner crenulated frills towards the anterior and posterior of the shell, the concentric frills taking up the character of the radial sculpture are distinctly corrugated on both their dorsal and ventral aspects, ridges corresponding in position to the radial riblets, and where the frills have become broad strong ridges, they show a corrugation on their upper flat surface as well.

Inner margin finely denticulated, in some well-preserved examples the denticles commence under the umbo and extend to the top of the posterior angulation.

Dimensions.—Antero-posterior diameter, 68 mm.; umbo-ventral diameter, 53 mm.

Locality.—Grange Burn, below Forsyth's, Western Victoria (T. S. Hall and G. B. P.). Kalimnan,—Miocene.

Observations.—This species is another of similar type to the foregoing but may be distinguished by its greater inflation, relative dimensions, and detailed characters of surface ornament.

EXPLANATION OF PLATES.

Plate XII.

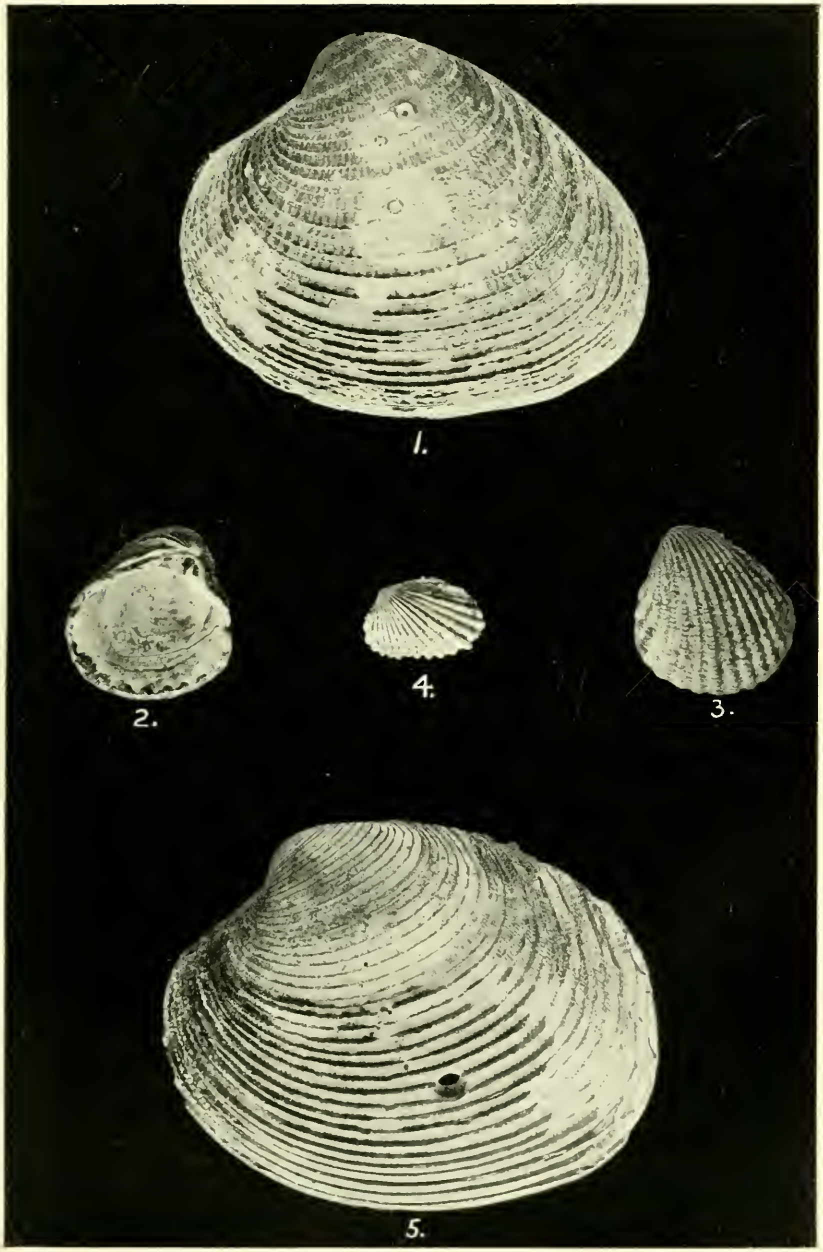
Fig. 1.—Chione etheridgei, sp. nov.
,, 2.—Cardita excrescens, sp. nov., internal aspect.
,, 3.—Cardita excrescens, sp. nov., external aspect.
,, 4.—Mytilicardia kalimnae, sp. nov., slightly reduced.
,, 5.—Chione cognata, sp. nov.

Plate XIII.

Fig. 1.—Crassatellites kingicoloides, sp. nov., external aspect.
,, 2.—Crassatellites kingicoloides, sp. nov., anterior aspect.
,, 3.—Crassatellites kingicoloides, sp. nov., dorsal aspect.

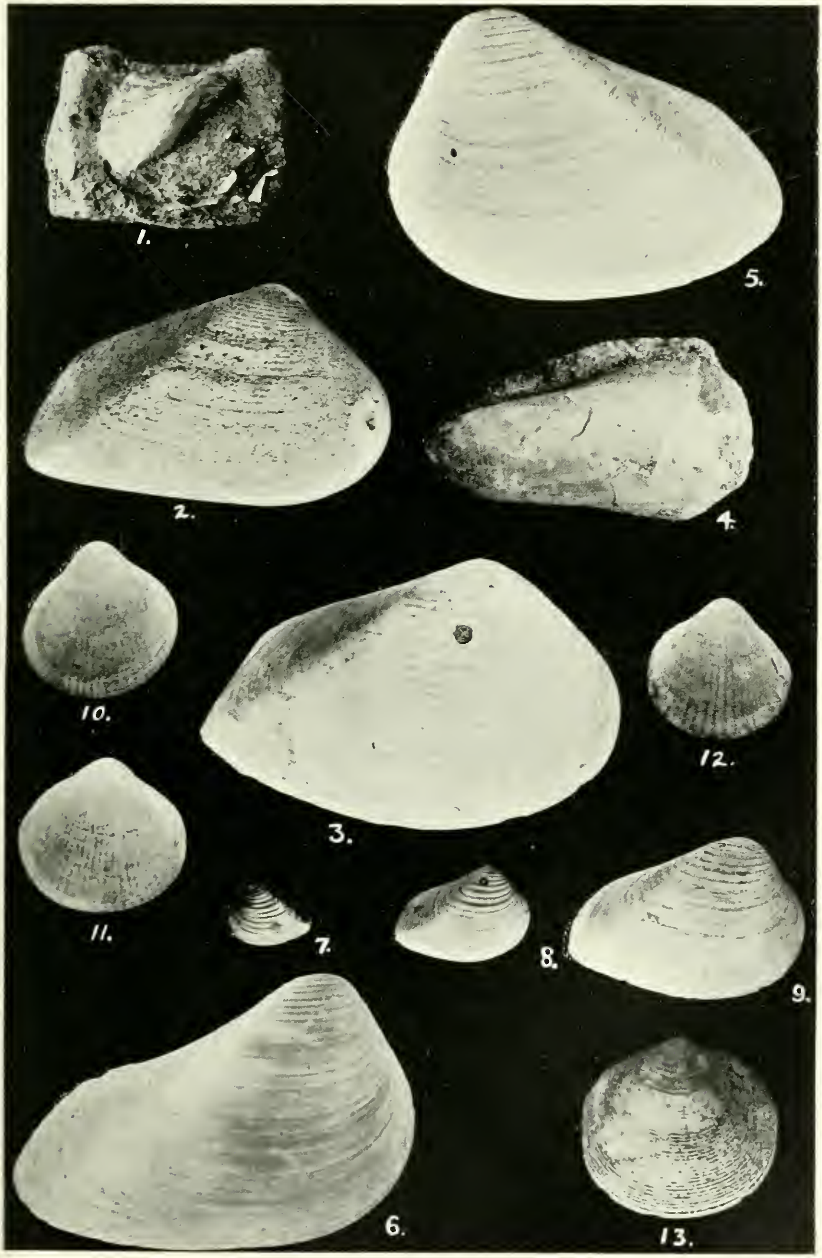
Plate XIV.

Fig. 1.—Mytilus mooraboolensis, sp. nov.
,, 2.—Crassatellites maudensis, sp. nov.
,, 3.—Crassatellites maudensis, sp. nov.
,, 4.—Lithophagus latecaudatus, sp. nov.
,, 5.—Crassatellites camurus, sp. nov., left valve, adult.
,, 6.—Crassatellites camurus, sp. nov., right valve, adult.
,, 7.—Crassatellites camurus, sp. nov., left valve, young, showing umbonal characters.

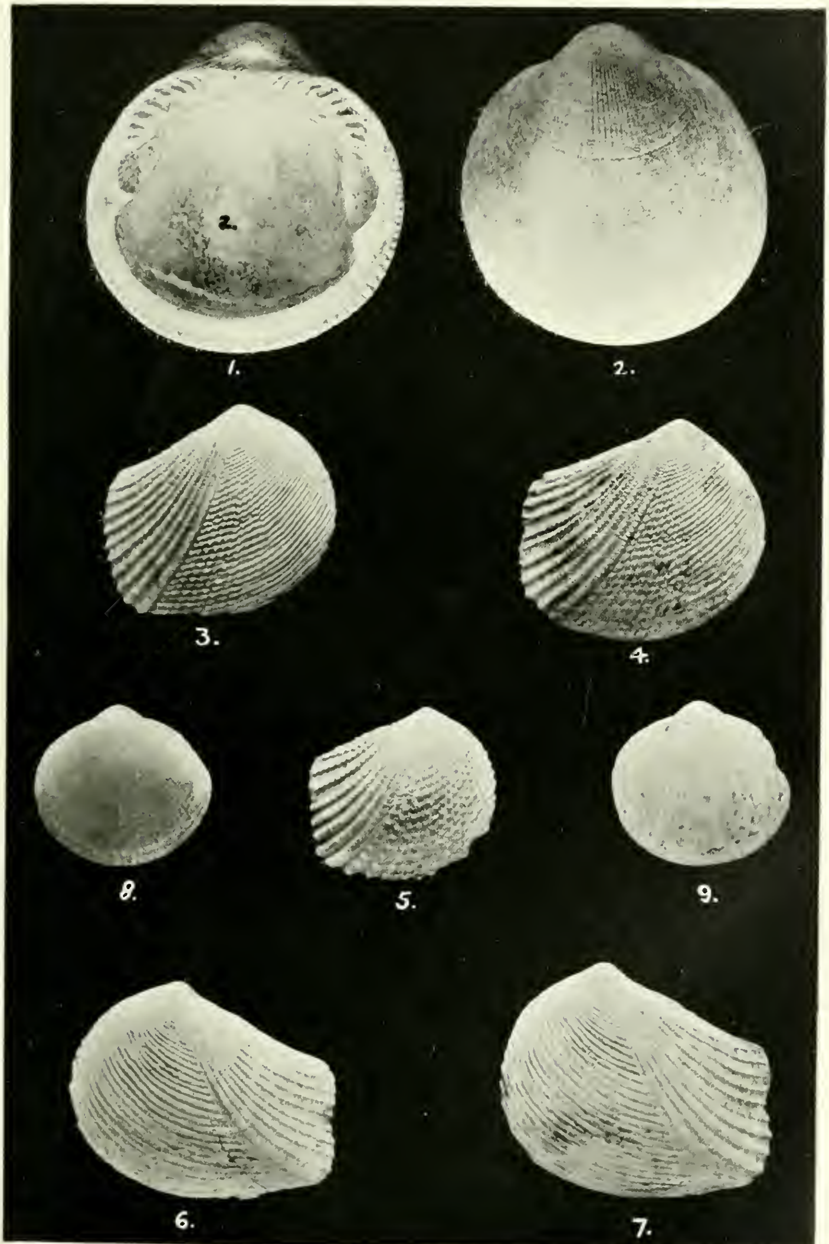


D. W. Paterson, Photo.

D. W. Paterson, Photo.



D. W. Paterson, Photo.



D. W. Paterson, Photo.

Fig. 8.—Crassatellites camurus, sp. nov., right valve, young.
,, 9.—Crassatellites camurus, sp. nov., right valve, young.
,, 10.—Glycimeris halli, var. intermedius, var. nov.
,, 11.—Glycimeris halli, var. intermedius, var. nov.
,, 12.—Glycimeris halli, var. paucicostatus, var. nov.
,, 13.—Lucina gunyoungensis, sp. nov., enlarged twice natural size.

Plate XV.

Fig. 1.—Glycimeris halli, sp. nov., internal aspect, adult.
,, 2.—Glycimeris halli, sp. nov., external aspect, adult.
,, 3.—Trigonia semiundulata, Jenkins, from Spring Creek series.
,, 4.—Trigonia semiundulata, Jenkins, from Spring Creek series.
,, 5.—Trigonia semiundulata, var. granosa, var. nov., right valve, from Lower Spring Creek series.
,, 6.—Trigonia semiundulata, var. lutosa, var. nov., left valve, from Muddy Creek lower beds.
,, 7.—Trigonia semiundulata, var. lutosa, var. nov., left valve, from Muddy Creek lower beds.
,, 8.—Glycimeris halli, sp. nov., young.
,, 9.—Glycimeris halli, var. paucicostatus, var. nov.

Art. XII.—*New or Little-known Victorian Fossils in the National Museum, Melbourne.*

Part I.—Some Palæozoic Species.

By FREDERICK CHAPMAN, A.L.S., &c.,
National Museum.

(With Plates XVI., XVII. and XVIII.).

[Read 11th September, 1902].

? PLANTÆ.

Genus *Bythotrephis*, J. Hall, 1848.

Bythotrephis tenuis, J. Hall. (Pl. XVI., Fig. 1).

B. gracilis, J. Hall, 1848, Palæontology of New York, vol. i, p. 62, pl. 21, fig. 1. [The specific name for this form was afterwards altered by Hall to tenuis, in 1852, on account of its non-agreement with the type specimens of B. gracilis from the Clinton group. See Pal. New York, vol. ii., p. 187].

'*Fucoides*,' Blandowski, 1858, Trans. Phil. Inst. Victoria, vol. ii., pt. 2, pp. 144-5, 2 pls.

Observations.—In the year 1858 W. Blandowski contributed a note to the Philosophical Institute of Victoria, on some fucoid remains which he had found in micaceous and flaggy sandstones in a quarry near the gates of the Botanical Gardens, Melbourne. These specimens were deposited by Blandowski in the Melbourne Museum, the collection in which being afterwards incorporated in the National Museum. The figured specimens, which have not yet come to light, were labelled 2980 and 2981. The specimen now described bears the number 2979 [246][1] and this is now figured.

The absence of any vestige of structure in the so-called fossil fucoids renders their exact determination a matter of some uncertainty. Some forms of hydrozoa, for instance, simulate them in their dendroid habit of growth. The tracks of polychæte

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1 This and all succeeding numbers in *square brackets* refer to registered specimens in the National Museum.

worms, likewise, often resemble the form or outline of a seaweed impression. On the other hand the evidence of a vegetable origin for these remains is strengthened where we have a distinct carbonaceous stain on the rock matrix; or as in these Victorian specimens, a bleached impression, resulting from the leaching of the limonite out of the sandy foundation immediately under the impression, by the decomposition of the vegetable substance, and the formation of an organic acid. And further, the nodose form of parts of the outline in our fossils, as well as their irregular branching habit, is strongly indicative of their plant origin.

This species was recorded by James Hall from the Trenton Limestone of Herkimer County, New York.

Description.—The main stem in this species of Bythotrephis throws off branches and branchlets slightly decreasing in width. Towards their extremities the branchlets have a crispate tendency of growth. Here and there nodosities occur, usually under the branches at the axils, but also along their general surface.

A somewhat analagous species in regard to the angle which the branches make with the main stem, is Brongniart's Fucoides targionii[1], but the more flexuous and slender habit of growth of the Victorian specimens renders the two forms distinct.

Occurrence.—The present examples occur in a fine-grained ferruginous sandstone containing some mica and argillaceous material; the rock resembling in structure an excessively fine arkose, and probably having originated from the finer portion of a granitic detritus. The fossil impressions are pale in colour, or almost white, in contrast to the ochre-coloured matrix, and appear to have been bleached in the manner suggested above.

Locality and Horizon.—Botanical Gardens, South Yarra. Silurian.

ANIMALIA.

Class ACTINOZOA.

Genus *Pleurodictyum*, Goldfuss, 1829.

Pleurodictyum megastomum, Dun. (Pl. XVI., Figs. 2–5).

Pleurodictyum? sp. ind. R. Etheridge, jun., 1896, descr. Tasmanian Sil. Foss., Secretary of Mines Rep., p. 31, pl. 1, fig. 1.

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1 Histoire des Végétaux fossiles, 1828-36, p. 56, pl. iv., fig. 2.

P. megastomum, McCoy MS., W. S. Dun, 1898, Proc. R. Soc. Vict., Vol. X., New Series, pt. II., p. 83, pl. III., fig. 1.

Observations.—By comparing the specimens of Pleurodictyum in the collections at the National Museum, to which Sir Frederick McCoy had attached a MS. name, I am able to verify Mr. Dun's supposition, that the specimens he figures from Mr. Sweet's collection are identical with those previously mentioned by McCoy.[1] Since, however, this form was neither figured or described prior to Dun's paper the reference remains as above.

Some of the specimens in the Museum are of large dimensions, a tabula in one [340] measuring 13 mm. in width, and the corallum 55 mm.

From the very complete examples available, the following diagnosis can be given.

Description.—Corallum roughly circular, or slightly elongated in one direction; base gently convex, often showing across the centre a deep impression of the crinoid stem to which it was in the habit of affixing itself. Epithecal layer of base concentrically rugose, marked by thin wavy ridges. On this basal surface the areas of the corallites are bounded by irregular ridges arranged radially from the centre of the corallum. In this latter feature, and also in its more complanate form, P. megastomum differs specifically from P. stylophorum, Eaton. Area of corallum consisting of from 8 to 14 polygonal corallites united by large mural pores, numbering about 8 or more in the length of the radial walls in one plane, and rather irregularly disposed. Surfaces of tabulæ pustulose, excepting near the periphery of the outer corallites where the surfaces tend to become radially ridged. Width of corallum in an average specimen, 45 mm.; height, 10 mm.

Occurrence.—P. megastomum usually occurs as a cast in the blue or brown Silurian argillaceous limestones; the rock often weathering to a bright yellow in parts, especially in the neighbourhood of the fossils. One of the specimens alone, from locality B. 23 [341], shows the original form and the epithecal layer, but the crinoid stem to which it was attached has been dissolved away.

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1 Ann. and Mag. Nat. Hist., series 3, vol. xx., 1867, p. 201, footnote. Also, Smyth's 1st Progress Report, Melbourne, 1874, p. 34.

Localities and Horizon.—Junction of Woori-Yallock and Yarra Rivers, collected by Geol. Surv. Vict. B. 23 [340-5], and gully near porphyritic dyke west of Mount Disappointment, south of Kilmore, collected by Geol. Surv. Vict. B. 16 [346-8]; specimens in National Museum. Also Kilmore and Mansfield district (Sweet collection, recorded by Dun, *loc. supra cit.*). Probably from Yass[1] (by W. S. Dun); and Yass district,—Bowning series,—New South Wales (by R. Mitchell)[2]; Zeehan, Tasmania (R. Etheridge, jun.). Silurian.

Class CRINOIDEA.

Family ? *Platycrinidae*, Roemer.

Helicocrinus, gen. nov.

Generic characters.—The arrangement of the plates in the dorsal cup is monocyclic. Basals, 3; radials, 5; primibrachs ? (only one preserved in specimen). Tegmen fairly high, vaulted over with numerous polygonal (usually pentagonal) plates. Arms, 5, forked once, ? on third brachial plate; pinnules numerous. Stem pentagonal, with alternate columnals transversely ridged, and crenelate. Evidence of small cirri at intervals down the stem. Proximal end of stem coiled (this last-named character is by no means confined to this genus, but it is so conspicuous in our specimen that it is incorporated in the new generic term merely as a distinction).

Observations.—This type approaches Hapalocrinus, Jaekel,[3] in many respects, but in the latter genus the tegmen is lower, and the stem is round, with longer columnals.

Helicocrinus differs from the typical platycrinids in the larger number of plates which make up the summit or oral region of the test, and also in the pentagonal form of the stem.[4] Its otherwise close relationship with Jaekel's group of the Hapalocrinidae, equivalent as Bather has shown[5] to Wachsmuth and Springer's interpretation of the Platycrinidae, compels one for the present at least, to leave it in this group.

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1 Proc. R. Soc. Vict., new series, vol. x., pt. ii., 1898, pp. 84, 85.

2 Proc. Lin. Soc. New South Wales, series 2, vol. ii., 1887, pp. 412, 413.

3 Palaeontologische Abhandl, Jena, vol. vii. (new series, vol. iii.), 1896-7, p. 95.

4 Wachsmuth and Springer, Revision of the Palaeocrinoidea, pt. iii., Proc. Acad. Nat. Sci. Philad., 1885, p. 314.

5 Geol. Mag., Dec. iv., vol. iv., 1897, p. 344.

Helicocrinus plumosus, sp. nov. (Pl. XVII. and XVIII., Figs. 1–5).

Specific characters.—Dorsal cup small, measuring 6 mm. in greatest width. Tegmen lofty, 13 mm. in height, covered by numerous pentagonal plates. With five arms, each branching once; length of longest arm, 43 mm. Pinnules long and slender, alternating from each side of arm, one to each secundibrach; the latter are slightly longer than broad, and the articulating surfaces are oblique, set on in a zigzag manner. Width of secundibrachs at their base 1 mm. Column pentagonal, with alternating ridges and depressions. The ridges are very pronounced at and just above the proximal coiled end of the stem; usually crenelate, with the intermediate area of the columnals finely and transversely striate. Length of column, not including the coiled portion, 88 mm. Greatest width of columnals, 1.5 mm. Proximal end of column coiled in two turns.

In the arrangement of the pinnules this form resembles Hapalocrinus victoriae, which was described by Dr. Bather, in 1897, from the Silurian of Melbourne.[1] A crinoid with a similarly coiled column is seen in Jaekel's Acanthocrinus rex.[2]

Occurrence.—This beautiful and singularly perfect specimen occurs in a fine sandy matrix, which seems to have been well adapted for preserving such a delicate specimen. The upper part of the crown of the fossil is represented in relief, but of the stem and the larger part of the calyx only a hollow cast remains. [384–5].

Locality and Horizon.—From a quarry at West Brunswick, between Albert and Victoria Streets. Silurian.

Family *Decadocrinidae*, Bather.

Genus *Botryocrinus*, Angelin.

Botryocrinus longibrachiatus, sp. nov. (Pl. XVIII., Figs. 6–8).

Specific characters.—Cup dicyclic, subtrigonal. Infrabasals, 5, pentagonal; basals, 5, hexagonal; radials 5, shield shape.

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1 Geol. Mag., vol. iv., p. 337, pl. xv.

2 *Op. supra cit.*, p. 16, pl. i.

Tegmen fairly high, covered by small hexagonal plates, a few of which are seen in the impression from the fossil. Arm ossicles smooth, usually having the deep ventral groove exposed. Primibrachs, height equal to width. Secundibrachs slightly elongated. Arms, three of which only are visible, branching on 4th primibrach, giving rise to two slender armlets, which subsequently branch again at unknown intervals (this last structure was seen in detached fragments). Stem pentagonal, with sulcate sides. Stem ossicles short, consisting of large projecting joints, and smaller non-salient ones. Stem canal, pentagonal.

Measurements.—Dorsal cup, 7.5 mm. high; width above, 10 mm.; width below, 3.5 mm. Length of arms visible to 40 mm. Width of stem at 5 mm. below cup, 2.75 mm.

Observations.—This species resembles B. quinquelobus, Bather[1] (from the Silurian of Dudley) in the form of the cup; the arms, however, are slender and more closely adpressed at the axils in our species.

Occurrence.—Found in a bluish micaceous sandstone, which also contains remains of Homalonotus harrisoni. The crinoidal remains occur chiefly in casts, of which, however, good impressions may be taken, as the rock is tenacious.

Locality and Horizon.—Royal Park, Brunswick (probably near the Model Farm). Collected many years since by Mr. T. Harrison, and presented by him to the National Museum. [390–2]. Silurian.

Order OSTRACODA.

Genus *Beyrichia*, McCoy, 1846.

Beyrichia kloedeni, McCoy.

McCoy, 1846, Synopsis Sil. Foss. Ireland, p. 58 (woodcuts). Id., 1851, Brit. Pal. Foss. pt. 2, fasc. 1, p. 135, pl. 1E., fig. 2. Jones, 1855, Ann Mag. Nat. Hist., ser. 2, vol. xvi., p. 165, pl. vi., figs. 7 and 9.

Jones and Holl, 1886, *ibid.*, ser. 5, vol. xvii., p. 349.

This rather variable form appears to be one of the commonest Victorian species, so far as we can tell from the limited collections

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[1] Ann. Mag. Nat. Hist., series 6, vol. ix. 1892, p. 189, pl. xi., figs. 1, 2.

already made. Possibly several described varieties are present, including var. torosa, Jones.[1] Many of the specimens from the Silurian of Victoria are represented by hollow moulds of the valves, from which it is possible to obtain a very faithful impression in wax. In others, again, we have a cast of the interior of the valve in relief, the shell having been dissolved completely away.

Locality and Horizon.—Junction of Woori-Yallock and Yarra Rivers. Collected by Geol. Surv. Vict. B. 23. [431-6] Silurian.

Beyrichia kloedeni, McCoy, var. *granulata*, Jones. (Pl. XVI., Fig. 8).

Jones, 1855, Ann. Mag. Nat. Hist., ser. 2, vol. xvi., p. 166, pl. vi., fig. 9. Jones and Holl, 1886, *ibid.*, ser. 5, vol. xvii., p. 350, pl. xii., fig. 2.

Several examples of the above variety were found amongst a collection of specimens labelled Beyrichia in the National Museum, one of which (the specimen now figured) shows the anterior lobe in the hypertrophied condition. [440]. The surface of the valve shows a certain amount of granulation like the variety figured by Prof. Rupert Jones. Our specimen seems to have been slightly crushed between the posterior and middle lobes.

Locality and Horizon.—Junction of Woori-Yallock and Yarra Rivers, east of Melbourne. Collected by Geol. Surv. Vict. B. 23. [437–40]. Silurian.

Beyrichia wooriyallockensis, sp. nov. (Pl. XVI., Fig. 6).

Description.—Valves sub-oblong, with three unequal lobes; the middle lobe is short, extending only halfway to the ventral edge of the valve, freely coalescing with the ventral ends of the anterior and posterior lobes; anterior lobe full, but not much longer than the middle lobe; the hind lobe broader and flatter at the dorsal edge of the valve than the other two, and modified by a vertical sulcus to nearly one-half its length; ends of lobes

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1 Ann. Mag. Nat. Hist., series 2, vol. xvi., p. 167, pl. vi., figs. 10, 11, ? 12.

slightly salient on the dorsal edge of the valve. The curved border has a raised marginal rim.

Measurements.—Length, 2.08 mm.; height, 1.08 mm. Proportions, 25:13.

Observations.—The above species shows some relationship to the well-known B. kloedeni, which we have now recorded from Victoria, and more especially to the variety described and figured by Jones and Holl as var. intermedia of that species,[1] the chief difference being the larger development of the gigot lobe with its vertical sulcus in B. wooriyallockensis. The valve in the latter form is also much longer in proportion to its breadth, and the lobes are distinctly coalescent. Another form to which our specimen at first sight shows affinity is B. admixta, Jones and Holl,[2] especially with regard to the prominence of the free ends of the lobes; the hind lobe in the Victorian species, however, is of quite a different form, and is not adpressed to the hinder curved border of the valve.

Locality and Horizon.—Found at the junction of the Woori-Yallock and Yarra Rivers, east of Melbourne. Collected by Geol. Surv. Vict. B. 23. [446]. Silurian.

Beyrichia maccoyiana, Jones, var. *australiæ*, nov. (Pl. XVI., Fig. 7).

Description.—This variety is distinguished from the type species by the narrower form of the anterior and middle lobes. In the present variety the hind or gigot lobe is divided by a vertical sulcus; also the area in proximity to the curved border is less encroached upon by the front lobe, and the frill on the ventral edge is consequently more conspicuous.

Observations.—A species of Beyrichia described by Krause from the Lower Silurian (Ordovician) Clays of the Baltic area, namely, B. marchica[3] bears a slight affinity to our form, but the difference in the position of the lobes is very marked.

Locality and Horizon.—Junction of the Woori-Yallock and

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1 Ann. Mag. Nat. Hist., series 5, vol. xvii., 1886, p. 352, pl. xii., figs. 3, 4.

2 Ann. Mag. Nat. Hist., series 5, vol. xvii., 1886, p. 359, pl. xii., fig. 5.

3 Zeitschr. deutsch. Gesellsch., 1889, p. 19, pl. ii., figs. 10, 11.

Yarra Rivers. Collected by Geol. Surv. Vict. B. 23. [441-3]. Silurian.

Beyrichia kilmoriensis, sp. nov. (Pl. XVI., Fig. 9).

Description.—Valves sub-oblong, general area flat. Dorsal line straight, except where broken by the salient lateral lobes. Ventral border well-rounded, especially in front. The two fore most lobes narrow, long, and curved towards the anterior end; the hind-lobe nearly obsolete, most conspicuous at the dorsal edge on the posterior angle. Curved border with an upturned rim. Surface of valves smooth.

Measurements.—Length, 2.45 mm.; height, 1.36 mm.

Observations.—This species and the next one to be described belong to the jugose type of Beyrichiæ, and in the narrowness of the lobes resemble B. complicata, Salter,[1] which, by the way, is a characteristic Ordovician fossil. The tapering character and evanescence of the two foremost lobes in the region of the ventral border in our species, however, is strikingly distinct.

Locality and Horizon.—Found at Broadhurst's Creek, east of Kilmore, Victoria. Collected by Geol. Surv. Vict. Bb 18. [445]. Silurian.

Beyrichia ligatura, sp. nov. (Pl. I., Fig. 10).

Description.—Valves sub-oblong, rather narrow in lateral aspect, surfaces somewhat convex, with the three lobes well-marked. The anterior lobe pear-shaped, salient, and strongly curved towards the antero-dorsal angle; middle lobe narrow pear-shape, and very prominent or even ridgelike, with a slight forward curvature, and salient on the dorsal edge of the valve; posterior lobe smaller than the anterior, pear-shaped and resting against the upturned rim of the ventral border. The other lobes do not quite reach the sulcate area inside the ventral rim of the valve.

Measurements.—Length, 1.6 mm.; height, 1 mm.

Locality and Horizon.—Junction of the Woori-Yallock and the

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1 Mem. Soc. Geol. Surv., 1848, vol. ii., pt. i., p. 352, pl. viii., fig. 16; also M'Coy, Brit. Pal. Foss., 1851, pt. ii, fasc. 1, p. 136, pl. i. E., fig. 3.

Salter, *ibid.*, 1852, fasc. 2, Appendix A, p. ii.

Compare Jones, 1855, Ann. and Mag. Nat. Hist., Ser. 2, vol. xvi., pl. vi., fig. 4.

Yarra Rivers. Collected by the Geol. Surv. Vict. B. 23. [444]. Silurian.

Order PHYLLOCARIDA, Packard.

Sub-Order Ceratiocarina.

Family *Caryocaridæ*, nov.

Genus *Caryocaris*, Salter, 1863.

Caryocaris angusta, sp. nov. (Pl. XVIII., Fig. 10).

Description.—Carapace bivalved, narrow, oblong, widest at the postero-ventral region; dorsal border straight, ventral gently convex, and well-rounded posteriorly[1]: usually three and a-half times as long as high, but variable in its proportionate length; smooth, with a faint creasing or folding parallel with the ventral margin. Length of figured specimen, 25 mm.; height, 7 mm.

Observation.—C. angusta approaches some varieties of C. wrightii, Salter,[2] from the Skiddaw Slates, especially those with narrow valves, but it differs from them in the less sharply truncate extremities. C. oblongus, Gurley,[3] from the calciferous shales of Canada, also closely approaches the Victorian specimens, but is not quite so long in proportion to its height. The above form was referred by Gurley to the graptolities.

Localities and Horizon.—Collected by the Geological Survey of Victoria, Ba 90 [193-4] and Ba 92 [195] near Guildford; also from the Parish of Coole Barghurk, W.L.S.2. From Castlemaine, associated with Didymograptus caduceus (T. S. Hall collection). Lower Ordovician.

Genus *Saccocaris*, Salter, 1868.

Saccocaris tetragona, sp. nov. (Pl. XVIII., Fig. 11).

Description.—Valves sub-rectangular, oblong,. Length, a little

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1 By the evidence of the position of the caudal appendages derived from the type of the genus *Rhinopterocaris* presently to be described, it seems necessary to reverse the relative position of the valves from that in which it was regarded by Salter, Jones, and Woodward for this particular group, and to take the narrow end as the anterior. By this reading also the valves correspond in position with *Hymenocaris*, which was, however, not so distinctly bivalved.

2 *C. wrightii*, Salter, Jones, and Woodward, 1892, Mon. Brit. Pal. Phyllopoda (Pal. Soc.), p. 89, pl. xiv., figs. 11-15.

3 Journal of Geology, vol. iv., No. 1, 1896, p. 87, pl. iv., fig. 2.

more than two and a-half times the height. Upper and lower edges straight or slightly undulate, and divergent towards the posterior extremity. Ends gently rounded; lower edge of valve apparently notched or fimbriate in some specimens. Length of figured example, 12 mm.; height, 4.5 mm.

Observations.—The valves of S. tetragona as they occur in the Victorian rock-specimen (a pale crumpled shale), are somewhat distorted, but the general outline can be distinctly made out in one or two better preserved examples. Its nearest ally seems to be S. minor,[1] from the Lower Ordovician of Arenig and Portmadoc.

Locality and Horizon.—Collected by the Geological Survey of Victoria B. 26. [196.] Lower Ordovician.

Genus *Rhinopterocaris*, gen. nov.

Generic characters.—Carapace bivalved, long ovate, shaped somewhat like the wing of a dipterous insect. Dorsal border gently convex, ventral more strongly curved; well-rounded posteriorly, tapering more acutely towards the anterior extremity, the anterior portion of the carapace sometimes exhibiting traces of thoracic or rostral structures. The caudal extremity having a short, sharply pointed telson, with vestiges of a sharp stylet. Carapace smooth, but having a few strong lateral folds on the ventral margin, and one on the dorsal margin. Masticatory apparatus like that of Dithyrocaris, but having the highest cusps in the middle of the ridge. An elongate pyriform pit is seen in the area immediately below the dorsal border at the anterior end, which seems to be comparable with the stalk-eye socket of the recent Nebalia, to which the palæozoic phyllocarids appear to be most nearly allied.

Rhinopterocaris maccoyi, Etheridge, fil., sp.
(Pl. XVIII., Figs. 9, ? 16, 17).

Lingulocaris maccoyi, R. Etheridge, fil., 1892, Records Geol. Surv. N. S. Wales, vol. iii., pt. 1, pp. 5–8, pl. iv.

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[1] Jones and Woodward, 1891, Rep. Brit. Assoc., p. 424, figs. 1-17; *Ibidem*, 1892, Mon. Brit. Pal. Phyllopoda Pal. Soc.), p. 86, pl. xiv., figs. 7-9.

Caryocaris curvilatus, Gurley, Journal of Geology, vol. iv., No. 1, 1896, p. 87, pl. iv., fig. 3; pl. v., fig. 3.

Specific characters.—Carapace thin, or even filmy, winglike in appearance, sub-elliptical, well-rounded ventrally, dorsal and ventral margins with deep folds, excepting on the extreme edge. A few oblique wrinkles crossing the ventral folds both ways in the posterior ventral region, which possibly mean a strong original inflation of that part of the carapace. Vestiges of chitinous thoracic or cephalic appendages sometimes preserved at the anterior extremity of the carapace; this end is distinctly blunt in general form in well-preserved specimens, thus differing from that of Lingulocaris. Occasionally the two valves are found united (see Fig. 17). Posterior extremity of carapace occasionally showing a minute tuberculation near the hinge line. Telson short, sharply pointed, and with a laterally attached and oblique stylet. Masticatory apparatus consisting of a maxillary ridge or base, with about eight sharp cusps, the highest being in the middle.

Measurements.—Extreme length of longest specimen figured, 40 mm. Greatest height of same specimen, 11 mm. Average length of carapace without appendages, 30 mm.

Observations.—In the lower Ordovician slates and shales of Victoria certain Phyllocarida occur, often in great abundance. The largest and commonest of these forms was referred by Sir F. McCoy to the genus Hymenocaris, and he gave the provisional or MS. name of H. salteri to the species in 1861.[1] Since that time, although often referred to by the above-mentioned name, it had not been systematically described until 1892, when Mr. Etheridge, jun. (*op. supra cit.*), gave a very complete account of the form, so far as specimens were available, with full references to past records; and figures were also given of some of these Victorian fossils. Etheridge then referred the form to the genus Lingulocaris on account of its general shape; the affinity to Caryocaris, in which genus Salter had previously suggested it should be included,[2] being considered slight, since it differed in its general outline. The specific name maccoyi was then substi-

[1] The ancient and recent Natural History of Victoria. Vict. Intercol. Exhib. Essays, p. 162.

[2] Quart. Journ. Geol. Soc., vol. xix., 1863, p. 139, note.

tuted by Etheridge, for Salter's name had already been attached to a species of Lingulocaris—L. salteriana.

R. R. Gurley has found certain fossil remains in the calciferous series of Summit, Nevada, and Point Levis, Canada, which may be referred to the above genus. They are associated in the North American strata, as in the Victorian, with graptolites of the Lower Ordovician types, and Gurley interprets their structure as representing the polypary of a graptolite, with "the proximal portion possibly thecaphorous." There appears to be no direct evidence, however, which points to that conclusion, and, moreover, the characters of Caryocaris, to which genus Gurley refers them, have been well defined by Messrs. Salter, Jones, and Woodward as a genus of bivalved crustacea of the phyllocarid group.

During my examination of an extensive series of phyllocarid remains in the collection of the National Museum, and in private collections, I was struck with the different appearances shown by the carapaces of these fossils when preserved in a crumpled rock, and when found in a fine-textured shale. For the better preservation of the carapace we naturally turn to specimens preserved in a fine-grained rock, or one which has been subjected to a minimum of deformation. In the fine-textured shales from the north of Lancefield the carapaces are found to be practically smooth in the central area, excepting where roughened secondarily by chemical action between the folia of the rock. The dorsal and ventral borders of the valves are deeply sulcate or folded and traversed obliquely by shorter folds, or sometimes by fine, long, hair-like grooves. In those examples which are found in the crumpled slates or phyllites the valve has been correspondingly crumpled and distorted, often, however, in a most regular manner, and at first suggestive of a primary wrinkling in the carapace itself.

The generic differences which separate this form from other previously described genera of the Phyllocarida is made apparent by the discovery of the exceptionally perfect specimen now figured, and which was collected by the Geological Survey of Victoria at the camp north of Lancefield Ba 27 [174]. This specimen, which is in the collection at the National Museum, shows that the animal possessed a short stylet, like that suggested by Salter for Caryocaris.[1] The outline of our specimen is essentially different from both Lingulocaris and Caryocaris; and the peculiarly formed rostral processes seen in our specimen seem to be quite unknown in the above-mentioned genera, to which this form might otherwise be somewhat related. The masticatory apparatus has not been recorded from any of its immediate allies, the nearest being the well-known dental ridges of Dithyrocaris, which, however, differ in having the longest cusps at the anterior end instead of the median, as in Rhinopterocaris.

Localities and Horizon.—Rhinopterocaris maccoyi occurs at several of the lowermost horizons in the Lower Ordovician of Victoria, which are characterized by different assemblages of Graptolites. The specimens obtained by the Geological Survey of Victoria, and now in the National Museum, are as follows:—Camp north of Lancefield, Bb 27 [174-7] associated with Tetragraptus fruticosus, T. serra and Phyllograptus typus, in a pale grey slate. Bb 31 [172-3] in chiastolite slate. Bb 39 [167-71] associated with Tetragraptus serra, in dark grey slate. Bb 40 [182-5] in phyllite. Bb 41 [188] in pinkish decomposed shale (caudal appendages). Bb 44, [186-7] in black shale. West of Gisborne, Ba 70 [244] in greenish-grey slate. (?) Barker's Street, Castlemaine, Ba 78 [245] associated with Didymograptus caduceus, Tetragraptus decipens, and Loganograptus logani, in greenish-yellow slate. E. of Guildford, Ba 83 [189] in decomposed shale. Near Guildford, Ba 91 [190-1] associated with Didymograptus sp. and Trigonograptus wilkinsoni, in decomposed shale. From Parish of Coole Barghurk, W.L.S.2 and W.L.S.3 [180-1] in black slate.

Also from Burn's Reef, Chewton, Bendigo, Castlemaine (T. S. Hall collection).

From Castlemaine, an exceptionally large carapace measuring 50 mm. in length, and 20 mm. in greatest height (G. B. Pritchard collection).

Mr. Etheridge's specimens came from Bendigo, and from Baynton's, Campaspe River, Central Victoria.

My best thanks are due to Mr. T. S. Hall, M.A., and Mr. G. B. Pritchard, for their kind loan of specimens which enabled me to work out the details of this and the foregoing species.

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[1] Quart. Journ. Geol. Soc., vol. xix., 1863, p. 137 (fig. 15) and p. 139.

Class BRACHIOPODA.

Genus *Siphonotreta*, de Verneuil, 1845.

Siphonotreta maccoyi, sp. nov. (Pl. XVIII., Figs. 12–14).

Description.—Valves sub-circular, front margin broadly rounded, sides irregularly rounded; surface of valves slightly convex and acuminate towards the foramen. Dorsal valve smaller and broader than the peduncle valve. Foramen small. Surface of valves ornamented with a series of fine, numerous and equidistant concentric striations, which are slightly imbricate, and bearing vestiges of blunt spines at distant intervals. Length generally equal to the breadth. The specimens vary considerably in size, and examples of intermediate dimensions occur; those from the Lower Ordovician are usually smaller than those of the Upper Ordovician. Limits of length measurement of specimens in the National Museum, 4 to 10 mm.

This species is easily separable from S. micula,[1] to which it bears most resemblance, by having a much larger number of concentric striæ, which are also finer; the latter form usually exhibit three or four concentric lineations, which are very strong and distinct.

In S. maccoyi the foramen is small and generally obscure, but can be traced by the position of the median fissure, seen in the more or less crushed examples, resulting from the fracture of the thin shell over the pedicle tube. Many of the valves have been distorted by pressure, laterally, longitudinally, or obliquely.

Observations.—In 1867 Prof. M'Coy noted the occurrence of Siphonotreta in Victoria, and referred to the fossils in the following words[2]:—

"As a general rule, the Graptolite slates in every part of the world contain no other fossils. I, many years ago, discovered in Wales, near Builth, the only shell I ever heard of in Graptolite slates (the *Siphonotreta micula*, M'Coy), and I was greatly surprised to recognise it also in Victoria in the Deep Creek section."

Since the above date this fossil has often been quoted as S.

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[1] Brit. Pal. Foss., 1852, p. 188, pl. 1H., fig. 3. Also Davidson, Mon. Brit. Sil. Brach. (Pal. Soc.), 1866, p. 76, pl. viii., figs. 2-6.

[2] Ann. Mag. Nat. Hist., ser. 3, vol. xx., 1867, p. 201.

micula in lists of Australian fossils. A careful examination of a large number of valves from the Deep Creek section and elsewhere has convinced me that they differ in essential characters from the well-known British species, and the form will I think most appropriately be designated by associating with it the name of its first discoverer.

Localities and Horizons.—Collected by the Geological Survey of Victoria, Bb 29 [198—9] Newham; associated with Didymograptus extensus, Tetragraptus quadribrachiatus, Clonograptus rigidus var. tenellus, Diplograptus sp., Lasiograptus sp., and Phyllograptus typus. Lower Ordovician.

Geological Survey of Victoria, Ba 62 [232-5] and 64 [219-31], Deep Creek, Saltwater River, north-west of Bulla; associated with Stephanograptus gracilis, Dicranograptus ramosus, Dicellograptus furcatus, Diplograptus sp., and Climacograptus bicornis. Upper Ordovician.

Order PTEROPODA.

Genus *Hyolithes*, Eichwald, 1840.

Hyolithes leptus, sp. nov. (Pl. XVIII., Fig. 15).

Description.—Shell straight, conical, and attenuate, tapering very gradually. (Apex missing.) Aperture opening obliquely towards the extended margin of the dorsal side. Surface of shell convex, but somewhat crushed in the present specimen; marked transversely with convex lines near the apex, but becoming sinuous nearer the apertural end. Sides of shell with a narrow sunken border possibly indicating a lateral angulation. Length when complete, about 50 mm.; length of specimen, 41 mm.; width at aperture, 7.5 mm.; width at broken proximal end, 3 mm.

Observations.—This species shows some affinity with certain forms of Hyolithes described by Billings and Walcott from the Lower Cambrian (Olenellus zone) of Newfoundland, Canada, and the United States, and especially with H. communis, Billings, var. emmonsi, Ford.[1] Our specimen, however, is more attenuate, and the surface striæ are not so fine, the area between them often forming superficial ridges. The specimen figured by Tate from

[1] Bull. U.S. Geol. Survey, No. 30, 1886, p. 137; Walcott, U.S. Geol. Surv. Tenth Ann. Rep. (1888-9) 1890, p. 621, Pl. lxxvii. fig. 4, 4*a*, *b*.

the Cambrian of Curramulka, South Australia, under the name of H. communis, Billings, is not far removed from our specimen in general appearance, but the striæ are finer and the shell is proportionately shorter.[2]

Locality and Horizon.—Collected by the Geological Survey of Victoria, W.L.S.2 [197], Parish of Coole Barghurk. Lower Ordovician.

EXPLANATION OF PLATES XVI., XVII. AND XVIII.

Plate XVI.

Fig. 1.—*Bythotrephis tenuis*, J. Hall. Natural size. [246].

Fig. 2.—*Pleurodictyum megastomum*, Dun. A cast of the corallum of a very large specimen. Natural size. [340].

Fig. 3.—*P. megastomum.* Base of a well-preserved specimen, showing the epithecal surface, and an impression of a crinoid stem-fragment to which the coral was originally attached. Natural size. [341].

Fig. 4.—*P. megastomum.* Taken from a wax squeeze, showing the under surface of a tabula, with radial ridges and tubercles. Natural size. [340].

Fig. 5.—*P. megastomum.* Two radial ridges of the above more highly magnified, to show the quasi-linear arrangement of the tubercles. × 3. [340].

Fig. 6.—*Beyrichia wooriyallockensis*, sp. nov. Right valve; taken from a wax squeeze. × 12. [446].

Fig. 7.—*Beyrichia maccoyiana*, Jones, var. *australiæ*, nov. Left valve. × 10. [441].

Fig. 8.—*Beyrichia klœdeni*, M'Coy, var. *granulata*, Jones. Right valve; a specimen showing the hypertrophied anterior lobe. From a wax squeeze. × 7. [440].

Fig. 9.—*Beyrichia kilmoriensis*, sp. nov. Left valve. × 11. [445].

Fig. 10.—*Beyrichia ligatura*, sp. nov. Right valve. × 15. [444].

2 Trans. R. Soc. S. Australia, vol. xv. (1891-2), p. 186, pl. ii., fig. 2.

PLATE XVII.

Helicocrinus plumosus, sp. nov. From the Upper Silurian of Brunswick, near Melbourne. Slightly under natural size. [384].

PLATE XVIII.

Fig. 1.—*Helicocrinus plumosus*, sp. nov. Calyx showing the arrangement of the plates in the dorsal cup and tegmen. Pinnules not shown. × 2. From a wax squeeze.

Fig. 2.—*H. plumosus*, sp. nov. Part of stem near distal end, with five columnals. × 4. From a wax squeeze.

Fig. 3.—*H. plumosus*, sp. nov. Transverse section of stem. × 4.

Fig. 4.—*H. plumosus*, sp. nov. Coiled proximal end of stem, nearly cylindrical, and with prominent ridges. Taken from a wax squeeze. × 2. [385.]

Fig. 5.—*H. plumosus*, sp. nov. Anterior extremity of a branch, showing the mode of attachment of the pinnules to the secundibrachs. × 2. [384.]

Fig. 6.—*Botryocrinus longibrachiatus*, sp. nov. The stem, dorsal cup, traces of the tegmen, and ventral aspect of brachials. From a wax squeeze. × 2. [390.]

Fig. 7.—*B. longibrachiatus*, sp. nov. Section of stem, with pentagonal canal. × 4. [392.]

Fig. 8.—*B. longibrachiatus*, sp. nov. Two slender armlets, one exposing the furrow for the axial cord. From a wax squeeze. × 3. [391.]

Fig. 9.—*Rhinopterocaris maccoyi*, Eth., fil., sp. An exceptionally perfect specimen, showing the masticatory apparatus. Left valve. × 2. [174.]

Fig. 10.—*Caryocaris angusta*, sp. nov. Left valve. Natural size. [195.]

Fig. 11.—*Saccocaris tetragona*, sp. nov. Right valve. × 2. [196.]

Fig. 12.—*Siphonotreta maccoyi*, sp. nov. Peduncle valve of a large specimen. × 2. [229.]

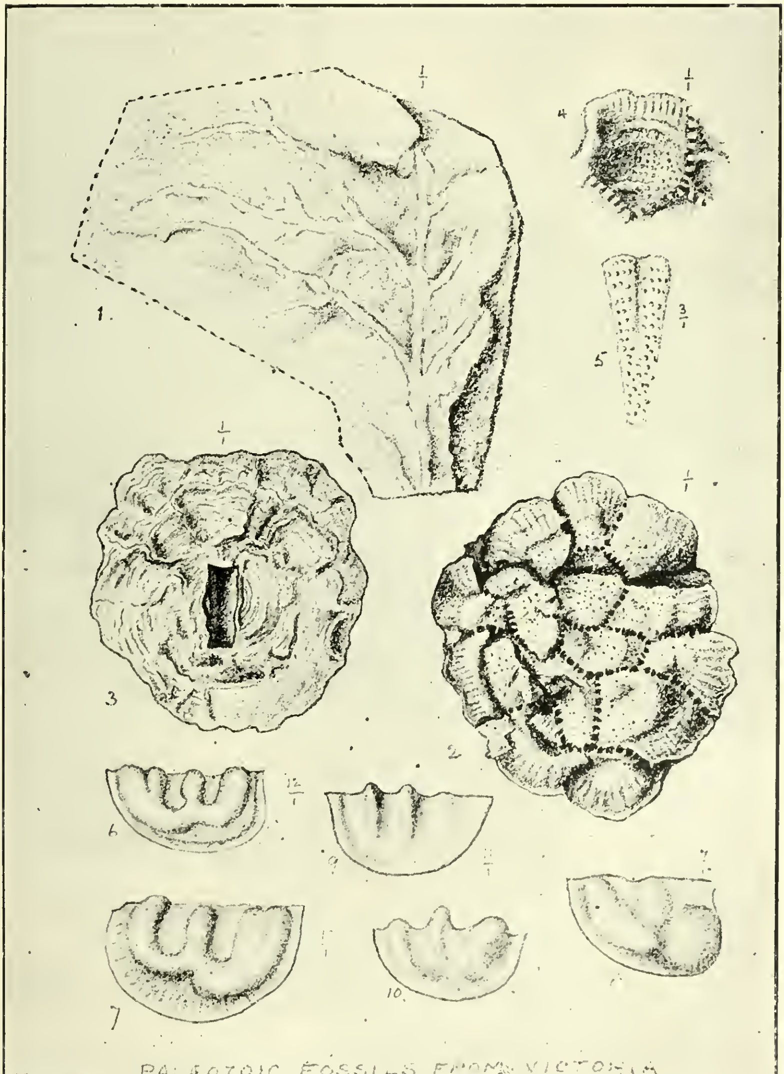
Fig. 13.—*S. maccoyi*, sp. nov. Dorsal valve of a smaller specimen, broadened by crushing. × 4. [199.]

Fig. 14.—*S. maccoyi*, sp. nov. Interior of a dorsal valve, distorted by pressure. × 4. [198.]

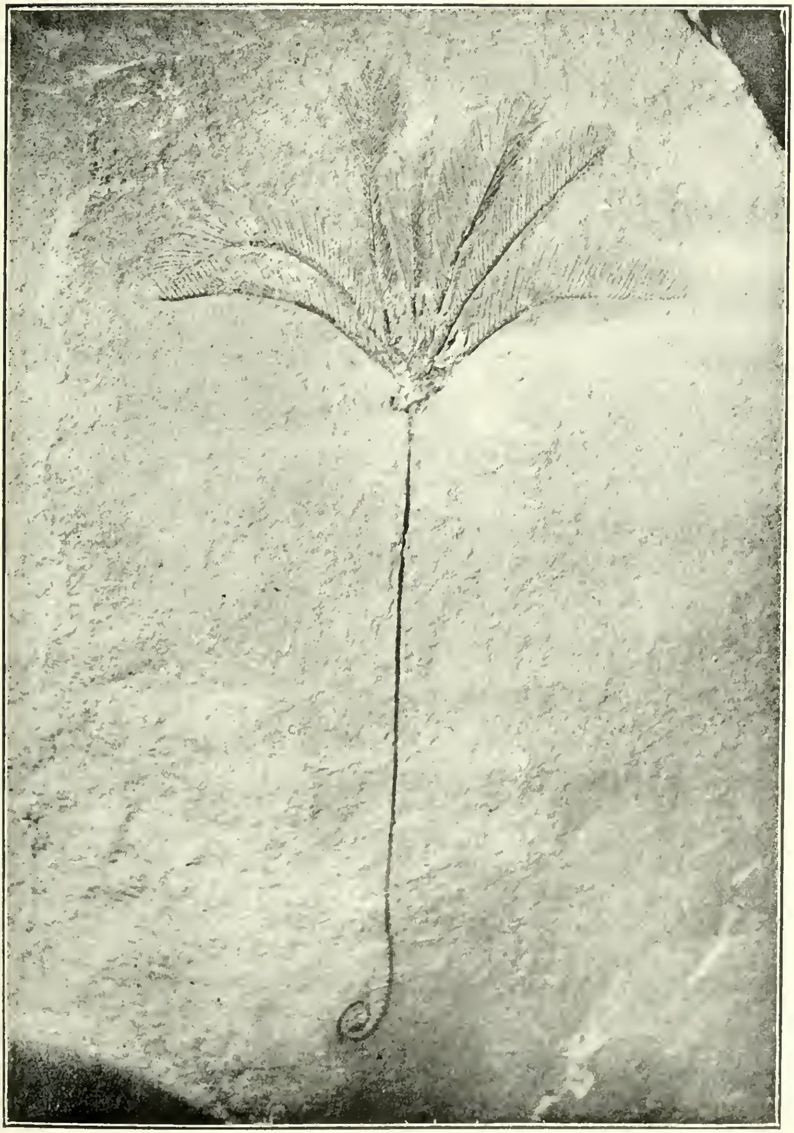
Fig. 15.—*Hyolithes leptus*, sp. nov. Natural size. [197.]

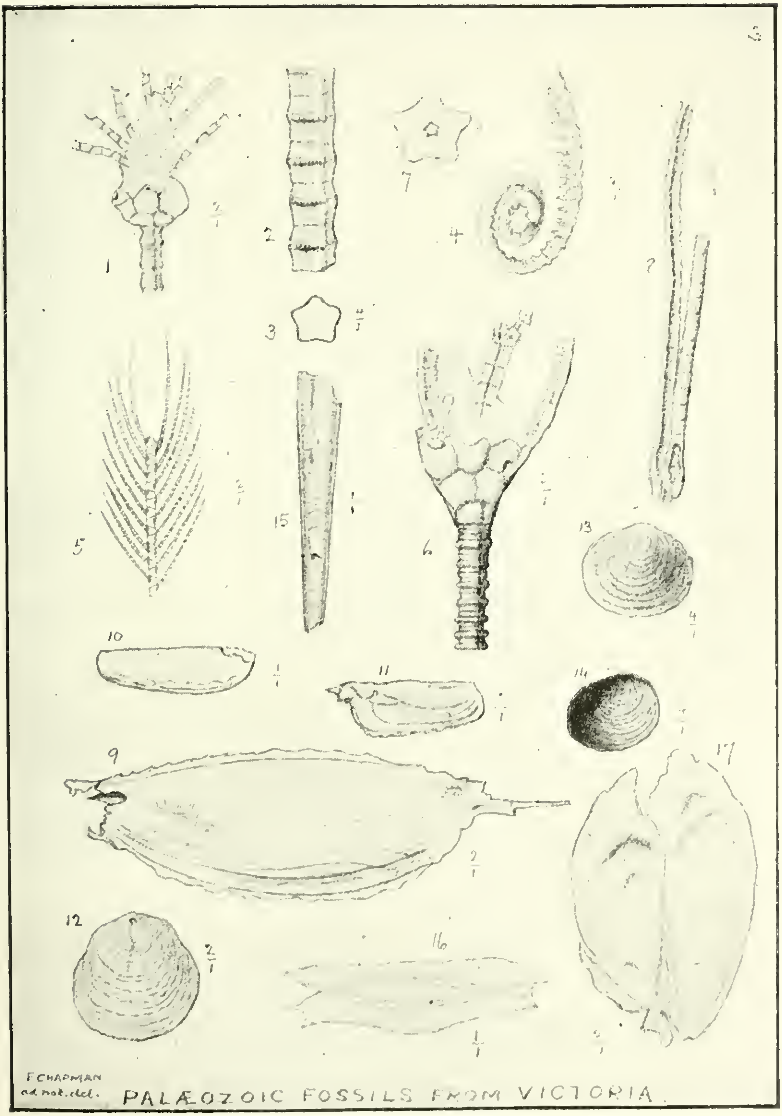
Fig. 16.—*? Rhinopterocaris maccoyi*, Etheridge, fil., sp. Two valves overlapping, and laterally displaced, the dorsal edges being outside. Natural size. [245.]

Fig. 17.—*R. maccoyi*, Eth., fil., sp. Two united valves. × 2. [184.]



PALÆOZOIC FOSSILS FROM VICTORIA.





PALÆOZOIC FOSSILS FROM VICTORIA.

Art. XIII.—*The Age of the Metamorphic Rocks of North-Eastern Victoria.*

By J. W. GREGORY, D.Sc., F.R.S.

[With Plates XIX.–XXI.].

(Read 11th September, 1902).

I.—Introduction.

The geological history of Victoria is generally represented as beginning in the ordovician (lower silurian) period.[1] This view is based upon the belief that the broad areas of schists and metamorphic rocks in the extreme west, and in the north-east of Victoria have been formed by the metamorphism of silurian and ordovician rocks in post-silurian times. This view is repeatedly expressed in the geological literature of Victoria. Dr. Selwyn attributes such an origin not only to the schists, but even to the granites. He stated[2] that the "granites are in no sense intrusive or irruptive masses, but only the completely-transmuted ends of the silurian rocks that have either been lowered in early geological times to within the influence of central heat, or by some means been subjected to other powerful transmuting agencies."[3]

The same theory is taught in Mr. R. A. F. Murray's "Physical Geography and Geology of Victoria" (pp. 37, 38); and Mr. A. W. Howitt lent the weight of his authority to this view by maintaining the existence of a passage from silurian sediments to metamorphic rocks in various parts of the Victorian Alps. In Mr. Howitt's later papers this view was re-considered in so far that the felspathic metamorphic rocks were regarded as altered plutonic rocks, and only the non-felspathic schists as altered

1 Exclusive of a small band near Heathcote, that has been described as cambrian.

2 Spec. Rep. Geol. Surv. Vict., 1892.

3 A. R. C. Selwyn: Notes on the Physical Geography, Geology and Mineralogy of Victoria. Internat. Exhib. Essays, 1866-1867, p. 155, Official Record, Melbourne, 1866.

sedimentary deposits. The most weighty expression of this view is given in Mr. Howitt's memoir, "Notes on the Contact of the Metamorphic and Sedimentary Formation at the Upper Dargo River,"[1] which is based upon careful study of a series of microscopic examinations of the rocks in question. Mr. Howitt there pointed out that the metamorphic rocks are of two distinct origins. The first set includes a series of schists containing felspar; Mr. Howitt no doubt quite correctly regards them as metamorphosed examples of igneous rocks. In regard to the second group, he concludes[2] that "when the crystalline schists are simply mica schists, without traces of felspar, and are connected by gradations with the sedimentary formations, they are clearly metamorphosed representatives of the latter."

Mr. Howitt explained that "the sediments are metamorphosed into mica schists, the plutonic rocks into mica schists and gneisses, and there is thus created an appearance of gradual transition from the normal sediments to the normal massive plutonic rocks."[3]

This view was a great advance on the theory of the origin of gneisses and granite by the alteration of lower Palaeozoic slates and sandstones; but it still accepted the view of the Ordovician and Silurian age of the materials in the metamorphic series.

Dr. Selwyn's theory is expressed in the Geological Survey map of Victoria, the preparation of which was concluded last year, and which has recently been issued. The explanation of the map describes the metamorphic rocks as containing "metamorphosed lower Silurian rocks east of Beechworth and at Stawell, silky micaceous schists, mica schists, and gneiss of many varieties, passing from unaltered Silurian into metamorphic granite."

Anxious to get a definite base for the geological history of Victoria, I had taken the first opportunity for a visit to the north-eastern district to examine the relations of the metamorphic and the normal palaeozoic rocks. The weather was unfavourable, and, though I found the two sets of rocks in close juxtaposition on the Cobungra Creek, a heavy snow fall covered them before I found the line of junction. I saw sufficient, however, to make me doubt the asserted passage from the silurian to the metamorphic

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1 Spec. Rep. Geol. Surv., Vict., 1892.

2 *Op. cit.*, p. 8.

3 *Ibid.*, p. 9.

rocks. A second search near Omeo was rendered futile by the fact that the boundary between the schists and sediments was not where it was marked on the then current edition (1880) of the Geological Survey map, on the scale of 8 inches to the mile. I accordingly failed to find the junction until too late to use it. That mattered the less, as Mr. A. W. Howitt had already determined that the schists in that case were not altered palaeozoic sediments, but altered plutonic rocks.

In my second vacation I returned to the north-east to renew this search on the boundary of the metamorphic rocks in Bogong. Snow and fog again hid the junction on the main divide, so I turned northwards to Yackandandah, hoping to find satisfactory exposures at a lower altitude.

II.—The Metamorphic and Ordovician Rocks at Yackandandah.

The Geological Survey map of Victoria shows the ordovician and metamorphic rocks at Yackandandah in close contact along Commissioner's Creek and crossing the ridge which separates that valley from Indigo Creek. The saddle between the heads of the two creeks looked a hopeful place at which to find exposures of the two series of rocks showing their mutual relations.

Yackandandah is situated on some flats beside the Yackandandah Creek, near its junction with Commissioner's Creek and Nine Mile Creek (Pl. XIX.). To the east is a low track of biotite-plagioclase-granite and granodiorite. To the north-west the rocks are all metamorphic, and they end westward along a line running from south-east to north-west against the ordovician rocks with granitic intrusions. Commissioner's Creek is shown on the map as flowing from the north-west, along the junction between the metamorphic and ordovician series. Nine Mile Creek flows from the south-west, apparently at right angles to the strike of the ordovicians.

The only literature upon this precise locality to which reference need be made is a paper by Mr. A. W. Howitt, "Notes on the Geology of the Ovens District, with Remarks on the Deep Leads." This paper includes[1] a brief account of Twist Creek, and

[1] Prog. Rep. Geol. Surv., Victoria, II., p. 78, 1874.

an admirable illustration of the contorted character of the gneiss and schist of Commissioner's Creek.

My first excursion from Yackandandah was along Commissioner's Creek in order to get a general idea of the creek and the rocks on both sides. The schists are exposed in the first cutting on the road along Commissioner's Creek. They strike to the north, and stand nearly vertical. They are traversed by euritic dykes, of which the largest is two feet in width. The next road cutting shows weathered mica schists, with small quartz veins. After crossing a small brook, and just before reaching another road cutting, a track leads to the left, by a watercourse passing near an old roofless wooden house. The track leads to a quarry, at the foot of the steep ridge. The rocks here are as metamorphic as those on the eastern side of the valley. The strike is from N.N.W. to S.S.E., and the main rock is a fine grained black gneiss, cut through by some dykes. Search for the junction with the ordovician series had, therefore, to be made further to the south-west. The ridge which is marked on the map as rising to 867 feet, is composed mainly of a medium grained gneiss and dykes of red pegmatite. On the ridge is some coarser hornblendic gneiss, the strike of which is generally to the north-west parallel to Commissioner's Creek. On the south-western side of this ridge lies Wood Cutter's or Sawpit Gully, the rocks on the left bank of which are mainly schists and gneiss. At the junction of Wood Cutter's or Sawpit Gully and Twist Creek there are some excellent exposures on the bed of the valley, where the gravel has been sluiced away during some mining operations. On the bed of the stream and on the right bank are some good exposures of contorted gneiss and schists, striking north-west by north. A very coarse-grained pegmatite cuts through this series. A little way up Twist Creek from the junction of Sawpit Gully are some beds of slate and sandstone, with a strike of from N.N.W. to N.N.W. by N., and dipping 80 degs. to the west. In the best exposure the beds are vertical, and the strike is N.N.W. $\frac{1}{2}$ N. In the angle between Sawpit Gully and Twist Creek is a wooded spur, from which the only specimens obtained were faulted quartzite and iron-stained micaceous slate. Ascending Twist Creek a series of green sandstones with quartz veins, slates, quartzites, and chloritic slates are seen on the bed of the stream.

These rocks are well exposed within 200 yards of the outcrops of the schists, which there strike N.W. $\frac{1}{2}$ N. Further down the main valley, by a small cataract, there are some well-exposed schists, again striking N.W. $\frac{1}{2}$ N.

I could find in the field no evidence whatever of a passage from the slates into the gneiss and schist series, and the strike of the two sets of beds was different. I have, therefore, examined a set of sections of the rocks in order to see if they show any indication of the derivation of the schists from the ordovician sediments.

III.—The Microscopic Structure of the Rocks.

Beginning with the metamorphic series, a rock from the summit of the ridge between Commissioner's Creek and Sawpit Gully may be taken as a typical example. The rock [154][1] examined microscopically consists of alternate bands of quartz and felspar, about 2 mm. and 3 mm. thick, respectively. At more distant and irregular intervals are dark thin lines. When the rock is examined microscopically the quartz appears in bands composed of mosaic. The felspathic material has been broken up into a complex mosaic of fine-grained constituents. Most of the felspar consist of allotriomorphic grains of plagioclase, which are crowded with granules and small prismatic crystals; both granules and prisms are of the same general character, and both are highly refractive. The small prismatic crystals are recognisable as zoisite, and the granules are probably of the same material. No orthoclase is determinable. With the zoisite are numerous small flakes of white mica. The dark bands lying scattered through the rock are composed of lines of biotite; at intervals the lines are thickened by small segregations of biotite, with which occur some flakes of muscovite. Muscovite is scattered abundantly through the felspathic material, and often occurs along the bands of quartz. The rock has the characters of a gneiss, in which the felspar has been broken up into a mosaic of plagioclase, zoisite and white mica.

Near the junction between the normal metamorphic series and the sediments, both are greatly crushed. On the bed of Twist

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1 The numbers are those of the rock collection of the Melbourne University.

Creek, near its junction with Sawpit Gully, are some hummocks of contorted gneiss. The rock [57; Pl. XX., Fig. 1] examined microscopically is shown to be highly contorted and traversed by a series of small faults; some bands in the rock are dark, owing to the abundance of biotite, and they are separated by layers of white quartz mosaic.

Another type of the metamorphic rocks is represented at the head of Twist Creek by some bands of contorted mica schists. The rock [61] consists of alternations of quartz mosaic and of greenish-white layers, which are intensely contorted, folded and faulted; the whitish layers are composed of packed crystals of white mica with some indeterminable argillaceous material. The rock originally contained many large simple grains of quartz; but the metamorphic action has altered most of them into secondary mosaic. This change, in some cases, has only affected the margin of the quartz grains.

The dykes in the metamorphic rocks are mostly coarse pegmatites. A specimen [65] collected half way up the hill above the stone quarry on the right bank of Commissioner's Creek, is composed of large coarse grains of quartz, intergrown with crystals of comparatively fresh orthoclase. There are some old felspar grains and abundant muscovite. The pegmatite is traversing a fine schist of quartz and muscovite. A second dyke [63] is of much coarser grain; it consists of quartz, muscovite and orthoclase, and contains abundant needles of tourmaline.

The rock of the ordovician series in closest contact with the gneiss is a dark reddish-brown indurated slate [55] with lenticular bands of quartz. Most of the quartz occurs as a fine mosaic, in which larger grains under polarized light show strain effects. The bulk of the rock is a brown crumpled slate, iron stained along lines which are roughly parallel. The constituents of the base are small quartz grains in a cleaved argillaceous base, containing minute crystals of authigenous mica. They appear to have been developed owing to the re-arrangement of the argillaceous material of the ordovician series. A less altered member occurs at the junction between Sawpit Gully and Twist Creek. It [62] is a crushed quartzose grit. Some of the quartz grains have obviously been crushed *in situ*, and there is one thin band of quartz mosaic. There are numerous flakes of muscovite which are crumpled and are clearly allothigenous. The slide includes one thick layer of iron stained argillaceous material, in which the quartz grains are small and scarce. The clastic origin of most of the material is apparent.

In the spur at the western side of Twist Creek occurs a coarse grit [56 ; Pl. XX., Fig. 2] with large quartz grains, nearly all of which are rounded. There are also some rounded grains of hornblende. The interspaces between the quartz grains are occupied by a fine grained quartz mosaic, due to secondary crystallization. Owing to the crushing of the rock, the quartz grains have crushed and caused a certain flow in the softer material. The rock can, therefore, be described as a mylonitic quartz grit. Another variety of arenaceous sedimentary rock occurs a little up Twist Creek, beyond the spur from which the last specimen was obtained. This rock [54; Pl. XXI., Fig. 4] is a fine-grained grit; it is composed of quartz, plagioclase and muscovite. The grains are irregularly arranged; the material is all allothigenous; and the rock represents a slightly altered sandstone, of which the materials were derived from some igneous rocks. A similar rock [58 ; Pl. XXI., Fig. 3] from the bed of Twist Creek, near the junction of the ordovician with the metamorphic series, shows the same materials ; it is a coarser grit in which the fragments are often irregularly oblong, and they are surrounded by fine material in curved lines. The material is stained brown by iron oxide. Between these grains are lines of quartz mosaic, and some of the larger quartz grains are beginning to show alteration into mosaic; but this structure is only developed on the edges or along lines running through the grains.

In the bed of Twist Creek, near the junction with Nine Mile Creek, is a rock [64] showing a further stage in the development of the quartz mosaic. Examined under singly polarized light the rock appears to consist of bands of white structureless material, separated by layers composed of colourless rounded grains, strongly set in a base of pale green slightly pleochroic material. On further examination the green material is shown to be mostly chlorite; the rounded grains in it are quartz and plagioclase, and the white bands break up into quartz mosaic, no doubt due to secondary change, as the large quartz grains are also passing into mosaic.

IV.—Summary of Conclusions.

The evidence of the microscopic structure of the rocks and their relations in the field both point to the following conclusions:—First, there is no evidence of a gradual passage from the ordovician to the schists and gneisses. The two rocks have a fairly sharp junction, and their strike is not parallel. Both rocks have been greatly disturbed since ordovician times, so that they have been crushed together, and a clear section showing an unconformable junction between them cannot be expected.

The ordovician rocks appear to be decidedly younger than the schists, for not only are they less altered, but they are clearly clastic rocks, and they appear to have derived most of their materials from pre-existing igneous rocks; they might easily have been formed as a series of shore deposits, derived from the weathering of the adjacent schists.

That the ordovician rocks are a later series than the schists is rendered further probable by their general distribution in the district, as represented by the Geological Survey map. The granitic rocks of Yackandandah have cut through both series, while those at Beechworth are intrusive only into the ordovician rocks. Had the metamorphic rocks been produced by the alteration of the ordovicians we should have expected the rocks close to the great plutonic intrusions to have been the most changed; but on the contrary the metamorphic rocks that extend from Indigo Creek to Wodonga are separated from the granites of the Pilot Range by a narrow band mapped as unaltered ordovician. I have not verified the existence of this band, but the mapping and the theory expressed in the legend of the map are clearly inconsistent. A further objection to the view so long officially accepted is that the distribution of the metamorphic rocks of the Beechworth district does not bear any relation to the granitic instrusions as we might expect had the metamorphic rocks been formed from the ordovicians.

We may therefore conclude that the schist series is a pre-ordovician series, on which the ordovician and silurian rocks have been laid down unconformably. The schist series may be of Cambrian age in the absence of evidence to the contrary, but considering

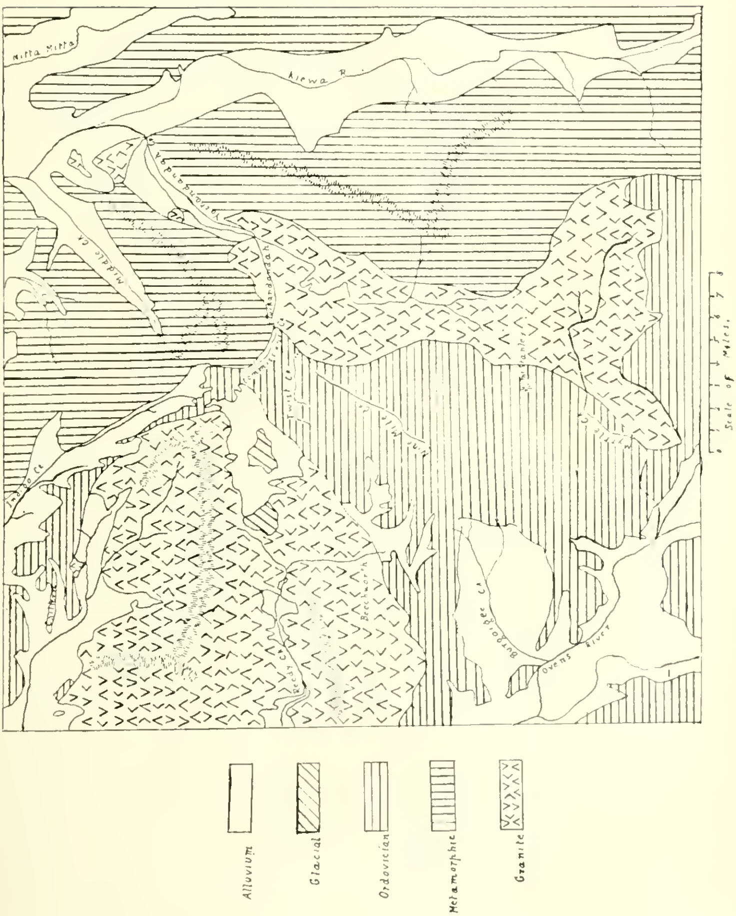
Mitta Mitta
Middle Ck
Beechworth
Ovens River
Scale of Miles
Alluvium
Glacial
Ordovician
Metamorphic
Granite

Fig. 1.

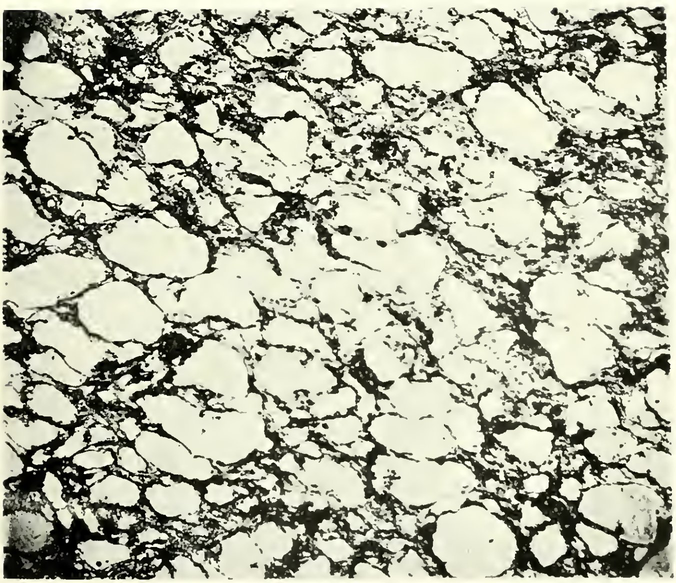

Fig. 2.

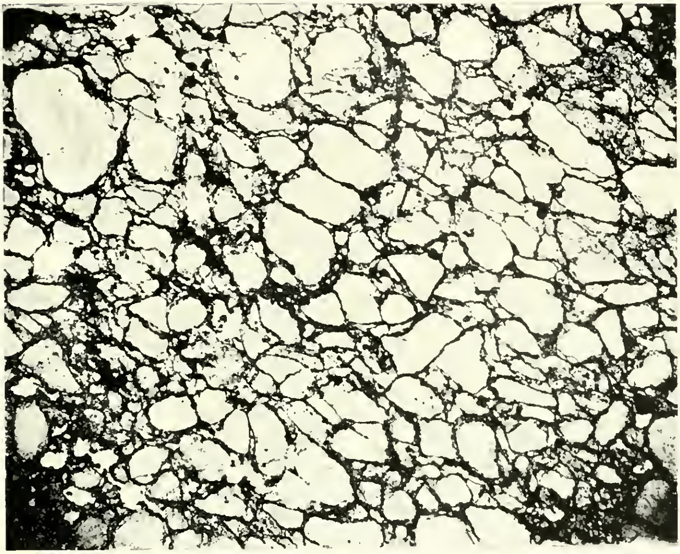

Fig. 3.

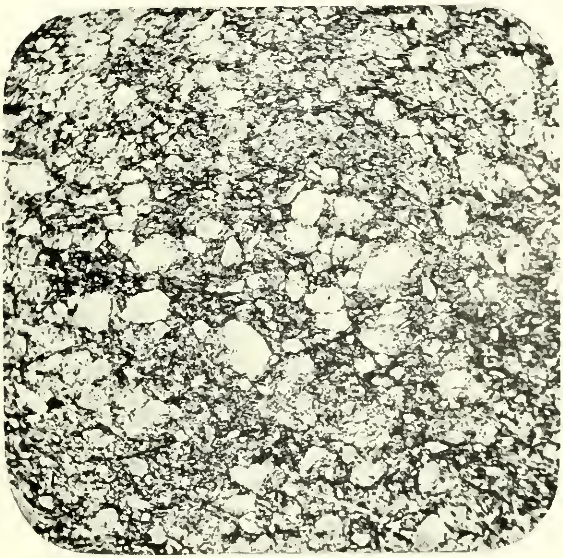

Fig. 4.

their crystalline character it will be safer to regard them as even older, and as Victorian representatives of the archean group.

DESCRIPTION OF FIGURES.

PLATES XIX., XX., XXI.

Plate XIX.

Locality Plan.

Showing the relation of the metamorphic rocks, ordovicians and granites, from the Geological Survey map.

Plate XX.

Fig. 1.—Contorted gneiss, from the bed of Twist Creek, near the junction with Sawpit Gully [No. 57]. Magnified 15 diam. Ordinary light. Most of the figure shows one of the dark bands which is much contorted, and the contortions are broken by a series of parallel microscopic faults.

„ 2.—Mylonitic quartz grit; western side of Twist Creek [No. 56]. Magnified 20 diam. Ordinary light. The rock is composed in the main of large quartz grains, in a base of fine quartz mosaic. Owing to pressure a flow has been produced in the rock, causing a roughly parallel arrangement of the quartz grains, and a flow of the base around them.

Plate XXI.

„ 3.—[No. 58] Quartz grit; the bed of Twist Creek, further from the junction. Magnified 20 diam. Ordinary light. The quartz grains are angular, and the flow structure of Fig. 2 has not been developed.

„ 4.—[No. 54] A fine grained grit; the bed on Twist Creek, still further from the metamorphic series. Magnified 45 diam. Ordinary light. The rock consists of grains of quartz and plagioclase, with flakes of mica, in a fine argillaceous base.

Art. XIV.—*On some Rocks from the fairway of Port Phillip Heads.*

By F. E. GRANT and E. O. THIELE.

[Read 9th October, 1902.]

Blasting operations were recently carried on at Port Phillip Heads under the supervision of the Engineer for Ports and Harbours with the view of deepening the Channel, so as to render the passage safer for ocean going vessels, and by this operation large blocks of stone were obtained containing numerous embedded fossils.

A block of this stone was obtained by the writers, and was found to consist of coarse sandy limestone of a creamy colour, composed mainly of a mixture of quartz grains and comminuted shell remains. On the side of the fresh fracture it was less compact and showed indistinct lines of stratification. This part of the rock was full of shell remains, all, unfortunately, more or less broken and corroded. By far the commonest form was a Bankivia sp., but on close examination we were able to identify the following :—

Bankivia sp. (aff. varians).
Mesodesma elongata.
Chione striatissima.
Mytilicardia aviculina.
Corbula sp.
Tellina sp.
Glycimeris sp.
Echini spines.

A sample of the rock treated with acid was found to consist of a little over 50 per cent. of carbonate of lime, the insoluble residue being grains of quartz—angular for the most part, with occasional more or less rounded fragments intermixed.

The chart shows that a rocky platform or reef extends from Point Nepean to Point Lonsdale at a depth along that line of little more than forty feet at the most. This reef ends abruptly on the inner side as is shown by the rapid change to deeper water, but on the seaside it shelves away much more gradually. The block of stone under consideration came from a position about midway between the Heads and a little on the seaside of a line joining these two points of land and from a depth of thirty-two feet. The outflowing tide meets suddenly with this submarine shelf, and the rough choppy sea, well-known as the "Rip," is the result. This disturbed state of the Channel is rendered more marked when a strong south-westerly wind is blowing. The tidal current as it rushes out and in through the entrance flows at a rate of about eight miles an hour, so that the scour is considerable. Enormous quantities of sand, loosened from the neighbouring beaches and sand banks inside the entrance, are at times carried backwards and forwards through the Channel, but it is hardly likely that the rock under consideration has resulted from the deposition of such sand under present conditions, especially where the current runs fastest.

It seems probable that the limestone represents a shallow water marine formation which may pass under the Dune limestone on either side.

If such be the case, taking into consideration the recent record of an extinct marsupial from the Dune rock[1], this deposit may represent in age the Bankivia beds on the Glenelg, recorded by Mr. Dennant as Pleistocene.[2]

We have to thank Captain Stalker of the Pilot Service, Mr. McLean, the Chief Engineer of Ports and Harbours, and Mr. T. H. Smith, Marine Surveyor, for opportunities afforded of making these observations.

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1 Proc. Roy. Soc. Vic., vol. xiv., p. ii., N.S., p. 139.

2 Trans. and Proc. Roy. Soc. Vic., vol. xxiii., p. 225. 1887.

Art. XV.—*Coorongite, a South Australian Elaterite.*

By ALEX. C. CUMMING.

(Communicated by Professor Orme Masson, D.Sc.).

[Read 9th October, 1902.]

The name Coorongite was given many years ago to a peculiar substance found as a thin superficial deposit on the soil in the Coorong district of South Australia. A small sample was recently sent to the Chemical Laboratory of the University of Melbourne, and has been examined by me, under Professor Masson's direction, with results to be described in the sequel.

Previous Accounts.—Coorongite is briefly described by Krausé (Mineralogy, p. 138), and by G. C. Morris (Proc. Acad. Nat. Sci. Philadelphia, 131, 1877), and references have been found elsewhere; but by far the best and fullest account of it that I have been able to find is contained in a paper by J. R. Jackson, published in the Pharmaceutical Journal of 1872 (pp. 763 and 785). From this paper it appears that Coorongite had, since its discovery in 1865, excited a good deal of interest both in Australia and in England, and that the question of its true nature and probable origin had been the subject of considerable discussion. Very different views were expressed, some regarding the substance as a bituminous hydrocarbon mineral, others believing it to be of vegetable origin. These discussions of thirty years ago appear to have been forgotten, and within the last year attention has been directed afresh to the same questions, still unsettled, by newspaper accounts of quests for mineral oil in the district where Coorongite occurs. Jackson's paper was not known to me till after I had done the work to be described. My results are, in the main, corroborative of those he records and quotes from other observers, but additional information has been gained as to the chemical nature of the material.

Description of Coorongite.—My specimens were in sheets varying from one-tenth to one centimetre in thickness. The substance varied in colour on the surface from greyish-black to black, but was uniformily black internally. It was soft, flexible, and elastic, resembling caoutchouc; one surface, probably the upper, was hard, black, and sponge-like; it contained a considerable quantity of sand and some vegetable fibres; it burnt readily with a white flame, melting before the flame, and giving, especially when extinguished, a characteristic odour, quite distinct from that from hydrocarbon minerals, and suggestive of burning animal or vegetable fats. Jackson gives the following analysis of Coorongite by Dr. A. J. Bernays :—

Moisture	0.4682
Carbon	64.73
Hydrogen	11.63
Ash	1.79
Fixed carbon	1.005
Oxygen and unest.	20.3768
	100.0000

The substance is insoluble in water and alcohol, and only partially soluble in carbon bisulphide, ether, chloroform, turpentine, benzene and toluene, giving bright yellow solutions. This confirms observations of G. Francis, quoted by Jackson. On evaporation of the solvent a soluble body of low melting point is obtained, the Coorongite being thus separated into this body, and a friable insoluble residue.

Separation into two constituents by extraction with Carbon Bisulphide.—100 grms. were cut up into small pieces and subjected to successive extractions with carbon bisulphide in a Soxhlet's extractor. After the first extraction the residue, which was quite friable, was rubbed to powder before adding fresh solvent. The product of each extraction was separately examined after evaporating off the carbon bisulphide. The results are shown in the following table :—

	Time of Extraction.	Weight of Extract.
1st Extraction ...	7 hours ...	20.80 grms.
2nd ,, ...	12 ,, ...	2.78 ,,
3rd ,, ...	16 ,, ...	.16 ,,
4th ,, ...	18 ,, ...	.05 ,,
	53 hours.	23.79 grms.

Thus the sample yielded nearly 24 per cent. of the soluble constituent. As the residue was found to contain from 30 to 40 per cent. of sand and other mineral matter, the soluble constituent formed about one-third, and the insoluble constituent about two-thirds of the organic material. The results of the later extractions show that separation was complete.

The Soluble Constituent.—This is a clear, yellow, translucent, wax-like solid. Softens enough to flow if kept at 35°, and is quite fluid at 42°. Heated in an oil bath it decomposed above 225°, yielding a little black distillate and a tar-like solid residue.

It dissolves readily, and in all proportions, in benzene, ether, toluene, chloroform, and carbon bisulphide, and is insoluble in water, methyl alcohol and ethyl alcohol.

The composition was obtained by combustion with cupric oxide in a current of oxygen. The results agree closely with the figures calculated for the formula $C_{10}H_{18}O$.

	I.	II.	III.	Mean.	Calculated for $C_{10}H_{18}O$
Carbon - - -	77.86	77.94	77.92	77.91	77.92
Hydrogen - - -	11.97	11.87	11.93	11.92	11.69
Oxygen (by difference) -	10.17	10.19	10.15	10.17	10.39

As the molecular weight could not be got by vapour density measurement, recourse was had to the freezing point method, using benzene as solvent. The benzene used was specially purified and had the freezing point 5.33° cor. Ice and water were used for freezing and five observations were made at each temperature. The constant K for the benzene was determined by experiment with napthalene, which gave a value of 5390.

1.080 grms. of the substance dissolved in 30.0 grms. benzene lowered the freezing point .080°.

Using the formula

$$M = K \frac{S}{\Delta L}$$

where M = molecular wt., K = a constant (5390 in this case) Δ = the depression produced, and L = weight of solvent, these figures indicate a molecular weight of 2425. The formula $(C_{10}H_{18}O)_x$ requires a molecular weight of 154, or some multiple thereof; and it would therefore appear that the value of x in benzene solution is 16 (M = 2464), or, in other words the soluble constituent of Coorongite is $(C_{10}H_{18}O)_{16}$ in benzene solution.

It is well known, however, that organic oxygen derivatives of the alcohol and acid kind are given to association in benzene solution, though they have simple molecules in other solvents, and that the molecular weight of a substance in benzene solution is often twice as great as the normal.

Observations were therefore made on the boiling point of an ether solution of the substance, using ether purified by distillation from sodium immediately before use.

The whole of the ether (about a litre) distilled at 34.2°, but the first and last portions were rejected.

The boiling point was raised .100° by the addition of 1.370 grms. of the material to 24.1 grms. of the ether, which by the formula

$$M = K \frac{S}{\Delta\ L}$$

where K for ether = 2100, S and Δ have values given above and L = 23.9 (allowing for vapour, etc.), gives the approximate value 1204 for the molecular weight, which is within the error of experiment, half the value obtained in benzene solution. In these experiments, Beckmann's freezing point and boiling point apparatus were used with thermometers divided into hundredths of one degree C. and capable of being read by eye to .002°.

The results obtained indicate that the soluble constituent of Coorongite is $(C_{10}H_{18}O)_x$ and that $x = 8$ in etheral solution and 16 in benzene solution; x may, of course, have other values under other conditions.

Only an incomplete examination of the chemical properties of this substance has been made as yet. It is unacted on by acids except strong H_2SO_4, which chars it.

It combines with bromine, forming a black, viscous, sticky, semisolid, readily soluble in carbon bisulphide and ether, but which has not yet been investigated.

It oxidises readily, as will be shown later. Attempts to saponify it led to negative results, though it is stated by Jackson to be saponifiable.

The Insoluble Constituent.—This was rubbed to a coarse powder during the extraction and resembled brown cork filings mixed with much sand. Practically all the elasticity is lost during the carbon bisulphide extraction ; it is combustible, burning with a white luminous flame and melting before the flame ; when burning it gives the same odour, like that of a burning fat, which Coorongite itself gives. Analysis by combustion gave the following results for the organic matter :—

	I.	II.	Mean.	Calculated for $C_{10}H_{20}O_3$
Carbon - - -	64.16	64.28	64.22	3.836
Hydrogen - - -	10.54	10.50	10.52	10.64
Oxygen (by difference) -	25.30	25.22	25.26	25.53
	100.00	100.00	100.00	100.00

The amount of ash (principally sand) varied from 30 to 40 per cent. The figures for the organic part agree remarkably well with those calculated for $C_{10}H_{20}O_3$, seeing that the material has undergone no purification other than the treatment with carbon bisulphide. Its dark colour suggests that it contains traces of some more highly carbonaceous material, which would account for the slight discrepancy.

This constituent, unlike the soluble one, was found to be saponifiable by hot alcoholic caustic potash, a soluble soap being obtained which yielded an insoluble fatty body, on treatment with acid. This action has not yet been further examined.

Intermediate Oxidation Products.—The similarity of the formulae $C_{10}H_{18}O$ and $C_{10}H_{20}O_3$ suggest that the insoluble ingredient is derived from the soluble one by a natural change involving hydration and oxidation combined.

Observations made in the course of the examination tended to confirm this and to show that changes of this nature are readily brought about. In the following table are given the results of the combustions of three products obtained from portions of the soluble extract. No. I. was got by blowing air through the carbon bisulphide solution ; No. II. was formed during an attempt to extract some of the substance with methyl alcohol ; No. III. was obtained when trying to distil it in steam. They were separated as completely as possible from unaltered substance by centrifuging the mixture at a temperature high enough to keep the latter in a molten condition. These three substances had the appearance of the clear first constituent of the Coorongite, but containing an opaque, yellowish, granular precipitate. They could not be separated by solubility in carbon bisulphide or ether, but a partial separation was effected by centrifuging.

For comparison, the mean results of the combustions of the soluble and insoluble constituents and the calculated values are again given. It is evident from the table that products I., II. and III. are incompletely oxidized mixtures.

	C.	H.	O (by diff.).
Calculated for $C_{10}H_{18}O$ -	77.92	11.69	10.39
Soluble constituent - -	77.91	11.92	10.17
Product No. II. - -	71.87	11.11	17.02
Product No. I. - -	70.35	11.42	18.23
Product No. III. - -	66.46	10.71	22.83
Insoluble constituent -	64.22	10.52	25.26
Calculated for $C_{10}H_{20}O_3$ -	63.83	10.64	25.53

The Ash.—The ash comprised about 25 per cent. of the sample on which this work was done, but in a latter specimen, since obtained from R. H. Walcott, Esq., F.G.S., of the National Museum, only 5.4 per cent. of ash was found. The analysis failed to show the presence of any phosphates, which would be expected if the Coorongite were of animal origin. The ash had the following composition :—

Silica	95.12
Aluminium and iron oxides	3.66
Calcuim oxide	1.17
Sodium chloride	Trace
	99.95

Mr. D. J. Mahony kindly examined the mineral part of Coorongite, and found a number of species of typical fresh-water diatoms. Only a small part consisted of diatoms, the ash being mostly sand, and it is doubtful whether the occurrence of these diatoms is more than accidental.

Conclusions.—Coorongite has been shown to consist of two substances, one with the formula $(C_{10}H_{18}O)_x$, and the other $(C_{10}H_{20}O_3)_y$. The physical properties of the substance have earned it the name of Mineral Caoutchouc, and these formulae favour the idea that it is really related to caoutchouc, which has the formula $(C_{10}H_{16})x$. Caoutchouc oxidizes readily, even taking up oxygen from the air, and some of the substances connected with it, and with gutta percha have compositions and properties very similar to those of the two constituents of Coorongite. The formulae for these constituents are readily derivable from $C_{10}H_{16}$ by oxidation and hydration. However, for the present the nature of Coorongite must still be considered an open question, as much remains to be done in the further chemical investigation of its constituents.

BIBLIOGRAPHY OF COORONGITE.

1862. Phipson, T. L. Geologist, vol. v., p. 141.

1866-7. Ulrich, G. H. F. Official Record of Intercolonial Exhibition, pp. 91 and 168.

1872. Jackson, J. R. The Pharmaceutical Journal and Transactions, pp. 763 and 785.

1877. Morris, G. C. Proc. Acad. Nat. Sciences, Philadelphia, p. 131.

1892. Dana, J. D. System of Mineralogy, p. 1019.

1889. Roscoe and Schorlemmer. Treatise on Chemistry, vol. iii., pt. 5, p. 498.

1896. Krausé, F. M. Introduction to the Study of Mineralogy for Australian Readers, p. 138.

1896. Chester, A. H. Dictionary of Names of Minerals, p. 64.

1902. Petroleum Prospecting in South Australia. "The Argus," Melbourne, June 23rd, p. 8.

Art. XVI.—*A New Ammonite from the Cretaceous Rocks of Queensland.*

By Professor J. W. GREGORY and F. VOSS SMITH.

[Read 9th October, 1902.]

(With Plate XXII.).

The Ammonite described in this paper was found by one of us in the Bourke Museum at Beechworth, where it was labelled simply from the "Mitchell River." It was associated with specimens from Gippsland, and under the impression that the Victorian Mitchell River was intended, the specimen was borrowed by kind permission of the Trustees of the Beechworth Museum.

The sutures were carefully developed by Mr. H. J. Grayson, and its approximate geological position was thus determinable. Its affinities were clearly cretaceous, but no rocks of cretaceous age were known from Victoria.

It was subsequently suggested by Mr. T. S. Hall that the specimen probably came from the Mitchell River of Queensland. It agrees fairly well in its matrix with specimens which we have seen from that area; and there can be little doubt that its locality has been correctly, though indefinitely, recorded. The specimen is of interest owing to the exceptional perfection with which the complicated sutures are shown. As some time had already been spent upon the specimen and we devoted further study to it after our return from Lake Eyre, when our attention had been directed to the Cretaceous fauna of that area, we now describe it.

We are much indebted to the Trustees of the Bourke Museum for their long loan of the specimen, and to Mr. Grayson for the skill with which he cleaned the suture lines.

DESCRIPTION OF THE SPECIMEN.

Desmoceras, Zittel.

Desmoceras jonesi, n. sp.

Diagnosis.—A large and discoid Desmoceras, with flat sides; young whorls marked by broad, rounded, well developed ribs. Back narrow, bluntly rounded. Umbilicus broad, the steps over the successive whorls are steep; about $\frac{2}{5}$th of each whorl is exposed below the next outer whorl. Mouth long, with the sides in part subparallel.

Sutures: on the outer whorl there are four paired lateral saddles. The siphonal saddle is short and broad, it has one projection on each side; and it appears bicornate owing to a lateral projection at the upper corners The first lateral saddle is very large and complex. It consists of four main divisions, of which the two middle ones are the largest and most complex; they both arise as branches from a narrow stem. The base of this saddle is large, it gives off the first branch on the dorsal side. This branch is simple but deeply notched. The second branch is on the ventral side, and is divided nearly to the base by a notch which divides it into a simple and a compound sub-branch. The last division begins with a narrow stem, and this dichotomizes to irregular and very sinuous sub-branches. The second lateral saddle is much smaller; it has two main simple branches on the ventral side and a compound division on the dorsal side. The third lateral saddle is slightly smaller than the second; it is divided into two divisions. The fourth lateral saddle is small and consists of three simple divisions.[1]

The notches on the lobes are comparatively broad and have blunt rounded ends.

DIMENSIONS.

Largest diameter of specimen -	25 cm.
Proportion (whole diam. = 1.)	
Outer whorl : whole diam. -	= .48
Width of umbilicus : whole diam.	= .28

[1] The saddles within the line of involution are not shown in the specimen.

Affinities.—This specimen is most nearly related to the Ammonite from the cretaceous of Southern India, described as A. beudanti,[1] and to the A. flindersi, McCoy,[2] from Queensland.

It differs from both those Ammonites as in it

1. The form is more laterally compressed.
2. The mouth is higher and narrower.
3. The notches in the lobes are not so sharp and are less numerous.

The full descriptions by Mr. Etheridge, jnr.,[3] of Haploceras daintreei, Eth.[4], suggest that it may be even nearer to the new species. The new species, however, has a greater complexity of sutures, and the saddles are wider proportionally to the lobes, than is the case in H. daintreei. H. daintreei moreover is thicker and broader, with a shorter aperture and deeper umbilicus.[5] Our Desmoceras is allied to the above two species, but its generic position is with Desmoceras rather than Haploceras with which the two well known Queensland forms have been placed.

Von Zittel's description of his genus Haploceras, states[6] it differs from Desmoceras by the first lateral saddle projecting extensively beyond the line of the rest of the saddles. In this character our species is a typical Desmoceras. Probably some of its nearest Queensland allies, as the species flindersi and daintreei, belong to the same genus.

We propose to name the new species jonesi, after Mr. J. W. Jones, the Conservator of Water in South Australia, whose work has thrown so much light on the water distribution in the Cretaceous rocks of Central Australia.

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1 Stoliczka, F.: Cretaceous Cephalopods of S. India, Pal. Indica, vol. i., p. 143, pl. lxii., figs. 1—4, and pl. lxii.

2 McCoy, F.: Trans. Roy. Soc. Vic. 1866, vii., p. 51. *Ibid.*, 1868, viii., pt. i., p. 42. See also Etheridge, R., junr.: Additional Notes on the Palaeontology of Queensland. Bull: No. 13, Geol. Surv. Queensland, pt. ii., 1901, p. 31.

3 R. Etheridge, Jnr. *Op. cit.*, pp. 30-31.

4 R. Etheridge, Senr.: Description of the Palaeozoic and Mesozoic Fossils of Queensland. Quart. Journ. Geol. Soc., xxviii., 1872, p. 346, pl. xxiv.

5 *c.f.* Fig. R. Etheridge, Jnr. *Loc. cit.*, pl. ii., fig. 6.

6 *e.g.* Grundzuge der Palaeontologie, 1895, p. 426.

DESCRIPTIONS OF PLATE No. XXII.

Fig. 1. The specimen from the side, from a photograph by Mr. H. J. Grayson. Reduced about $\frac{1}{2}$ diam.

Fig. 2. One of the sutures. Nat. size.

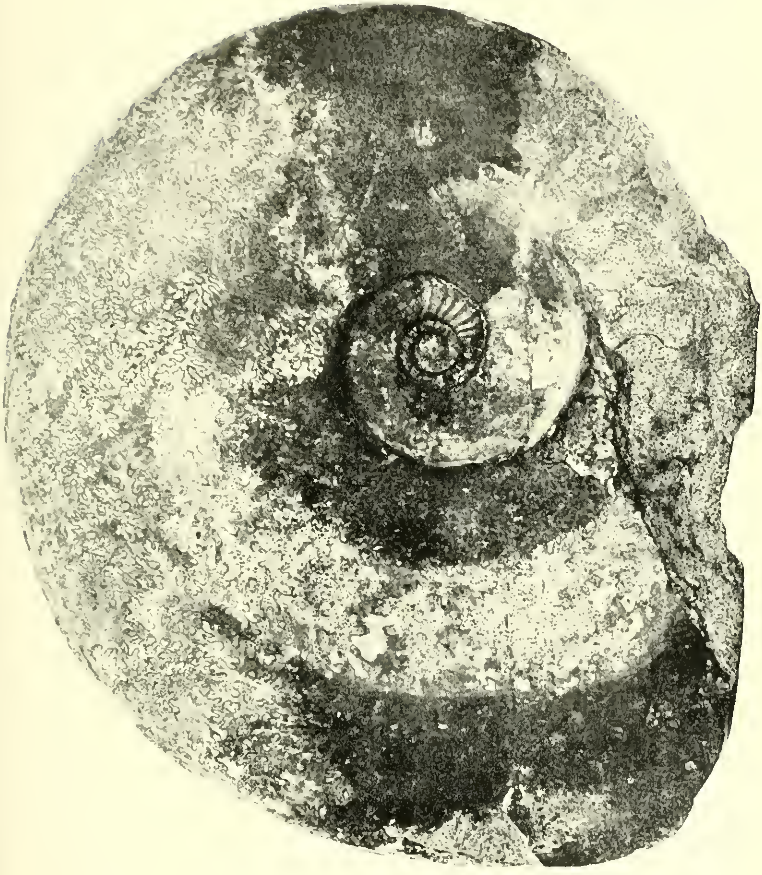

Fig. 1.

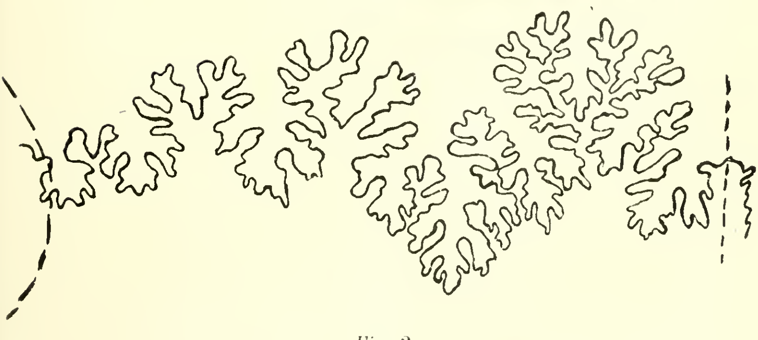

Fig. 2.

Art. XVII.—*Description of two new Australian Lizards, Varanus spenceri and Diplodactylus bilineatus.*

By A. H. S. LUCAS, M.A., B.Sc., and C. FROST, F.L.S.

[Read 9th October, 1902.]

Varanus spenceri, sp. n.

Description.—Snout very short, depressed at the end, measuring about one-fifth less than the distance from the anterior border of the orbit to the ear; canthus rostralis not very distinct. Nostril oval, distant from the end of the snout about one-third less than its distance from the orbit. Limbs stout; digits strong, moderately elongate. Tail swollen and depressed at the base, compressed with a doubly toothed keel posteriorly, a little longer than the head and body. Upper head scales larger than those on the temples, subequal; supraocular scales very small, granular, subequal. Scales of upper surfaces small, varying in size and shape, round or oval, convex, sometimes tubercular. Abdominal scales smooth, flat, in from 115 to 120 transverse series. Upper and lateral caudal scales tubercular at the base, bluntly keeled posteriorly.

Colour.—Pale yellowish-brown above, with numerous broad, dark brown bands on the back and sides, usually rising alternately to right and left from the vertebral line; head with or without dark brown blotches and streaks. Tail with dark brown annuli, under surfaces uniform pale yellowish-brown.

Dimensions of Type.

Total length - - - -	76.5	cm.
From tip of snout to gular fold	13	,,
From gular fold to vent - -	25	,,
Max. width of head - -	3.5	,,
Fore limb - - - -	10	,,
Hind limb - - - -	13	,,
Tail - - - - -	38.5	,,

Habitat.—Table lands 50 miles to N.E. of Tennant's Creek, Central Australia.

We have named this fine species after Professor Baldwin Spencer, F.R.S., who obtained fine specimens on the Spencer-Gillen expedition, and who, during his travels in Central Australia, has added so much to our knowledge of the fauna of those little known regions.

Type, in the National Museum, Melbourne.

The specimen chosen for the type is the largest perfect individual, although apparently not fully grown. Two other imperfect specimens in the series under examination attain a total length respectively of 81 cm. (tail reproduced) and a skin 110 cm. Tail, 52 cm.

This species belongs very clearly to group III. B2 of Boulenger in the British Museum Catalogue, viz., V. varius, V. giganteus, V. gouldii. The members of the group are not differentiated by very strongly marked characters. The chief points of distinction are the shape of the nostril and its position, and the number of transverse rows of abdominal scales. The colour markings are very variable, as is the number of well marked rows of abdominal scales.

The present species differs from all these in the comparative shortness of the tail, in which character it agrees with V. brevicauda, Boulenger.

Diplodactylus bilineatus, sp. n.

Description.—Head rather short, high, convex. Snout pointed, scarcely longer than the distance between the eye and the ear opening, latter small, vertically oval. Body moderate; limbs rather short. Digits rather long, moderately depressed with rounded tubercles below; apical dilations with two suboval plates inferiorly. Upper surfaces covered with small granular scales, largest on the middle of the back. Rostral large, not twice as broad as high, with trace of median cleft above; nostril pierced between the rostral, first labial, and five or six nasals, the supero-anterior large, and in contact with each other. Seventeen upper labials, first very high; fifteen lower labials, anterior large. Mental large, subtriangular, rounded behind.

Abdominal scales granular, smaller than the dorsal. Tail swollen, contracted at the base, tapering very rapidly, with rings of suboval scales, convex above, and flat, imbricate beneath. Male with a group of five or six blunt spines on each side of the base of the tail.

Colour. —Pinkish-brown above, a broad black-edged light band along the middle of the back and tail, bifurcating on the nape and extending to behind the orbit, enclosing a dark subtriangular patch on the occiput ; a few small dark dots occur in the light median area. The black edges bordering the lighter vertebral band are produced in two conspicuous but discontinuous black lines extending to the very tip of the tail.

Dimensions.

Total length	- - - -	88 mm.
Head -	- - - - -	10 ,,
Width of head	- - - -	9 ,,
Body -	- - - - -	48 ,,
Fore limb	- - - - -	15 ,,
Hind limb	- - - - -	18 ,,
Tail	- - - - - -	30 ,,

Habitat.—Caernarvon, Western Australia.

Type, in the National Museum.

This is a form allied to D. steindachneri, Boulenger, but differs in the oval ear opening, the greater number of labials, the absence of a fringe of conical scales to the upper eyelids, in the abdominal scales considerably smaller than the dorsal, and greatly in the relative measurements of head and body. In D. steindachneri the body is 2.3 times as long as the head, in D. bilineatus it is 4.8 times as long. In colour our species is conspicuous by the two dark longitudiual bands reaching to the tip of the tail, whilst there are no dorsal ocelli which are so marked in D. steindachneri as figured in the British Museum Catalogue.

Art. XVIII.—*The Heathcotian—a Pre-Ordovician Series —and its Distribution in Victoria.*

By J. W. GREGORY, D.Sc., F.R.S.

[Read 13th November, 1902].

[With Plates XXIII.-XXVI.].

I.—Introduction.

One of the most interesting and instructive rock series in Victoria occurs along the floor of the Heathcote Valley, and forms the crest of the Colbinabbin Range. Conflicting opinions have been expressed as to the age and character of these rocks. Several visits to different parts of the outcrop of the rocks suggested to me a solution, which promised, to some extent, to reconcile the views as to their interpretation. I have recently been able to test this idea during a four days' visit to Heathcote with my assistants, Messrs. H. J. Grayson and D. J. Mahony, and the students of the Geological Department of the Melbourne University. Our joint examination of the country showed that the explanation was well founded.

Heathcote is a straggling township extended for about three miles along the Bendigo Road, in the broad valley of McIvor Creek. It is situated seventy-four miles northward from Melbourne. Along the floor of the Heathcote Valley, and upon its south-western slope are numerous exposures of a series of igneous rocks, which can be divided into an acid and a basic series. In close contact with these igneous rocks are some narrow belts of rocks which are clearly metamorphic sediments. These metamorphic and igneous rocks extend from the head of McIvor Creek, along a bold curve to the north-west; bending to the north, they are continued on the floor of the valley to the west of Mount Ida, whence they gradually rise and form the long Colbinabbin Range. The rocks of these metamorphic and diabase series extend along this line, with occasional slight interruption, for about thirty miles. On the north-eastern side of this line the rocks are quartzites of silurian age. On the outer side of the curve to the west and south-west the rocks are slates, quartzites, and sandstones of ordovician age.

II.—Previous Literature.

The literature begins in 1866 with Selwyn's Geological Sketch of the Colony of Victoria,[1] in which the rocks of this line are marked simply as trap, and they are described (p. 172) as dykes. More precise information was given by Selwyn in 1868 in his "Descriptive Catalogue of the Rock Specimens and Minerals in the National Museum, Melbourne" (p. 16), in which the rocks from Mount Camel, the highest peak in the Colbinabbin Range, were determined as diabase; but in the same work, in the list of errata, the name was changed to diorite, owing to the indentification of the ferromagnesian constituent as an amphibole instead of a pyroxene. A material described as a mineral under the name of selwynite,[2] which occurs in these rocks four miles north of Heathcote was described as in "a vein in the upper

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1 A. R. C. Selwyn: Official Record Intercol. Exhib., Austral., 1866-1867, pp. 147-227.
2 *Ibid.*, p. 18.

silurian rocks"; so that we must interpret Selwyn's view as being that the diabase series was intrusive in post-silurian times.

The next contribution to the Lower Palaeozoic geology of Heathcote was a short but important note by Mr. E. J. Dunn, published in 1889; he described the rock series as beginning with some "schistose beds," (p. 77), followed by lower silurian [ordovician] and upper silurian. That Dunn regarded the schistose beds as older than the ordovician is stated by Sir F. McCoy, when describing some markings from Heathcote which he determined as worm tracks. Dunn's "Notes" moreover state that the basic rocks, which he calls "greenstone" are intrusive.[1]

In 1894 Mr. Lidgey published a fuller account of the Heathcote rocks, in which he stated Mr. Dunn's views as to the pre-silurian [*i.e.*, ordovician] age of the metamorphic rocks. He added the opinion that the basic rocks were lavas and amygdaloids.

During the survey of this area by the Victorian Geological Survey, Mr. W. H. Ferguson discovered a series of fossils, which were described by Mr. R. Etheridge, jun., as of cambrian age. In 1896 Mr A. W. Howitt published the results of a most careful microscopic study of the rock specimens collected near Heathcote by the officers of the Geological Survey; he recognised the intrusive character of many of the rocks. According to his instructions, Mr. Lidgey re-examined the ground, and some of the sections were visited by Mr. Howitt. The result was the conclusion that the rocks of the diabase series were intruded in devonian times, and that they were injected along the line of junction of the ordovician and silurian series.

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1 McCoy's note suggested that Dunn had done more work on the Heathcote rocks than is given in his report of 1889. On enquiry in the Mines Department, I have seen a letter from Mr. Dunn (6th July, 1891) in which he clearly expresses the view that the Heathcote rocks include a pre-silurian system. He says—"The formation is of pre-silurian age, and the beds of which it consists comprise highly siliceous and jaspideous rocks, very talcose splintery schists, tufaceous deposits, quartzite, and ancient vesicular basalts, once surface flows but now intercalated with other strata. The railway cuttings near Heathcote expose a tongue of these rocks; they extend and widen out in a northerly direction towards Mounts Camel and Pleasant; how far they continue has yet to be determined, as I only discovered the formation on Saturday last, and traced it towards Mount Camel." Mr. Dunn then makes the interesting suggestion that these rocks have marked resemblences to the rocks of the Te Anari series in New Zealand.—J.W.G., 13-xi.-02.

Mr. O. A. L. Whitelaw, in the geological sketch map of the parish of Heathcote (1896), used the nomenclature based upon Mr. Howitt's view. Mr. W. H. Ferguson in 1900 described the relations of the beds yielding the fossils, described by Mr. Etheridge as cambrian. Mr. Hall has referred to the possibility of the occurrence of graptolites in these beds, in which he has "detected theca of the type of *Bryograptus.*" Ranft asserted the presence of ordovician graptolites at Costerfield.

The following bibliography enumerates the literature of the geology of Heathcote, excluding papers dealing only with the glacial deposits and mineralogy :—

1. Dunn, E. J.—Notes on the Geological Features of Heathcote and Neighbouring Parishes. Quart. Rep. Min. Dep., Dec. 31, 1888 (1889), pp. 76-77.
2. Etheridge, R., jun.—Evidence of the Existence of a Cambrian Fauna in Victoria. Proc. Roy. Soc. Vict., new ser., vol. viii., 1896, pp. 52-64, pl. 1.
3. Also Mon. Prog. Rep. Geol. Surv. Vict. No. 11, 1900, p. 26.
4. Ferguson, W. H.—Report on an Area of Cambrian Rocks at Heathcote. *Ibid.*, No. 2, 1899, pp. 23-25, 1 pl.
5. Hall, T. S.—Supposed Graptolites from Heathcote. *Ibid.*, No. 11, 1900, p. 26.
6. Howitt, A. W.—Notes on Diabase and Adjacent Formations of the Heathcote District. Spec. Rep. Dep. Mines Vict., 1896, 16 pp., 5 pl. [with appendix by E. Lidgey, p. 15].
7. Jenkins, H. C.—Report on the Heathcote, Costerfield, Graytown, Rushworth, Whroo, and Redcastle Districts. Spec. Rep. Dep. Mines Vict., 1900, 7 pp.
8. Lidgey, E.—Notes on Quarter Sheet No. 80, N.W.—Parishes of Dargile, Heathcote, Costerfield and Knowsley. Prog. Rep. Geol. Surv. Vict., No. viii., 1894, pp. 44-46, 4 pl. Also *vide* Howitt.
9. McCoy, F.—Report on Palaeontology of the Geological Survey for the Year 1891. Ann. Rep. Sec. Mines for 1891 (1892), p. 30.

10. Ranft, J. A. H. T.—Origin and Formation of Auriferous Rocks and Gold. Sydney, 1889.
11. Selwyn, A. R. C.—Notes on the Physical Geography, Geology, and Mineralogy of Victoria. Intercol. Exhib. Essays, 1866-67. Off. Rec., pp. 147-227.
12. Selwyn, A. R. C.—A Descriptive Catalogue of the Rock Specimens and Minerals in the National Museum. 96 pp. Melbourne, 1868.
13. Walker, B. D.—Report on Neglected Gold Fields, Part II., Spec. Rep. Dep. Mines Vict., 1894, 12 pp.
14. Whitelaw, O. A. L.—Geological Sketch Map of the Parish of Heathcote. Mines Dep., Sept., 1896.

III.—The Geological Sequence at Heathcote.

The palaeozoic rocks at Heathcote may be divided between four systems. The famous glacial deposits of Derrinal occur to the west; though often recorded as mesozoic, they are probably of upper carboniferous age. Their only concern with this paper is that they are rich in fragments of the metamorphic and diabase rocks. The remaining palaeozoic rocks belong to the silurian and ordovician systems, and to a group of igneous and metamorphic rocks.

III. (A).—*Silurian.*

The silurian rocks lie to the north-east of Heathcote, and occur as a thick series of breccias, conglomerates, quartzites and quartzose grits. Certain bands are extremely rich in fossil casts, including encrinite stems, brachiopods, gastropods, and occasional trilobites. I have not given attention to the palaeontology of these beds; but they contain a Homolonotus of the type found in the lower part of the Victorian silurian system. Further east the sandy type is less persistent and some shales occur. The prevalent strike of the silurian rocks is from north to south, but around Mount Ida the strike is from east to west; this change is no doubt due to a fault, which is now hidden by the valley to the south of the mountain. In the breccias the pebbles are mainly quartzites, derived in the main from the silurian and ordovician rocks. Mr. Lidgey has recorded the occurrence of pebbles of the metamorphic rocks in the breccias on the summit of Mount Ida. (No. 8[1]).

The silurian rocks can be seen in close contact with the diabases on the eastern side of the Murray-road, opposite the so-called copper mine. There is no sign of any contact alteration of the silurian rocks there. The silurian sandstones are often reddish-brown, owing to the abundance of material, which the microscope shows to be mainly decomposed diabase.

The junction of the silurian rocks with the diabase series is rarely shown, as they are generally separated by the alluvium along the McIvor Creek; but in some workings by the old scheelite mine at South Heathcote the silurian rocks were exposed close to the diabases; there is no apparent sign of contact alteration in the silurians; the development of the scheelite was probably a secondary change due to the action of solutions.

III. (B).—*The Ordovician.*

The ordovician rocks to the south and west of Heathcote are in the main sandstones, quartzites, shales, micaceous mudstones and shales. The strike is generally from north to south; but near Heathcote it changes to from N. 30 W. to S. 30 E. The beds, as a rule, are not much contorted, and the bedding is fairly regular. Some of the beds which had been mapped as ordovician slates, Mr. Howitt has determined as phyllitic schists. Most of the ordovician rocks still clearly show their clastic origin, and they have not been converted into schists. The rocks are themselves unfossiliferous, except for a band which lies along the eastern border of the ordovician series, in the parish of Knowsley East. The fossiliferous band occurs across the paddocks from 3q, 3p, 3m, 3j, 3n, 3l, and 3i. It has been carefully described by Mr. Lidgey and Mr. Ferguson, and the latter has twice collected from it a series of fossils. The first determined fossil from this band was described by Mr. R. Etheridge, jun., as a new genus of trilobite, of cambrian age. He named it Dinesus ida.

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1 The reference numbers are to the bibliography on p. 151.

III. (C).—*The fossils of the Dinesus ida Beds, and Notasaphus, a new genus of Trilobites.*

The need for more precise determination of the age of the Dinesus ida beds renders necessary reconsideration of the fossils found in them. Some supposed graptolites are too indefinite to be of use. The trilobites give the most important evidence. They were discovered by Mr. Ferguson, and some specimens were collected by Mr. Lidgey. The specimens consist of some cranidia and pygidia scattered together in an iron-stained shale. Mr. R. Etheridge, jun., who described the specimens, naturally concluded that they belonged to the same species. Mr. Etheridge gave a detailed description of the material then available; he referred it to a new genus and species, Dinesus ida. He did not refer the genus to a family, though he carefully contrasted it with several lower cambrian genera.

In order to obtain more material to settle the generic affinities of Dinesus, Mr. Ferguson made an excavation in the shales during last June, and obtained additional specimens of the trilobites. The new specimens are also fragmentary, but their evidence shows that at least two distinct trilobites have been included in Dinesus ida. They show that the pygidia and cranidia figured as Dinesus do not belong to the same genus. The pygidia figured by Mr. Etheridge agree better with some cranidia recently obtained by Mr. Ferguson. One specimen of Dinesus shows two of the thoracic segments.

Mr. Ferguson's recent collection enables me to suggest the following arrangement of the trilobite remains from this horizon.

1. Family Asaphidae.

Genus *Dinesus*, R. Etheridge, fil., 1896.

Diagnosis.—An asaphid with a nearly smooth glabellum, which has the sides sub-parallel or slightly contracted in front; the axial grooves are deep. The third side-lobes are cut off from the rest of the glabellum by the junction of the third side furrows and the neck furrow. Eye lobes small, and slightly projecting. Facial suture cutting the frontal border in front of the axial groove. The fixed cheeks are triangular, long, regularly tapering to the front; they are gently convex. Neck furrow deep and straight. Thoracic segments large; the number is probably small. The pleura are wide, but short.

Type species, *Dinesus ida.* R. Eth. fil.: Cambrian Fauna in Victoria. Proc. R. Soc. Vict., Vol. VIII. (new ser.), 1896., pp. 56-57, pl. 1, fig. 1, 2, 3 and 4, not fig. 5 and 6.

This genus differs from *Asaphus* by its large, parallel-sided glabellum, small eyes, triangular fixed cheek, and much deeper thoracic segments.

Genus *Notasaphus*, n. g.[1]

Diagnosis.—An Asaphid, with glabellum expanded widely in front; it is crossed by deep, well marked neck furrow, with a slight projection on the middle line. Lateral furrows barely recognisable. Fixed cheeks broad behind, and with a well-rounded expansion in front of the deep, well marked eye lobes. Free cheeks large.

Pygidia large, with three or four large annulations on the axis. In the front pygidial segments the pleura are wide; but the hindermost pleura are narrow, and the whole bordered by a wide doublure with the edge broken into four, five or six pairs of long, projecting spines. Number of thoracic segments unknown.

Distribution.—Lower ordovician. Victoria.

Type species, **Notasaphus fergusoni**, n. sp. (Pl. XXVI.)

Affinities.—The collection may include two species of this genus as the number of spines and width of the doublure on the pygidia vary. The cranidia found all appear to belong to the same species, and one of them was attached to a pygidium with five pairs of spines. This genus appears to be an asaphid, as the cephalic shield and pygidium are large and sub-equal, and it no doubt had but a small number of thoracic segments. Only some isolated fragments of the thoracic segments remain.

The genus differs from the other genera of Asaphidae by its spiny pygidium; but as a doublure is found in some asaphids

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1 From Greek, νοτιος—southern.

the development of spines is not remarkable. The genus resembles Asaphiscus, Meek, 1873, which has, however, a conical glabellum. The spiny border of the pygidium resembles that of Ceraurus (syn. Chicrurus), but Notasaphus appears to be a true Opisthoparian (using Beecher's classification), as the specimens suggest that the genal spines were born on the free cheeks.

Dinesus and Notasaphus both have the characters of ordovician rather than of cambrian trilobites. They might be upper cambrian; but their evidence does not necessitate the separation of the Dinesus ida beds from the ordovician system.

In some shales associated with the trilobite bed are some fossils resembling graptolites or algae. Mr. T. S. Hall has failed to find any more definite evidence than hydrotheca of the Bryograptus type, so they give us no definite evidence. In Mr. Ferguson's later collection there are a few brachiopods, which have been examined by Mr. F. Chapman, who has reported on them, and regards them as of ordovician and probably even of upper ordovician age. The strike of the fossiliferous band is conformable with the strike of the overlying ordovician beds. It seems to me safest, with our present knowledge, to include them in the ordovician, as the lowest part of that system along the Heathcote line. The beds may be shown on the Victorian Survey Map as simply Dinesus beds of lower ordovician age.

III. (D).—*The Heathcotian Series.*

The last rocks of this area may be grouped together as the Heathcote series. They may be divided into two main divisions: the first includes some clearly altered sediments; the second a series of altered igneous rocks.

The microscopic structure of the rocks has been carefully described in Mr. Howitt's excellent memoir, to which reference may be made for detailed description of most of the rocks and the character of their minerals. Mr. Howitt has determined the rocks of the acid series as aplites, granophyres and labradorite-porphyrites; and the rocks of the basic series he has identified as diabase, diabase-porphyrite, enstatite-diabase-porphyrite and hornblende-diorite; and one very altered series is referred to as spilite.

IV.—The Petrography of the Heathcote Rocks.

With Mr. Howitt's description of the petrography of the rocks I am in agreement, except in a few minor matters of nomenclature. The rocks may be divided into four groups—the unaltered sediments, metamorphic rocks, acid igneous rocks, and basic igneous rocks.

The unaltered sediments show nothing of special interest. Reference has already been made to the occurrence of fragments of the diabasic materials in the silurians. The ordovician rocks are normal clastic rocks, considerably crushed, but not foliated.

The metamorphic rocks of the Heathcote series are of two types. They include schists and sandstones. As a type of the altered schists I may refer to a specimen collected 130 yards west of the so-called copper mine, on the Murray road, two and a-half miles north of Heathcote. The rock is a phyllite, traversed by two distinct cleavage planes. The rock was first altered by the development of a foliation, which formed alternate bands of fine grained argillaceous matter and quartz. It was subsequently cleaved obliquely to the foliation planes. The rock breaks readily along the second planes, and these are clearly shown in section as they are marked by limonite stains. The typical rock of this group is phyllitic schist.

The second type of the metamorphic rocks includes a series of black cherts, which are especially well shown near Lady's Pass in Dargile. These cherts when fresh are of a black colour with a satiny lustre. When exposed for some time to the weather, they become grey or they may be quite bleached. These rocks have been described by Mr. Howitt as adinoles. An adinole is a rock altered by a basic intrusion, and the term seems to imply the absorption by the altered rock of some material from the intrusive rock. Two analyses of adinoles given by Rosenbusch[1] show 8.33 and 7.77 per cent. of soda respectively, whereas the analysis of the Heathcote rocks, made by Mr. F. Stone for Mr. Howitt,[2] show only 0.84 and 1.98 per cent. of alkalies. The analyses are as follows :—

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1 Rosenbusch: Elemente der Gesteinslehre, 1898, p. 333.

2 Howitt, *op. cit.*, p. 8.

I.		II.		III.		IV.
SiO_2 - -	91.08	SiO_2 -	92.74	SiO_2 -	72.63	76.30
Al_2O_3 - -	6.00			Al_2O_3 -	15.81	14.68
Fe_2O_3 - -	tr.			FeO -	0.74	trace.
CaO - -	0.14			CaO -	1.02	0.18
MgO - -	.25			MgO -	1.21	0.02
K_2O - -	1.82	K_2O }	.84	K_2O -	0.75	0.53
Na_2O - -	.16	Na_2O }		Na_2O -	8.33	7.77
Loss on ignition	.96 (1)			H_2O -	0.61	0.48
	100.41				101.10	99.96
				Sp.G.	2.778	2.637

I. "Metamorphosed Sediment," analagous to adinole, allotment 12, Parish Crosbie. Howitt, A. W., "Notes on Diabase and Adjacent Formations of the Heathcote District," p. 8.

II. The same, No. 18 Gatehouse, at Heathcote. Howitt, A. W. *Op. cit.*, p. 8.

III. Adinole, Heinrichsburg, near Mägdesprung. Harz. H. Rosenbusch, "Elemente der Gesteinslehre," p. 333.

IV. Adinole, Gitzhügel, near Hasselfelde. Harz. H. Rosenbusch, *Op. cit.*, p. 333.

The acid igneous rocks have been carefully described by Mr. Howitt, who states that "I have felt much difficulty in assigning a place in classification to these granitic rocks." (6, p. 5.) He finally called them aplites and suggested for them the provisional term of plagioclase-aplites. With Mr. Howitt's determination of the mineral constituents and structure of these rocks I entirely agree. There are two distinct varieties of rock. The first—those identified as aplites—consists of orthoclase in eroded and altered crystals, idiomorphic crystals of plagioclase, rounded grains of quartz, and flakes of colourless mica. The plagioclase, as Mr. Howitt remarks, is "more or less completely replaced by flakes and rosettes of a colourless mica." Biotite is also present in small patches.

In the second variety of rock—Mr. Howitt's labradorite-porphyrite—the structure is porphyritic, and the base is granophyric. The colour of the rock is dark grey to bluish or blackish grey. Plagioclase occurs both in phenocrysts and in radial tufts.

(1) This sample lost .20 per cent. on drying at 212 deg. F.

The plagioclase, according to Mr. Howitt's measurements, is a member of the labradorite group. There is also an amphibole. either anthophyllite or a monoclinic species with a nearly straight extinction. The rocks of this second type Mr Howitt described as later effusions from the aplite magma, and he calls them labradorite-pophyrite.

The two varieties of the rocks are probably associated, as Mr. Howitt concluded, and the labradorite-porphyrite is intermediate between the more acid variety and the diabase.

The use of the term aplite for either of the rocks seems to me open to doubt. Taking Rosenbusch's[1] last definition of the term aplite, he describes it as "a panidiomorphic granular rock, which consists of predominant potash felspar (orthoclase, microcline with lattice structure, microperthite, more rarely microclinmicroperthite), and quartz with acid plagioclase and a very limited quantity of muscovite and biotite, or both these micas." The structure, therefore, of an aplite is panidiomorphic, whereas in these Heathcote rocks the structure is hypidiomorphic. The rock, moreover, occurs more in masses than dykes, and it seems to me safer to regard the rocks as fine-grained granodiorites. It is quite natural to find them associated with later effusions, as Mr. Howitt describes them, or possibly dykes having the chemical character of rocks of the intermediate group. The porphyritic granophyric labradorite rock in allotment No. 16, at South Heathcote, can be more easily explained as derived from a granophyr than from an aplite.

The typical granodiorites occur at the Red Hill, where they are seen to be clearly intrusive into the diabase series. They also occur in the area round the water reserve, where they occur as a series of small tors.

The labradorite-porphyrite is best shown in South Heathcote, on the northern side of Photograph Knob.

The Diabase Series.

The rocks of this series, as Mr. Howitt has pointed out, are very varied in their petrographic characters. Many of them, such as the diorite, the enstatite-diabase, and most of the

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1 H. Rosenbusch: Elemente der Gesteinslehre, 1898, p. 206.

porphyrites, have the characters of intrusive rocks. In various parts of the series there are diabases which have the structures of lavas, though the material is now entirely altered. Photograph Knob, South Heathcote, consists of one of the most interesting rocks in this series; it has the characters of a volcanic agglomerate. Hence, especially at South Heathcote, some of the diabases are of eruptive and volcanic character.

V.—Age of the Heathcotian Series.

According to the view which has hitherto prevailed, the Heathcote series is of post-silurian age. In that case the rocks of the diabase series are intrusive into the silurians.

(A).—*Relation with the Silurian.*

The first evidence against this view is the complete absence of any contact alteration along the line of junction of the diabase and silurian series. Where they are in close juxtaposition the silurian rocks have not been baked. Lidgey has already quoted the occurrence of pebbles of the metamorphic rocks in the silurian; and the microscopic examination of the basal silurian rocks at the Copper Mine shows that they contain a considerable proportion of diabasic material. These facts clearly show that the silurian is later than the Heathcotian series, and is resting unconformably upon it.

(B).—*Relations with the Ordovician.*

The relation of the ordovician and eruptive rocks is less clear. As a rule the junction is somewhat obscure; and I have not attempted to follow it all along the line. I have examined typical sections where the ordovician and the diabase series occur in contact, and in some cases found no evidence of contact alteration. In places, as at Red Hill, the diabase series is separated from the ordovician rocks by a band of schists, and I have not been able to find any sharp junction between these schists and the overlying ordovician beds; but, on the other hand, I have not been able to see any passage from the schists into the ordovician beds. I have in no case been in doubt, after the application of the microscope, as to whether a rock belonged to the schistose or to the ordovician series.

In Craven's paddock, in Knowsley parish, allotment 32, the two rocks can be well seen in contact close along the eastern fence. Here, as elsewhere, the junction between the hard cherts of the metamorphic series and the normal slates and sandstones of the ordovician series can be clearly recognised.

A serious difficulty in the view that the diabase rocks were intrusive into the ordovician rocks is the sporadic character of contact alteration along the line of junction. Thus in Mr. O. A. L. Whitelaw's sketch map of Heathcote, the diabases are represented in contact with the ordovician rocks from the northern boundary of the parish across Mount Ida Creek and McIvor Creek to the west of the northern end of the township. Along this line of two and a half miles no metamorphic rocks are represented as occurring between the ordovician and diabase series. In the Heathcote township there are two blocks of metamorphic rocks. One is shown on the map to the north and east of the water reserve; but these metamorphic rocks, instead of occurring between the diabase rocks and the ordovician, are on the wrong side of the igneous series. A small narrow band of metamorphic rocks occurs at Red Hill; it is a quarter of a mile in length, about ninety yards in width at the thickest point; it thins out to north and south, leaving unaltered ordovician rocks resting directly upon the diabases. Then follows another mile and a half without any metamorphic rocks along the contact; then, close by a small patch of diorite on the eastern side of the road going to Arygle's reef, there is another patch of metamorphic rock (Pl. XXIV., Fig. 1). It forms a bay running into the diabase series, which occurs round it on the north and east; on the south is a small outcrop of diorite, which appears to be sharply marked off from the ordovician rocks by a line running from north-west to south-east. This line cuts with equal abruptness straight across the metamorphic rocks, the diorite and the diabase, as if they were all part of the same series. The last patch of the metamorphic rocks occurs in South Heathcote, in allotments Nos. 15 and 16 (Pl. XXIV., Fig. 2). Here a bay, represented on the map as unaltered ordovician, runs up between the diabase on the north and an intrusion of aplite on the south-east. The unaltered ordovician is shown as half a furlong in width, but the only part which is represented as metamorphic is a circular patch at the extreme head of this ordovician bay. Had the metamorphic rocks been formed by the alteration of the ordovicians owing to the intrusion of the diabases and the aplites, then we should have certainly expected the whole of this narrow band of the ordovicians to have been altered.

The map at the northern end of the Heathcote series is equally difficult to explain on the view that the metamorphic rocks have been formed by the alteration of the ordovicians (Pl. XXIV., Figs. 3, 4). For instance, the plan of Crosbie and Redcastle (Nos. A and B, opposite p. 4, in Mr. Howitt's Monograph) shows one thin band of metamorphic rock in the southern half of paddock 4C; it lies between diabase on the east and the ordovician on the west; but the ordovician rocks at the northern end overlap the metamorphic and rest directly on the diabases. Similarly on the western flanks of the diabase range at the south-eastern corner in Crosbie and south-western corner of Redcastle and north-western corner of Dargile. Here for most of the way the ordovicians are separated from the diabase by a band of metamorphic rocks; but at the northern half of paddock 15aa in Redcastle, the ordovician rocks are shown[1] to overlap the metamorphic band and rest directly on the diabases.

I have not been able to confirm the mapping in these localities, and have not visited the sections at the northern part of Crosbie. But the evidence is of importance as it is inconsistent with the view expressed in the memoir accompanying those maps. The field relations show, according to the work of the surveyor, that the ordovician rocks have been deposited unconformably on the edge of an old series of metamorphic rocks and diabases. In some cases the ordovicians were laid down upon the metamorphic rocks and in other cases directly upon the diabase. Moreover, the metamorphic rocks occur in places where there are no igneous rocks exposed in the immediate vicinity. Thus an exposure of

[1] Howitt, *op. cit.*, Map facing p. 4; the part in question is reproduced on pl. xxiv., fig. 4.

the typical cherts of the metamorphic series occurs along the eastern edge of allotment 3Q in Knowsley East. The cherts occur between the silurian rocks on one side and unaltered ordovician on the west. There are some diabases a little south of this allotment, but none occur in it. If we explain the metamorphism there as due to a continuation of the diabases at a slight depth below the surface, then it is difficult to understand why there is no sign of alteration in the Dinesus ida beds, which must be approximately the same distance from any such assumed igneous mass.

Further evidence of a negative, but still of an important character is the fact that, although these diabases and igneous rocks occur along a line of nearly thirty miles in length, not one case is known of an apophysis or of a dyke striking from this series into the silurian or ordovician beds. Had this complex series of intrusive igneous rocks been injected in post silurian times, it is highly improbable that they should have kept along the actual line between the two lower palaeozoic systems, and should not, in a single case, have sent off an intrusion into the lower palaeozoic beds.

C.—*Geological Sequence at Heathcote.*

The evidence therefore seems to me conclusive that the series is as follows:—

Silurian - - Sandstone and Quartzites.

Unconformity.

Ordovician { Sandstones and slates.
Dinesus ida beds.

Heathcotian { Granodiorites and granophyric porphyrites.
Diabase series partly eruptive and partly intrusive.
Cherts and schists.

According to this view, Mr. Dunn was right in regarding the rocks in the Heathcote series as pre-ordovician (or as he has put it, pre-silurian), and the diabases as in part effusive. Mr. Howitt was right in his rock determinations, and in the view that the diabase and acid rocks are mainly intrusive; but both the igneous and the metamorphic rocks were of pre-ordovician instead of post-silurian age.

VI.—The Distribution of the Heathcote Series in Victoria.

We must enquire where else in Victoria representatives of the Heathcote series occur. South of the Colbinabbin Range of the Heathcote Valley we find a similar rock series forming the Mount William Range, and extending from Mount William to south of the Lancefield Gap. The distribution of the rocks is well shown in the quarter sheet of the Geological Survey Map (No. 5, S.E.), where they are marked as "Trap or Hypogene and metamorphic silurian." The famous aboriginal quarries of Mount William were worked in outcrops of the amphibolites and impure nephrites of the Heathcotian series.

Mr. W. H. Ferguson[1] has shown that at Dookie there is another outcrop of diabases, and some specimens that he collected (now in the Mines Deparment) show that both the igneous and the associated metamorphic rocks have the characters typical of the Heathcotian series.

The bores put down by the Mines Department at Rushworth have revealed beneath the silurian sandstones and shales a thick series of hard black quartzites. I have had sections prepared from these rocks and they show that these deeper Rushworth quartzites have the characters of the Heathcotian cherts. Mr. A. M. Howitt has re-examined the bore records of the Rushworth bores and has sorted out the sample of the cores. The non-success of the boring for gold at that locality was due to the fact that the deeper bores passed into the barren series of Heathcotian cherts.

That the Heathcotian rocks had at one time a considerable extension further east than Dookie is probable from the evidence of the glacial conglomerates between Chiltern and the Springs. I have been guided over these deposits by Messrs. S. Hunter and A. W. Gahan. The most abundant foreign boulders in these deposits are cherts of the Heathcotian series. They are

[1] W. H. Ferguson: Notes on the Rocks at Dookie. Prog. Rep. Geol. Surv. Vict., No. viii., pp. 59-60, 1894.

associated with fossiliferous quartzites, which resemble those of Mount Ida. Both materials were probably derived from the denudation of an eastern extension of the rocks exposed at Heathcote.

South of the Lancefield Gap another outcrop of hypogene trap is recorded on the survey maps. I have been able to examine the rocks of this outcrop owing to the kindness of the Rev. H. Hennell, of Lancefield, who has collected some specimens for me.

Mr. Hennell's collection includes several varities of diabases, and a specimen of banded chert, which nearly resembles that of the Heathcotian series. The lithological characters and stratigraphical position of these rocks both suggest that they are a southern continuation of the Mount William range.

Near Geelong there are some more outcrops of the Heathcotian series. The two largest are shown on the Geological Survey Map, No. 24, S.E., and are there coloured as Trap or Hypogene. They were determined by Selwyn as diabases. An unmapped exposure occurs flanking the granodiorites of the Dog Rocks in the Moorabool Valley. As I understand that Mr. E. G. Hogg is undertaking a study of these rocks, I have only examined them as far as is necessary for the course of this paper. In the Moorabool Valley, opposite the Dog Rocks, is an irregularly foliated amphibolite (No. 149); it is mainly composed of needles of green hornblende, associated with zoisite and some material, probably derived from altered grains of felspar. The rock was a basic igneous rock, intensely altered—in part, no doubt, owing to the intrusion of the adjacent granodiorites of the Dog Rocks.

A second amphibolite (No. 143) of somewhat the same character occurs at George's Hill in the Barwon Valley. It was collected by Messrs. D. J. Mahoney and G. Voss Smith. This rock is less foliated and the remains of the felspars are larger and more angular than in the amphibolites from the Dog Rocks. The rock has been altered and the ferromagnesian constituents now consist of abundant needles and plates of amphibole. This mineral has an extinction of 12 degrees, a prismatic angle of about 123 degrees, and its pleochroism ranges from blue or bluish green to pale green and yellowish green. It may therefore be identified as arfvedsonite.

A rock represented by specimens in the conglomerates at the Barwon Falls has been called gabbro. It gives us a better indication as to the original character of one of the rocks of this series. It (147) is an enstatite-diabase, not unlike some of the specimens from Heathcote.

A specimen from the Barwon Falls, Geelong (150), is normal epidiorite, with the plagioclase well developed and the uralitic hornblende abundant.

An analysis of one rock from the outcrop near Geelong has been given in Selwyn's "Descriptive Catalogue of the Rock Specimens and Minerals in the National Museum," 1868, pp. 17, 94. It is identified as a "Greenstone (diabase)." The analysis was interpreted to identify the plagioclase as labradorite, and the green mineral as probably chlorite. The exact locality of the rock is not stated.[1]

GREENSTONE (diabase), GEELONG.

Silica - - - - - - -	50.84
Alumina - - - - - -	12.92
Sesquioxide of Iron - - - -	0.52
Protoxide of Iron - - - -	6.99
Lime - - - - - - -	14.35
Magnesia - - - - - -	10.97
Potash - - - - - -	1.83
Soda - - - - - - -	traces.
Water - - - - - - -	0.71

In south-western Victoria, near Mount Staveley, we have another development of the Heathcotian rocks. They extend in a band, coloured on Mr. Everett's Geological Survey Map of Victoria[2] as "Porphyrites, Diorites, and Trachytoid rocks, &c." This band extends north and south for some twelve miles. I have been able to examine this bed near Mount Staveley, between Wickliffe Road and Glen Thomson. This hill is mainly composed of hard cherts of the Heathcotian type; they are associated with diabases, also like those of the Heathcotian series. The ridge may be regarded as another exposure of the pre-ordovician rocks.

[1] *Ibid.*, p. 94.

[2] Geol. Survey, 1902.

The confused rocks at Waratah Bay, Cape Liptrap, may include an outcrop of the Heathcotian series. Mr. Stirling[1] has recorded the occurrence there of "hard felsitic beds" "either silurian or pre-silurian"; of a gabbro with serpentine veins; and of a "hornfels-like contact rock." But he regards the gabbro and diabasic rocks as associated with deep-seated apophyses, from the granitic area of Wilson's Promontory; and the granitic rocks there have been generally regarded as devonian in age. On Mr. Stirling's plates some rocks in fig. 1 are marked as cambrian; in fig. 2 the diabase or "melaphyre" is shown as intrusive into the silurian (?); in the view of Waratah Bay the "felsitic jointed rock" is stated as pre-silurian (?); and in the sketch section at "Serpentine Dyke, to west of Bird Rock," it is said to be cambrian, and the serpentine is shown intrusive into it, separated by a "contact rock (mica porphyrite)."[2]

Another area where Heathcotian rocks may occur is on the line of junction of the silurian and devonian rocks in Wonnangatta. The most probable locality would be in the Howqua Valley, south of Mount Buller. Mr. Murray's[3] report on this district refers to the upper silurian beds being there "partly metamorphic in character." So far I know of no certain evidence of Heathcotian rocks in that area.

VII.—Relations of the Ordovician and Silurian Systems.

The above conclusions help us to understand the relations of the ordovician and silurian deposits in Victoria. It has been well known since the time of Selwyn's work that the ordovician and silurian rocks meet along a line running from Melbourne northward through Heathcote; but no very satisfactory junctions have been found along this line.

Starting at the Mount William Range the hills are formed by a continuation of the Heathcotian series. Immediately at the

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1 J. Stirling: Notes on the Silver Deposits and Limestone Beds of Waratah Bay. Prog. Rep. Geol. Surv. Vict., No. viii., pp. 68-69, pl. 4.

2 The general impression left by the above account is that the rocks are probably Heathcotian; but one of my colleagues on the Geological Survey is of opinion that the supposed pre-ordovician rocks are altered silurians.

3 R. A. F. Murray: Howqua Hills District. Prog. Rep. Geol. Surv. Vict., No. vii., 1884 (1885), p. 57.

western foot of the hills are the Lancefield beds; going westward we cross an ascending series of the ordovicians, coming first to the Bendigo and then to the Castlemaine divisions of this system. Whereas, on the generally accepted view that Victoria is in the main one great synclinal, we should expect to find the uppermost, and not the lowermost, of the ordovician beds nearest to the junction with the silurians.

So far there is no fully convincing, definite evidence of the silurian beds resting upon the ordovician beds. There are three possible cases. Specimens collected by Mr. Ferguson in Wombat Creek, in north-eastern Victoria, have enabled Mr. Robert Etheridge, jun., to record the occurrence of silurian fossils from beds above a series with ordovician fossils. But Mr. T. S. Hall's determination of the graptolites from that area suggests doubt as to the occurrence of both the ordovician and silurian systems of that locality.

A second possible case is at Costerfield. Ranft, in his "Origin of Gold," refers to the occurrence of abundant ordovician graptolites in the tip heaps in the mines of Costerfleld, although the beds on the surface are there mapped by the Geological Survey as silurian. If Ranft and the Geological Survey are both right in their determinations, then the silurians at Costerfield rest upon the ordovicians.

The third possible case is at Sandy Creek, a tributary of the Mitchell River, in Dargo. Mr. Herman collected some fossils there, which have been identified by Mr. R. Etheridge, jun., as silurian, and the beds are marked accordingly on the last edition of the Geological Map of Victoria. Mr. Herman, however, had previously mapped these beds as middle devonians.[1] The collection included a *Productus*. Mr. Etheridge suggests that this fossil was accidentally included with the Sandy Creek fossils.[2] A definite conclusion in this case must await further evidence.

The Heathcote evidence gives a simple explanation of this remarkable fact that there is no evidence of the super position of the silurian on the ordovician. During the time of deposition of the ordovician rocks a high ridge probably extended across

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1 H. Herman: Trans. Austral. Instit. Min. Eng., vol. v., Paper No. 68.

2 R. Etheridge, jun.: Note forthcoming in Records Geol. Surv. Vict.

Central Victoria from south to north. The deposition of the ordovician beds began by the sinking of the ground to the west of the line from Heathcote to Melbourne, and by a second subsidence in eastern Victoria from Bogong to Dargo. The oldest deposits were naturally deposited on the sinking shore lines, so that the Lancefield series was laid down on the eastern side of the land made up of Heathcotian and perhaps also still older rocks; as the subsidences continued later sediments accumulated further and further to the west (Pl. XXV., Fig. 5). During the time represented by the unconformity between the ordovician and silurian rocks, the country to the west of the Heathcote-Melbourne line was probably upraised; subsidence or denudation in the counties of Evelyn, Anglesey and Rodney led to a silurian sea running northward from Port Phillip to the Murray basin. This silurian sea was bounded both to the west and east by highlands of ordovician rocks (Pl. XXIII). It is possible that gulfs from the ordovician sea ran into the old Heathcotian land area, Sandy Creek and Wombat Creek; and in these places the ordovician deposits may have been covered by silurian sediments. The silurian rocks may also have extended westward from Mount Ida over the eastern border of the ordovician series; but in all probability, the main part of the ordovician and silurian rocks were deposited in independent basins; and these basins were separated by a range of old rocks, which once extended from Geelong to Mount Camel, and of which the Colbinabbin and Mount William Ranges are the best preserved remnants.

The range of the Heathcotian rocks does not appear to have been continuous from Lancefield to Geelong even in upper ordovician times. No trace of it is known where the silurian and ordovician rocks occur near together, between Keilor and Sunbury. Rocks of the Melbournian division of the silurian system are exposed near rocks belonging to the upper ordovician. Thus, near Diggers' Rest, there are slates with Dicranograptus ramosus and Coenograptus gracilis, which are regarded as upper ordovician. The slates along the Coimaidai Creek, near Bacchus Marsh, contain Didymograptus caduceus, Didymograptus extensus and Tetragraptus quadribrachiatus; they are typical of the Castlemaine series, the uppermost of Mr.

Hall's three subdivisions of the lower ordovician. At Matlock we have again upper ordovician graptolites such as Dicellograptus morrisi, and Diplograptus foliaceus. It is therefore probable that while the ordovician series was being deposited, denudation was destroying the land area of Heathcotian rocks. The transgressions of the ordovician sea carried the higher part of the ordovician rocks round the southern flank of the Mount William and Lancefield Ranges across the line that formerly connected them to the Heathcotian rocks near Geelong. In the neighborhood of Melbourne the rocks of the silurian and ordovician systems are not, so far as I know, exposed in actual contact; for the junction is covered by the basalt sheets. Yet it is possible that the Melbournian rocks rest unconformably upon the upper ordovician.

Again, east of Melbourne, in the basin of the Upper Yarra, and on the main divide near Mount Matlock, there are some upper ordovician rocks; they show that the ordovician transgression had carried the sea into the area occupied by land throughout the lower ordovician.

VIII.—The Subdivision of the Silurian System.

The relation of the ordovician and silurian rocks in Victoria raises the question of the silurian succession in Victoria. Surprise has often been expressed at the absence of clear junctions between the rocks of those two systems or of the superposition of the silurian upon the ordovician. But, as we have seen, this difficulty is explained by the geology of Heathcote.

The silurian rocks of Victoria occur in three distinct types. There is a series of coarse grained shore deposits which are best shown at Mount Ida, near Heathcote. They consist of coarse-grained conglomerates, grits and sandstones. The second type consists of alternations of shale and sandstone. It is well developed around Melbourne, near which the beds are often intensely contorted. The third type consists of a series of lenticular masses of limestone, associated with sandstone and shales; they occur at Lillydale, Loyola, Cape Liptrap and the Thomson River. The relation of these three lithological divisions of the silurian is obscured by the intense folding of certain bands. These contortions are especially well shown near

Melbourne, in our most familiar silurian sections; hence there has naturally been a tendency to exaggerate the importance of this folding in the Victorian series. The foldings occur on certain lines of fracture and contortion, which are separated by broad bands, in which the silurian rocks have a fairly normal sequence. The silurian rocks seem to me to be bent into two main anticlinals and two main synclinals (Pl. XXV., Fig 6). Along the eastern side of Melbourne is an extremely contorted zone, which is especially well shown in the cutting by the Yarra at the Johnston Street Bridge and near Heidelberg. East of this Melbourne fracture zone the beds have a regular dip to the west. This slope is part of a great anticlinal, of which the axis passes through Warrandyte. Along this anticlinal axis there is another line of contortions and faults, along which occurs a series of auriferous quartz reefs. The eastern leg of the anticlinal is much steeper than the western; and beyond it we come to the great synclinal which passes through Lillydale and Yering. We will therefore call it the Lillydale synclinal. A smaller synclinal with some Yeringian beds appears to occur in the upper Yarra. Eastward again we come to another great anticlinal. Some ordovician beds are exposed in the axis of this anticlinal near Matlock; we may therefore call it the Matlock anticlinal. To the east again comes the great synclinal of Walhalla; its two legs are said by Mr. O. A. L. Whitelaw to have a very regular dip, though the beds along the axis line of this synclinal are intensely folded and contorted. Beyond the Walhalla synclinal the beds are unconformably covered by the rocks which are included in the devonian system.

In tracing the folding of the silurians it is important to get a palaeontological basis for the correlation of the beds; but unfortunately, owing to the comparative scarcity of fossils, their imperfect preservation, and the great difference in characters between the limestone and shale faunas, the palaeontological evidence is at present insufficient. There seems, however, to be evidence of two main subdivisions; the first we may call the Melbourne series or Melbournian; many fossils have been obtained from it at Moonee Ponds and at the Yarra improvements; and it can be traced north-westward from Melbourne through Keilor, East Kilmore and Heathcote. The beds at

Reefton, MacMahon's Creek, Macclesfield, Alexandra, and Matlock also seem to belong to the Melbournian horizon.

The second series we may call the Yeringian, after Yering north of Lillydale, where the beds have yielded a small brachiopod fauna. These beds are best shown at Lillydale, but the name Yeringian is preferable, as based on a native Australian place name. This Yeringian series includes the most important silurian limestones, including those of Lillydale, Loyola, the Thomson River, Cape Liptrap, and also the beds of Seville and various localities in the basin of the Woori Yallock. We should expect this horizon also to appear in the synclinal to the west of the Warrandyte anticlinal; but so far I know no definite palaeontological evidence of its occurrence here.

No satisfactory list of the distinctive fossils of these two horizons can yet be drawn up; but I may quote the following species, using the names generally known in Victoria, without any attempt to revise the nomenclature.

MELBOURNIAN—

Phacops (Odontochile) caudatus, Brgn.
Forbesia euryceps, McCoy.
Homolonotus harrisoni, McCoy.
Cyphaspis spryi, Greg.
Hapalocrinus victoriae, Bath.
Retiolites australis, McCoy.
Spirifera plicatella (L.), var. macropleura (Conr.).
Cardium gippslandicum, McCoy.
Orthoceras (Cycloc.) ibex, Sow.
Orthoceras bullatum, Sow.

YERINGIAN—

Phacops (Portlockia) fecundus, Barr.
Lichas australis, McCoy.
Homolonotus sp. n.
Leptaena (Leptagonia) rhomboidalis (Wilck). ?
Spirifera sulcata, His.
Spirifera reticularis, L.
Pentamerus australis, McCoy.
Orthoceras lineare, Mst.
Trochus (Scalactrochus) lindstromi, Eth.
Pleurotomaria (Phanerotrema) australis, Eth.

Bellerophon cresswelli, Eth.
Tremanotus pritchardi, Cresswell.
Favosites grandipora, McCoy.

IX.—Summary of Conclusions.

1. The heathcotian series of Victoria consists mainly of phyllites and schists, with diabases, porphyrites, and amphibolites. Some of the igneous rocks are intrusive, others are eruptive, and some are volcanic agglomerates.

2. The heathcotian series is of pre-ordovician age. The evidence at present is insufficient to show whether it be cambrian or pre-cambrian. It is probably, however, more recent than the metamorphic rocks of north-eastern Victoria and of Dundas.

3. The Dinesus ida beds may be regarded as of lower ordovician age, and they contain a new genus of trilobite, Notasaphus.

4. Dinesus, so far as the available evidence goes, may be included in the Asaphidae.

5. The heathcotian series is best exposed on the Colbinabbin and Mount William Ranges. The latter extends from Mount William to the south of Lancefield Gap, and has an outlier in Deep Creek, south-east of Lancefield. Representatives of this series also occur at Dookie ; under the silurian rocks of Rushworth ; some miles west and north-west of Geelong, in the valleys of the Barwon and the Moorabool ; at Mount Staveley in Western Victoria. Probably also at Waratah Bay, Cape Liptrap. Possibly also on the Howqua River.

5. The heathcotian rocks formed, in lower ordovician times, an extensive land area across Central Victoria. By the upper ordovician times, the sea had spread eastward across what is now the Melbourne basin and the Upper Yarra.

6. The silurian system in Victoria may be divided into two divisions, a lower or Melbournian and an upper or Yeringian. The silurian system occurs partly in a series of gentle folds and partly in belts along a series of meridional fracture lines, along which the beds are intensely contorted. Going eastward from the western edge of the series the main folds in the silurian are (1) the contorted zone of the Melbournian

beds; (2) the Warrandyte anticlinal; (3) the Lillydale synclinal; (4) the anticlinal of the Upper Yarra, in the centre of which, near Matlock, upper ordovician rocks are exposed; (5) the geosynclinal of Walhalla.

7. The heathcotian rocks are the fragments of the old framework upon which Victoria has been built.

EXPLANATION OF PLATES XXIII.–XXVI.

Plate XXIII.

Sketch map of the distribution of land and sea in Victoria in ordovician times. The areas in black are the present outcrops of the Heathcotian series. In upper ordovician times there was a transgression of the sea round the northern end of the Colbinabbin Range and into the Upper Yarra.

Plate XXIV.

Fig. 1.—Map of part of Heathcote, showing diabase series in part between the metamorphic rocks of the ordovician, and also the overlap of the ordovician across the metamorphic series. From the Geological Survey Map of Mr. O. A. L. Whitelaw, as reduced in Howitt's Memoir.

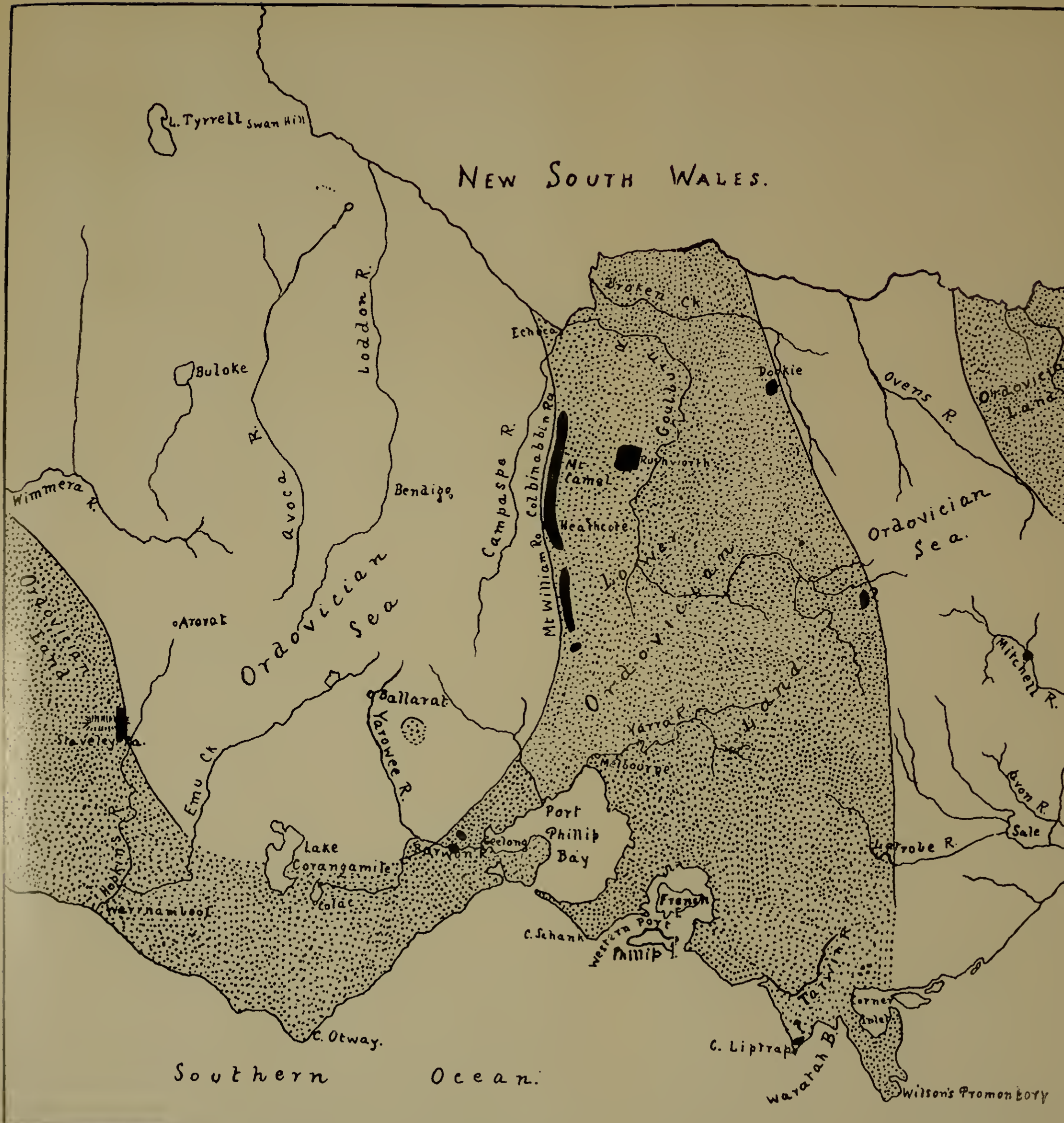
Fig. 2.—Map of the relations of the ordovician and metamorphic rocks, near South Heathcote. After O. A. L. Whitelaw.

Fig. 3.—Copy of Mr. Lidgey's map of part of Crosbie, representing the overlap of the ordovician rocks across the metamorphics.

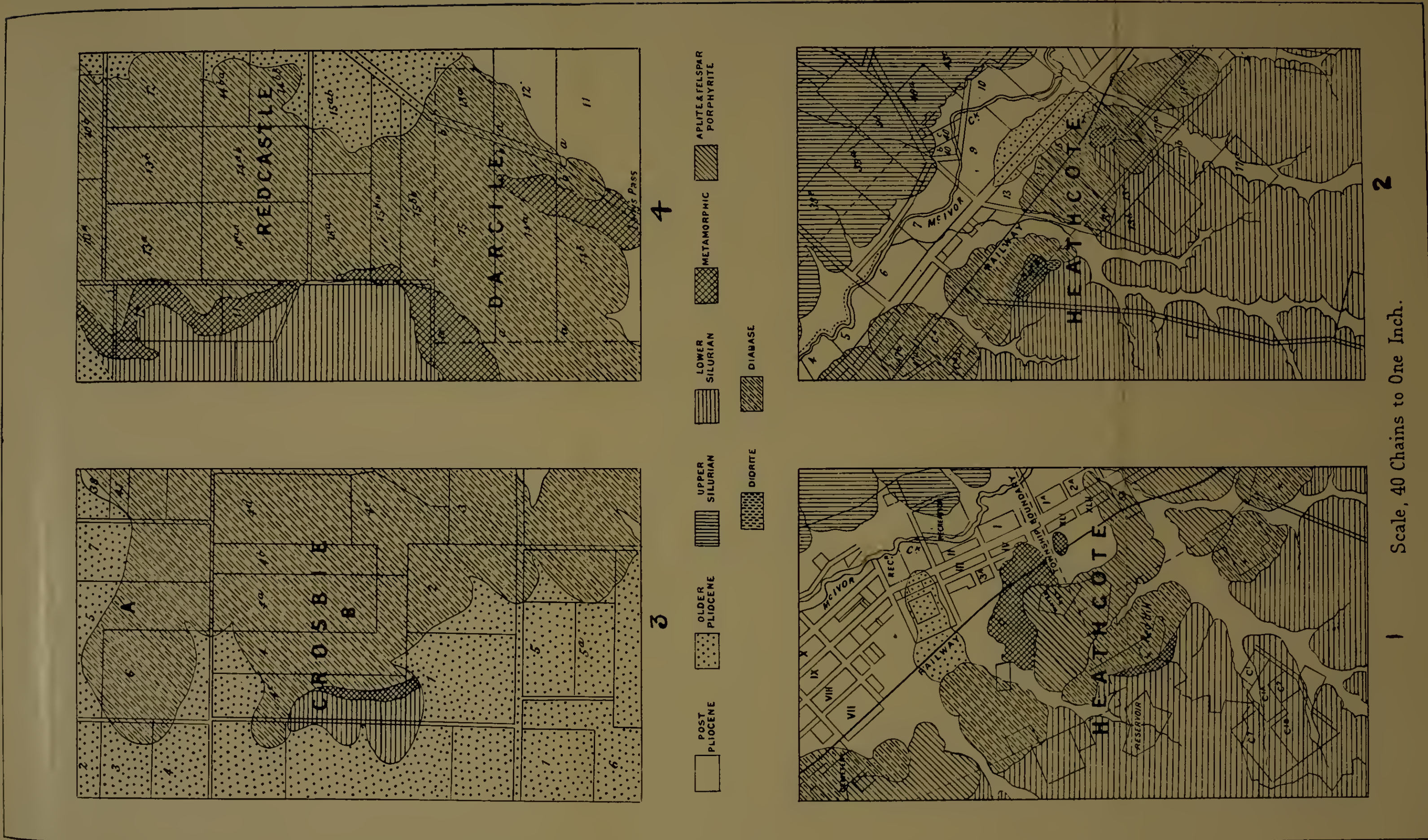
Fig. 4.—Copy of Mr. Lidgey's map of part of the parish of Knowsley.

Plate XXV.

Fig. 5.—Diagrammatic section showing the relations of the ordovician, heathcotian, and silurian rocks, near Lancefield.



Scale of Miles. 5 0 10 20 30 40 50

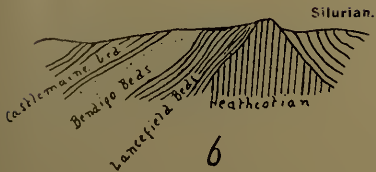


REDCASTLE
DARCILE
4
CROSBIE
A
B
3
HEATHCOTE
2
HEATHCOTE
1
POST PLIOCENE
OLDER PLIOCENE
UPPER SILURIAN
LOWER SILURIAN
METAMORPHIC
APLITE & FELSPAR PORPHYRITE
DIORITE
DIABASE
Scale, 40 Chains to One Inch.

5

Diagrammatic Section from West of Melbourne along the Yarra & across the Macallister River to Mt Wellington, showing the chief folds and fracture Zones of the Silurian System, the relations of the Yeringian and Melbournian series, and the probable occurrence of Heathcotian rocks on both sides of the Silurian basin

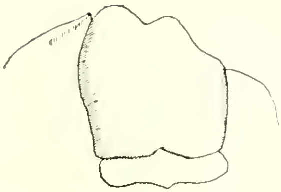
Section East and West across Mt William Range, showing Relations of Ordovicians, Silurian and Heathcotian.



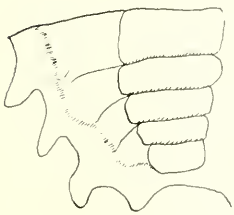
6

7 Diagrammatic Section from Bendigo to Benambra.

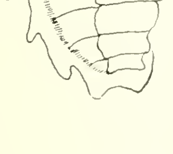
11



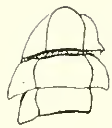
12 a



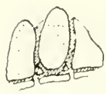
12 b



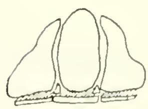
13.



8



9



10

Fig. 6.—Diagrammatic section across the silurian rocks from Melbourne to Mount Wellington.

Fig. 7.—Diagrammatic section from Bendigo to Benambra.

PLATE XXVI.

Fig. 8.—Cranidium and two thoracic segments of Dinesus ida.

Figs. 9 and 10.—Two cranidia of other specimens of Dinesus ida.

Fig. 11.—Cranidium of Notasaphus fergusoni, showing fixed cheeks. Natural size.

Figs. 12 *a* and *b*.—Cranidium and pygidium of Notasaphus fergusoni. Natural size. The two probably belonged to the same individual.

Fig. 13.—Pygidium of another specimen of Notasaphus fergusoni.

(The specimens on Pl. XXVI. are in the collection of the Mines Department, Victoria).

Art. XIX.—*Catalogue of the Marine Shells of Victoria.*

Part VI.

By G. B. PRITCHARD and J. H. GATLIFF.

[Read 9th October, 1902.]

The present paper refers to one hundred and twelve species, contained in the following families:—Stomatiidae, Haliotidae, Pleurotomariidae, Fissurellidae, Patellidae, Lepidopleuridae, Ischnochitonidae, Mopaliidae, Acanthochitidae, Cryptoplacidae, Chitonidae, Tornatinidae, Scaphandridae, Bullidae, Akeridae, Ringiculidae, Philinidae, Aplysiidae, Pleurobranchidae, Umbrellidae, Siphonariidae, Gadiniidae, and Dentaliidae.

The previous papers, Parts I. to V., dealt with 419 species, so that with the present additions the total number of species now dealt with amounts to 531.

We have omitted from present consideration our representatives of the families Truncatellidae, Auriculidae, and Amphibolidae, as they are not strictly marine forms.

The present part concludes the Gastropoda and Scaphopoda, with the exception of some species which have been obtained and identified subsequent to the publication of the various parts to which they belonged; these will be included in an appendix at the end of the treatment of the Lamellibranchiata.

Subsequent to the reading of our last paper, Professor Tate and Mr. May published a Revised Census of the Marine Mollusca of Tasmania, in which they deal with 679 species, including the Palliobranchiata and brackish water forms. We do not agree with all their conclusions, and will take an opportunity later on of discussing the points on which we differ.

Family Stomatiidae.

Genus **Stomatella**, Lamarck, 1809.

Stomatella imbricata, Lamarck.

1822. Stomatella imbricata, Lamarck. Anim. S. Vert., vol. vi., (2), p. 209.

1822. Stomatia imbricata, Sowerby. Genera, vol. ii., pl. 143, f. 1.
1839. Stomatella imbricata, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 509, No. 1.
1843. Stomatella imbricata, Lamarck. *Id.*, (ed. Deshayes), vol. ix., p. 16, sp. 1.
Stomatella imbricata, Deshayes. Encycl. Méth., vol. iii., p. 984, No. 1., pl. 450, f. 2a, b.
1850. Stomatella imbricata, A. Adams. P.Z.S. Lond., p. 30.
1854. Stomatella imbricata, Adams and Sowerby. Thes. Conch., vol. ii., pt. 15, p. 833, sp. 1, pl. 174, f. 1.
1867. Stomatella imbricata, Angas. P.Z.S. Lond., p. 218, No. 201.
1874. Stomatella imbricata, Reeve. Conch. Icon., vol. xix., pl. 2, f. 10.
1875. Stomatella imbricata, Woodward. Man. Moll., p. 267, pl. 10, f. 19.
1886. Stomatella imbricata, Watson. Chall. Zool., vol. xv., p. 111, No. 1.
1887. Stomatella imbricata, Fischer. Man. de Conch., p. 838, pl. 10, f. 19.
1890. Stomatella imbricata, Tryon. Man. Conch., vol. xii., p. 9, pl. 52, f. 62, and pl. 51, f. 4, 5.

Hab.—Port Phillip; common along the rocky parts of the western shores of Western Port; Kilcunda to Cape Patterson (W. H. Ferguson).

Genus **Gena**, Gray, 1840.

GENA NIGRA, Quoy and Gaimard.

1834. Stomatella nigra, Quoy and Gaimard. Astrolabe Zool., vol. iii., p. 307, pl. 66 *bis*, f. 10-12.
1839. Stomatella nigra, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 509, No. 6.
1843. Stomatella nigra, Lamarck. *Id.* (ed. Deshayes), vol. ix., p. 18. sp. 6.

1850. Stomatia (Gena) strigosa, A. Adams. P.Z.S. Lond., p. 37.
1854. Gena nigra, Adams and Sowerby. Thes. Conch., vol. ii., pt. 15, p. 829, sp. 4, pl. 173, f. 14-16.
1854. Gena strigosa, Adams and Sowerby. *Id.*, p. 830, pl. 173, f. 11, 12.
1867. Gena strigosa, Angas. P.Z.S. Lond., p. 218.
1874. Gena nigra, Reeve. Conch. Icon., vol. xix., pl. 2, f. 11.
1874. Gena strigosa, Reeve. *Id.*, pl. 2, f. 12.
1886. Stomatella (Gena) nigra, Watson. Chall. Zool., vol. xv., p. 112, No. 3.

Hab.—Western Port.

Family Haliotidae.

Genus **Haliotis**, Linnaeus, 1735.

Haliotis albicans, Quoy and Gaimard.

1834. Haliotis albicans, Quoy and Gaimard. Astrolabe Zool., vol. iii., p. 311, pl. 68, f. 1, 2.
1839. Haliotis albicans, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 514, No. 16.
1846. Haliotis albicans, Reeve. Conch. Icon., vol. iii., pl. 10, f. 30.
1882. Haliotis albicans, Sowerby. Thes. Conch., vol. v., pt. 37, p. 30, pl. 430, f. 20.
1883. Haliotis albicans, Weinkauff. Conch. Cab. (ed. Küster), p. 71, pl. 21, f. 6, and pl. 28, f. 2.
1890. Haliotis albicans, Pilsbry. Tryon, Man. Conch., vol. xii., p. 78, pl. 5, f. 27.

Hab.—Sorrento, Port Phillip; Port Phillip Heads to West Head; common in Western Port, and along the shores of Phillip Island; Warrnambool; Portland.

Haliotis naevosa, Martyn.

1784. Haliotis naevosa, Martyn. Univ. Conch., vol. ii., f. 63.

1839. Haliotis naevosa, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 515, No. 20.

1843. Haliotis naevosa, Lamarck. *Id.* (ed. Deshayes), vol. ix., p. 34. No. 20.

1846. Haliotis naevosa, Reeve. Conch. Icon., vol. iii., pl. 8, f. 27*a.*, and pl. 9, f. 27*b*, and *c*.

1865. Haliotis naevosa, Angas. P.Z.S. Lond., p. 183, No. 178.

1867. Haliotis naevosa, Angas. *Id.*, p. 218, No. 203.

1882. Haliotis naevosa, Sowerby. Thes. Conch., vol. v., pts. 37, 38, p. 31, No. 59, pl. 433 (Genus 6), f. 39, and pl. 437 (Genus 10), f. 73.

1883. Haliotis naevosa, Weinkauff. Conch. Cab. (ed. Küster), p. 34, pl. 14, f. 1-3.

1886. Haliotis naevosa, Watson. Chall. Zool., vol. xv., p. 49, No. 1.

1890. Haliotis naevosa, Pilsbry. Tryon, Man. Conch., vol. xii., p. 116, pl. 11, f. 56, 60.

Hab.—Coast generally.

Obs.—This is our commonest species, and it shows considerable variation, but it is always easily identified. Pilsbry indicates figure 26, plate 5, as this species in addition to the figures on plate 11, but we do not think that this represents our species.

HALIOTIS EMMAE, Reeve.

Haliotis emmae, Gray. MSS., Brit. Mus. Cat.

1846. Haliotis emmae, Reeve. Conch. Icon., vol. iii., pl. 10, f. 29.

1860. Haliotis emmae, Reeve. Elements of Conch., vol. ii., pp. 12, 13, pl. 23, f. 131.

1882. Haliotis emmae, Sowerby. Thes. Conch., vol. v., p. 32, pl. 429 (Genus 2), f. 16.

1883. Haliotis emmae, Weinkauff. Conch. Cab. (ed. Küster), p. 56, pl. 22, f. 1, 2.

1890. Haliotis emmae, Pilsbry. Tryon, Man. Conch., vol. xii., p. 122, pl. 14, f. 75.

Hab.—Port Phillip and Western Port, but much rarer than the preceding species.

Obs.—We do not accept figures 27-29 on plate 49 in the Manual of Conchology as representing this species. Having been asked whether this species was not H. carinata, Swainson, we can distinctly state that it is not; the latter name being only a synonym of H. parva, Lin., a Cape of Good Hope species.

HALIOTIS EXCAVATA, Lamarck.

1822. Haliotis excavata, Lamarck. Anim. S. Vert., vol. vi., p. 215.
Haliotis excavata, Deshayes. Encycl. Méth. Vers, vol. ii., p. 179, No. 4.
1839. Haliotis excavata, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 512, No. 4.
1846. Haliotis excavata, Reeve. Conch. Icon., vol. iii., pl. 8, f. 25.
1882. Haliotis excavata, Sowerby. Thes. Conch., vol. v., pl. 3, f. 21, 26.
1883. Haliotis excavata, Weinkauff. Conch. Cab., p. 39, pl. 16, f, 1, 2.
1890. Haliotis excavata, Pilsbry. Tryon, Man. Conch., vol. xii., p. 119, pl. 9, f. 51, and pl. 49, f. 23.

Hab.—Portsea, Port Phillip.

HALIOTIS GRANTI, Pritchard and Gatliff.

1902. Haliotis granti, Pritchard and Gatliff. P.R.S. Vic., vol. xiv., n.s., pt. 2, p. 183, pl. 10, 3 figures.

Hab.—Shoreham, Western Port.

Obs.—This species has been collected by Mr. E. Ashby, at Cape Northumberland, in South Australia. It is closely allied to H. naevosa, Martyn, but may be distinguished from it by being proportionately broader, by its more elevated and terraced spire whorls and their more circular enrolment, and by the coarse development and strong tubiform projection of the perforations.

Family PLEUROTOMARIIDÆ.

Genus **Scissurella**, d'Orbigny, 1823.

SCISSURELLA OBLIQUA, Watson.

1886. Scissurella obliqua, Watson. Chall. Zool., vol. xv., p. 116, pl. 8, f. 5.

1890. Scissurella obliqua, Pilsbry. Tryon, Man. Conch., vol. xii., p. 58.

Hab.—Ocean Beach, Flinders; Ocean Beach, Point Nepean; San Remo.

Obs.—Pilsbry in Tryon refers to plate 58, figures 20 and 21, for this species, but it is not there, that plate being wholly occupied by Fissurellidæ. It seems probable that plate 65, figures 20 and 21, are copied from the Challenger Report, but unfortunately there is no explanation of this plate in Tryon's volume xii., as the references cease with plate 64.

Genus **Schismope**, Jeffreys, 1856.

SCHISMOPE ATKINSONI, T. Woods.

1877. Scissurella atkinsoni, T. Woods. P.R.S. Tas., pp. 149, 150.

1878. Schismope atkinsoni, T. Woods. *Id.*, p. 43.

1886. Schismope carinata, Watson. Chall. Zool., vol. xv., p. 119, pl. 8, f 6.

1890. Schismope atkinsoni, Pilsbry. Tryon, Man. Conch., vol. xii., p. 66.

1890. Schismope carinata, Pilsbry. Tryon, *Id.*, p. 65., pl. 65, f. 17-19.

Hab.—Flinders, and dredged off Rhyll, Western Port; Cape Schanck; Puebla Coast.

SCHISMOPE BEDDOMEI, Petterd.

1884. Schismope beddomei, Petterd. Jour. of Conch., vol. iv., p. 139, No. 16.

1890. Schismope beddomei, Pilsbry. Tryon, Man. Conch., vol. xii., p. 67.

Hab.—Flinders, Western Port.

SCHISMOPE PULCHRA, Petterd.

1884. Schismope pulchra, Petterd. Jour. of Conch., vol. iv., p. 139, No. 17.

1890. Schismope pulchra, Pilsbry. Tryon, Man. Conch., vol. xii., p. 68.

Hab.—Off Rhyll, Western Port.

Family FISSURELLIDAE.

Genus Fissurella, Bruguière, 1789.

FISSURELLA OMICRON, Crosse and Fischer.

1864. Fissurella omicron, Crosse and Fischer. Jour. d. Conch., p. 348.

1865. Fissurella omicron, Crosse and Fischer. *Id.*, p. 41, pl. 3, f. 4-6.

1890. Fissurella omicron, Pilsbry. Tryon, Man. Conch., vol. xii., p. 174, pl. 22, f. 45-47.

Hab.—Portsea, Port Phillip; Cowes, Phillip Island, Western Port.

Genus Megatebennus, Pilsbry, 1890.

MEGATEBENNUS CONCATENATA, Crosse and Fischer.

1864. Fissurella concatenata, Crosse and Fischer. Jour. d. Conch., p. 348, pl. 3, f. 4-6.

1865. Fissurella concatenata, Crosse and Fischer. *Id.*, p. 41, pl. 3, f. 1-3.

1882. Fissurellidaea concatenata, Tate. T.R.S. S.A., vol. v., p. 46.

1890. Megatebennus concatenata, Pilsbry. Tryon, Man. Conch., vol. xii., p. 187, pl. 22, f. 40-42.

1893. Fissurellidaea concatenata, Adcock. Hand List Aq. Moll. S.A., p. 9, No. 382.

Hab.—Port Phillip, relatively uncommon; Western Port, fairly common under rocks at low tide; Anderson's Inlet and Kilcunda (W. H. Ferguson).

MEGATEBENNUS TRAPEZINA, Sowerby.

1834. Fissurella trapezina, Sowerby. P.Z.S. Lond., p. 126.

Fissurella scutella, Gray. B.M. Cat., Fissurella, No. 42.
1841. Fissurella scutellum, Sowerby. Conch. Ill., p. 5, No. 42, pl. 73, f. 34.
1849. Fissurella scutella, Reeve. Conch. Icon., vol. vi., pl. 6, f. 33.
1866. Fissurellidaea scutella, Sowerby. Thes. Conch., vol. iii., p. 203, pl. 244 (Genus, pl. 9), f. 207.
1878. Fissurella scutella, T. Woods. P.R.S. Tas., p. 44.
1890. Megatebennus trapezina, Pilsbry. Tryon, Man. Conch., vol. xii., p. 188, pl. 62, f. 10-12.
1893. Fissurellidaea scutella, Adcock. Hand List Aq. Moll. S.A., p. 9, No. 381.
1901. Fissurella (Megatebennus) scutella, Tate and May. P.L.S. N.S.W., vol. xxvi., pt. 3, p. 408.

Hab.—Common Western Port; Sorrento to Portsea, Port Phillip; Kilcunda and Anderson's Inlet (W. H. Ferguson).

Genus **Lucapinella**, Pilsbry, 1890.

Lucapinella nigrita, Sowerby.
1834. Fissurella nigrita, Sowerby. P.Z.S. Lond., p. 127.
1841. Fissurella nigrita, Sowerby. Conch. Ill., p. 6, No. 51, f. 47.
1849. Fissurella nigrita, Reeve. Conch. Icon., vol. vi., pl. 6, f. 41.
1866. Fissurellidea nigrita, Sowerby. Thes. Conch., vol. iii., p. 203, No. 7, pl. 243 (Genus, pl. 8), f. 196.
1878. Fissurella nigrita, T. Woods. P.R.S. Tas., p. 44.
1890. Megatebennus nigrita, Pilsbry. Tryon, Man. Conch., vol. xii., p. 187, pl. 44, f. 97, 98.
1893. Fissurella nigrita, Adcock. Hand List Aq. Moll. S.A., p. 9, No. 380.
1895. Lucapinella nigrita, Hedley. P.R.S. Vic., vol. vii., n.s., pp. 197, 198, pl. 11, f. 1, 2, from living specimen.
1897. Fissurella nigrita, Tate. T.R.S. S.A., vol. xxi., p. 43.

Hab.—Anderson's Inlet and Kilcunda (W. H. Ferguson), Shoreham, West Head, Flinders, Western Port.

LUCAPINELLA PRITCHARDI, Hedley.

1895. Lucapinella pritchardi, Hedley. P.R.S. Vic., vol. vii., n.s., pp. 198, 199, pl. 11, f. 3-7, shell, animal and radula.

Hab.—Port Phillip; Western Port, alive under rocks at extreme low tide; Kilcunda and Anderson's Inlet (W. H. Ferguson).

Obs.—Professor Tate states, in a paper entitled "Critical Remarks on some Australian Mollusca," in the Transactions of the Royal Society of South Australia, 1897, Vol. XXI., p. 43, that he regards this species as synonymic with F. nigrita, an opinion with which we cannot agree, for Hedley's shell is consistently more elongate, apart from other distinctive features. In the recent "Revised Census of the Marine Mollusca of Tasmania," by Tate and May, 1901, the above is, however, not included as a synonym of F. nigrita.

Mr. Hedley, in the course of correspondence, has stated that he thinks this species may be F. oblonga, Menke, Moll. Nov. Holl., p. 33, No. 181; but, on the other hand, in Professor Tate's paper in the Linnaean Society of New South Wales, Vol. VI., p. 401, on Menke's Australian Shells, that author republishes Menke's original description and appends a note that F. oblonga is probably F. scutella, Gray.

Genus **Macrochisma**, Swainson, 1840.

MACROCHISMA TASMANIAE, Sowerby.

1841. Fissurella macroschisma, Sowerby. Conch. Ill., p. 5, No. 45, pl. 73, f. 39, 39*.

1850. Fissurella macrochisma, Sowerby. P.Z.S. Lond., p. 202.

1866. Macrochisma tasmaniae, Sowerby. Thes. Conch., vol. iii., p. 206, pl. 244 (Genus, pl. 9), f. 223.

1876. Macroschisma tasmanica, T. Woods. P.R.S. Tas., p. 157.

1877. Macroschisma weldii, T. Woods. P.R.S. Tas., p. 156.

1890. Macroschisma tasmaniae, Pilsbry. Tryon, Man. Conch., vol. xii., p. 191, pl. 59, f. 52, 53, 54.

1890. Macroschisma weldii, Pilsbry. Tryon, *Id.*, pl. 59, f. 33, 34, 35.

Hab.—Portsea, Port Phillip; Flinders to Balnarring, San Remo, Western Port; Geelong (Nat. Mus.); Kilcunda and Anderson's Inlet (W. H. Ferguson).

MACROCHISMA PRODUCTA, A. Adams.

1850. Macrochisma producta, A. Adams. P.Z.S. Lond., p. 202.

1865. Macrochisma producta, Angas. P.Z.S. Lond., p. 185.

1866. Macrochisma producta, Sowerby. Thes. Conch., vol. iii., p. 205, No. 5, pl. 244 (Genus, pl. 9), f. 224.

1890. Macroschisma producta, Pilsbry. Tryon, Man. Conch., vol. xii., p. 194, pl. 59, f. 62.

Hab.—Front beach Sorrento, Port Phillip; Flinders, Western Port.

Genus **Fissuridea**, Swainson, 1840.

FISSURIDEA LINEATA, Sowerby.

1841. Fissurella lineata, Sowerby. Conch. Ill., p. 7, pl. 78, f. 68.

1850. Fissurella incii, Reeve. Conch. Icon., vol. vi., pl. 10, f. 69a, b.

1866. Fissurella lineata, Sowerby. Thes. Conch., vol. iii., p. 195, No. 80, pl. 241, f. 134, 135.

1890. Glyphis lineata, Pilsbry. Tryon, Man. Conch., vol. xii., p. 219, pl. 63, f. 29, 30, and pl. 38, f. 63, 64.

1900. Fissuridea lineata, Hedley. P.L.S. N.S.W., vol. xxv., pt. 1, p. 95, pl. 3, f. 11.

Hab.—Sandringham, Mornington, and Sorrento, Port Phillip; Kilcunda, Cape Patterson (W. H. Ferguson).

Obs.—This species used to be set out in the National Museum, Melbourne, as Fissurella McCoyi, T. Woods, type from Brighton, but, as is the case with some others of his species, we have been unable to find any published figure or description.

Genus **Puncturella**, Lowe, 1827.

Puncturella harrissoni, Beddome.

1883. Cemori harrissoni, Beddome. P.R.S. Tas., p. 168, No. 11.

1890. Puncturella harrissoni. Pilsbry. Tryon, Man. Conch., vol. xii., p. 294.

1894. Puncturella henniana, Brazier. P.L.S. N.S.W., vol. ix., 2nd series, p. 177, pl. 14, f. 14.

1894. Puncturella harrisoni, Brazier. *Id.*, p. 699, No. 11.

Hab.—Flinders, and dredged off Rhyll, Western Port.

Obs.—Brazier himself admits after examining Mr. Beddome's types that his species is identical.

Genus **Emarginula**, Lamarck, 1801.

Emarginula candida, A. Adams.

1851. Emarginula candida, A. Adams. P.Z.S. Lond., p. 85, No. 30.

1863. Emarginula candida, Sowerby. Thes. Conch., vol. iii., p. 213, pl. 11, f. 45, 46.

1873. Emarginula candida, Reeve. Conch. Icon., vol. xix., pl. 7, f. 45.

1890. Emarginula candida, Pilsbry. Tryon, Man. Conch., vol. xii., p. 258, pl. 28, f. 36.

Hab.—Fairly common in Port Phillip and Western Port; Anderson's Inlet and Kilcunda (W. H. Ferguson); Cape Otway; Warrnambool; Portland.

Obs.—Emarginula tenuicostata, Sowerby, in Thesaurus Conchyliorum, p. 215, figures 17 and 18, habitat unknown, appears to us as likely to represent a form of the above species.

Emarginula dilecta, A. Adams.

1851. Emarginula dilecta, A. Adams. P.Z.S. Lond., p. 85, No. 28.

1863. Emarginula dilecta. Sowerby. Thes. Conch., vol. iii., p. 211, pl. 11, f. 5.

1874. Emarginula dilecta, Reeve. Conch. Icon., vol. xix., pl. 4, f. 23.

1890. Emarginula dilecta, Pilsbry. Tryon, Man. Conch., vol. xii., p. 265, pl. 28, f. 17.

Hab.—Port Phillip; Western Port; Puebla Coast; Anderson's Inlet (W. H. Ferguson).

Genus **Subemarginula**, Blainville, 1825.

Subemarginula emarginata, Blainville.

1825. Emarginula emarginata, Blainville. Malac, p. 501, pl. 48 bis., f. 3.

1834. Emarginula australis, Quoy and Gaimard. Astrolabe Zool., vol. iii., p. 328, pl. 68, f. 11-12.

1839. Emarginula emarginata, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 215.

1863. Emarginula australis, Sowerby. Thes. Conch., vol. iii., p. 217, pl. 247, f. 67, and pl. 248, f. 94.

1873. Emarginula australis, Reeve. Conch. Icon. vol. xix., pl. 3, f. 19.

1890. Subemarginula emarginata, Pilsbry. Tryon, Man. Conch., vol. xii., p. 276, pl. 64, f. 23-26.

1890. Subemarginula australis, Pilsbry. *Id.*, p. 278, pl. 29, f. 1-3.

Hab.—Western Port; Kilcunda and Anderson's Inlet (W. H. Ferguson); Portland.

Obs.—We think it likely that E. tasmaniae, Sowerby, and E. cumingii, Sowerby, should be included as synonyms of the above species on account of the great amount of variation it usually exhibits. It may be noted that figure 3 in Tryon is duplicated on plate 64; in the explanation of the plate the figure of this shell is referred to as 23, and again in the text as figure 3.

Subemarginula rugosa, Quoy and Gaimard.

1834. Emarginula rugosa, Quoy and Gaimard. Astrolabe Zool., vol. iii., p. 331, pl. 68, f. 17-18.

1836. Emarginula rugosa, Lamarck. Anim. S. Vert. (ed. Desh.), vol. vii., p. 585, No. 7.

1837. Hemitoma rugosa, Angas. P.Z.S. Lond., p. 219.
1839. Emarginula rugosa, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 215, No. 7.
1842. Emarginula conoidea, Reeve. Conch. Syst., vol. ii., p. 23, pl. 140, f. 7.
1851. Clypidina candida, A. Adams. P.Z.S. Lond., No. 11, p. 88.
1863. Emarginula rugosa, Sowerby. Thes. Conch., vol. iii., p. 58, pl. 248, f. 92, 93 and 95-97, 100-102.
1874. Emarginula rugosa, Reeve. Conch. Icon., vol. xix., pl. 1, f. 1.
1875. Emarginula (Hemitoma) rugosa, Woodward. Man. Moll., p. 274, pl. 11, f. 7, 8.
1886. Emarginula (Hemitoma) rugosa, Watson. Chall. Zool., vol. xv., p. 35.
1887. Emarginula (Subemarginula) rugosa, Fischer. Man. Conch., p. 860, pl. 11, f. 7, 8.
1890. Subemarginula (Clypidina) rugosa, Pilsbry. Tryon, Man. Conch., vol. xii., p. 278, pl. 64, f. 39-41, and pl. 29, f. 10, 11.

Hab.—Anderson's Inlet and Kilcunda (W. H. Ferguson); Western Port; Port Phillip; Puebla Coast; Airey's Inlet; Cape Otway; Warrnambool; Portland.

Genus **Scutus**, Montfort, 1810.

Scutus anatinus, Donovan.

1817. Parmophorus elongatus, de Blainville (non Lamarck). Bull. Soc. Philom., Paris, p. 25.
1820. Patella anatina, Donovan. In Rees' Encycl., vol. v., Nat. Hist. plates, Conchology, pl. 16.
Parmophorus elongatus, de Blainville. Dict. Sc. Nat., vol. xxxvii., p. 557.
(?) 1825. Parmophorus elongatus, de Blainville. Malac., pl. 48, f. 2, 2*a*.
1822. Parmophorus australis, Lamarck. Anim. S. Vert., 1st ed., vol. vi., pt. 2., p. 5.

1834. Parmophorus australis, Quoy and Gaimard. Astrolabe Zool., vol. iii., p, 321, pl. 69, f. 1-4.

1834. Parmophorus convexus, Quoy and Gaimard. *Id.*, p. 322, pl. 69, f. 5-16.

1836. Parmophorus australis, Lamarck. Anim. S. Vert., 2nd ed., vol. vii., p. 579.

1839. Parmophorus australis, Lamarck. *Id.* (3rd ed. Deshayes and Edwards), vol. iii., p. 213, No. 1.

1842. Parmophorus australis, Reeve. Conch. Syst., vol. ii., pl. 139, f. 2, 3.

1851. Scutus unguis, A. Adams (non Linn.). P.Z.S. Lond., p. 221.

1860. Parmophorus australis, Chenu. Man. Conch., vol. i., p. 373, f. 2801.

1860. Parmophorus australis, Reeve. Elements of Conch., vol. ii., p. 28, pl. M., f. 2.

1863. Scutus elongatus, Adams and Sowerby. Thes. Conch., vol. iii., pt. 22, pl. 248, f. 1, 2.

1867. Scutus elongatus, Angas. P.Z.S. Lond., p. 219, No. 212.

1868. Parmophorus australis, Hogg. Trans. Micro. Soc. Lond., vol. xvi., pl. 12, f. 57 (the dentition).

1870. Scutus elongatus, Reeve. Conch. Icon., vol. xvii., pl. 1, f. 1*a*, 1*b*.

1875. Parmophorus australis, Woodward. Man. Moll., p. 274, pl. 11, f. 9.

1879. Scutus anatinus, E. A. Smith. Jour. Conch., vol. ii., Aug., p. 257.

1883. Parmophorus australis, Tryon. Struct. and Syst. Conch., vol. ii., p. 329, pl. 83, f. 21.

1886. Emarginula (Scutus) anatinus, Watson. Chall. Zool., vol. xv., pp. 35, 36, No. 3.

1887. Scutum australe, Fischer. Man. de Conch., p. 861, f. 606, and pl. 11, f. 9.

1890. Scutus anatinus, Pilsbry in Tryon. Man. Conch., vol. xii., p. 288, pl. 40, f. 1, 2, 3.

Hab.—Back Beach, Sorrento, to Cape Schanck and Flinders. Common under rocks at low tide Western Port, in all stages of growth from less than a quarter of an inch in length up to $4\frac{1}{2}$ inches in length. Kilcunda and Anderson's Inlet (W. H. Ferguson); Port Phillip.

Genus Tugalia, Gray, 1844.

TUGALIA PARMOPHOIDEA, Quoy and Gaimard.

1834. Emarginula parmophoidea, Quoy and Gaimard. Astrolabe Zool., vol. iii., p. 325, pl. 68, f. 15, 16.
1836. Emarginula parmophoidea, Lamarck. Anim. S. Vert. (2nd ed. Desh.), vol. vii., p. 583, sp. 3.
1839. Emarginula parmophoidea, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 215, No. 3.
1842. Parmophorus intermedius, Reeve. P.Z.S. Lond., p. 50.
1842. Parmophorus intermedius, Reeve. Conch. Syst., vol. ii., pl. 139, f. 5, 6.
1843. Tugalia elegans, Gray. Dieffenbach's N.Z., vol. ii., p. 240.
1851. Tugali parmophoroidea, A. Adams. P.Z.S. Lond., p. 89, No. 5.
1851. Tugali intermedia, A. Adams. *Id.*, p. 88, No. 2.
1863. Tugalia parmophoridea, Sowerby. Thes. Conch., vol. iii., pt. 22, p. 221, sp. 1, pl. 248, or Gen. 15, f. 5, 11, 16.
1863. Tugalia ossea, Adams and Sowerby (non Gould). Thes. Conch., vol. iii., p. 221, pl. 249, f. 18.
1863. Tugalia cinerea, Adams and Sowerby (non Gould). *Id.*, p. 221, pl. 249, f. 15, 17.
1865. Tugalia parmophoridea, Angas. P.Z.S. Lond., p. 185, No. 194.
1870. Tugalia parmophoridea, Reeve. Conch. Icon., pl. 1, f. 4 *a*, *b*.
1873. Tugalia parmaphoroides, Hutton. Cat. N.Z. Moll., p. 43, No. 194.
1873. Emarginula (Tugalia) parmophoroides, von Martens. Crit. List N.Z. Moll., p. 35.

1877. Tugalia tasmanica, T. Woods. P.R.S. Tas., p. 156.

1878. Tugalia australis, T. Woods. *Id.*, p. 44.

1880. Tugalia parmophoidea, Hutton. Man. N.Z. Moll., p. 106.

1883. Tugalia intermedia, Brazier. P.L.S. N.S.W., vol. viii., p. 227.

1886. Emarginula (Tugalia) parmophoidea, Watson. Chall. Zool., vol. xv., p. 35, No. 1.

1890. Subemarginula (Tugalia) parmophoidea, Pilsbry. Tryon, Man. Conch., vol. xii., p. 285, pl. 43, f. 78–80.

1890. Subemarginula (Tugalia) intermedia, Pilsby. *Id.*, f. 83, 84.

Hab.—Western Port; Anderson's Inlet (W. H. Ferguson); Port Phillip.

Family Patellidae.

Genus **Patella**, Linnaeus, 1757.

Patella tramoserica, Martyn.

1784. Patella tramoserica, Martyn. Univ. Conch., vol. i., pl. 16.

1795. Patella tramoserica, Chemnitz. Conch. Cab., vol. xi., p. 179, p. 197, f. 1912, 1913.

1836. Patella tramoserica, Lamarck. Anim. S. Vert. (2nd ed. Desh.), vol. vii., p. 542, sp. 47.

1839. Patella tramoserica, Lamarck. *Id.* (3rd ed. Deshayes and Edwards), vol. iii., p. 199, No. 47.

1848. Patella diemenensis, Philippi. Zeit., f. Malak., p. 162.

1852. Patella tramoserica, Gould. U.S. Expl. Exped., vol. xii., Mollusca, p. 343.

1854. Patella tramoserica, Reeve. Conch. Icon., vol. viii., pl. 13, f. 27*a*.

1854. Patella variegata, Reeve. *Id.*, pl. 16, f. 36*a*, *b*, *c*.

1867. Patella tramoserica, Angas. P.Z.S. Lond., p. 221, No. 222.

1873. Patella tramoserica, Hutton. Cat. N.Z. Moll., p. 44, No. 202.

1878. Patella tramoserica, T. Woods. P.R.S. Tas., p. 45.
1879. Patella tramoserica, T. Woods. P.R.S. Tas., p. 45.
1880. Patella tramoserica, Hutton. Man. N.Z. Moll., p. 109.
1884. Patella tramoserica, Hutton. P.L.S. N.S.W., vol. ix., p. 377.
1886. Patella tramoserica, Watson. Chall. Zool., vol. xv., pp. 27, 28.
1891. Helcioniscus tramoserica, Pilsbry in Tryon. Man. Conch., vol. xiii., p. 142, pl. 70, f. 49-52.
1891. Helcioniscus melanostomus, Pilsbry. *Id.*, p. 151, pl. 32, f. 67-69.
1891. Patella diemensis, Pilsbry. *Id.*, p. 155.
1893. Helcionsiscus tramoserica, Brazier. P.L.S. N.S.W., vol. viii., 2nd ser., pt. 1, p. 119.

Hab.—A very common species on the rocks at all parts of our coast.

Obs.—This common form, though showing considerable variation in height, colour, and outline, is, nevertheless, easy of identification. The figures quoted by Reeve, viz., f. 27, *a*, *b*, *c*, we cannot agree with, being only able to accept f. 27*a* as representing this species. Mr. Brazier in his paper to the Linnaean Society of New South Wales, pp. 119, 120, discusses the various erroneous localities given by various authors for this species, and also discusses the probability of P. antipodum, E. A. Smith, being identical.

Patella limbata, Philippi.

1849. Patella limbata, Philippi. Abbild. und Besch. Conch., vol. iii., p. 71, pl. 3, f. 2.
1854. Patella limbata, Reeve. Conch. Icon., vol. viii., pl. 13, f. 29*a*, 29*b*.
1865. Patella limbata, Angas. P.Z.S. Lond., p. 185.
1876. Patella limbata, T. Woods. P.R.S. Tas., p. 48.
1878. Patella limbata, T. Woods. *Id.*, p. 45.
1891. Helcioniscus limbata, Pilsbry in Tryon. Man. Conch., vol. xiii., p. 143, pl. 71, f. 53-56, and pl. 17, f. 28, 29.

Hab.—Cape Otway (G.B.P.).

PATELLA USTULATA, Reeve.

1855. Patella ustulata, Reeve. Conch. Icon., vol. viii., pl. 31, f. 88*a*, *b*.
1876. Patella tasmanica, T. Woods. P.R.S. Tas., p. 157.
1877. Patella ustulata, T. Woods. *Id.*, p. 43.
1878. Patella ustulata, T. Woods. *Id.*, p. 45.
1878. Patella tasmanica, T. Woods. *Id.*, p. 45.
1891. Patella (Scutellastra) ustulata, Pilsbry in Tryon. Man. Conch., vol. xiii., p. 101, pl. 22, f. 11, 12.

Hab.—Coast near Gellibrand River; Otway Coast; Back Beach, Sorrento; Kilcunda and Anderson's Inlet (W. H. Ferguson); Western Port; Port Phillip.

PATELLA ACULEATA, Reeve.

1855. Patella aculeata, Reeve. Conch. Icon., vol. viii., pl. 32, f. 90.
1855. Patella squamifera, Reeve. *Id.*, pl. 32, f. 94.
1867. Patella aculeata, Angas. P.Z.S. Lond., p. 221, No. 224.
1867. Patella squamifera, Angas. P.Z.S. Lond., p. 221, No. 225.
1878. Patella aculeata, T. Woods. P.R.S. Tas., p. 45.
1883. Patella aculeata, Brazier. P.L.S. N.S.W., vol. viii., p. 224.
1891. Patella (Scutellastra) aculeata, Pilsbry in Tryon. Man. Conch., vol. xiii., p. 100, pl. 25, f. 20, 21, and pl. 62, f. 71-73.

Hab.—Otway Coast; Apollo Bay; Western Port; Anderson's Inlet (W. H. Ferguson); Back Beach, Sorrento.

PATELLA CHAPMANI, T. Woods.

1876. Patella chapmani, T. Woods. P.R.S. Tas., p. 157.
1877. Acmaea alba, T. Woods. *Id.*, pp. 155, 156.
1891. Patella chapmani, Pilsbry in Tryon. Man. Conch., vol. xiii., p. 101.
1891. Acmaea alba, Pilsbry. *Id.*, p. 54, pl. 42, f. 76-78.

Hab.—Flinders, San Remo, Western Port; Portsea, Port Phillip.

Obs.—Our commonest form is that described by T. Woods under the name of Acmaea alba, but we have been unable to distinguish this from Patella chapmani, except that the latter shows a more striking development of the radial ribs, which project over the margin and give the shell a more stellate appearance, but with a good series of specimens there can be no doubt about their connection.

PATELLA HEPATICA, Pritchard and Gatliff, nom. mut.

1891. Acmaea striata, Pilsbry (non Quoy and Gaimard). Man. Conch., vol. xiii., p. 47, pl. 35, f. 27, 28, 29.

Hab.—Back Beach, Sorrento; Western Port, Flinders and San Remo; Anderson's Inlet and Kilcunda (W. H. Ferguson); Apollo Bay.

Obs.—The shell as figured by Pilsbry agrees well with our species, but we have been unable to see its identity with Acmaea striata, Quoy and Gaimard, and we have not been able to make out any other identification, so that it appeared to us necessary to treat it in the above manner.

PATELLA PERPLEXA, Pilsbry.

1891. Acmaea saccharina, var. perplexa, Pilsbry, Tryon. Man. Conch., vol. xiii., p. 50, pl. 36, f. 69-71.

Hab.—Port Phillip.

Obs.—Our specimens agree well with Pilsbry's figure and description and indicates a well-marked stellate form. There has been some confusion of this form with P. saccharina, Lin., and P. stellaris, Quoy and Gaimard, which we regard as quite distinct from the above.

Family ACMAEIDAE,

Genus **Acmaea**, Eschscholtz, 1828.

ACMAEA COSTATA, Sowerby.

1839. Lottia costata, Sowerby. Beechey's voy., Zool., p. 147, pl. 39, f. 2.

1865. Patella alticostata, Angas. P.Z.S. Lond., p. 56, pl. 2. f. 11.

1867. Patella costata, Angas. P.Z.S. Lond., p. 221.
1877. Acmaea costata, T. Woods. P.R.S. Tas., p. 50.
1878. Acmaea costata, T. Woods. *Id.*, p. 44, 45.
1891. Acmaea costata, Pilsbry. Tryon, Man. Conch., vol. xiii., p. 51, pl. 36, f. 72-77.

Hab.—A very common species along our coast generally, usually the largest form of the genus obtained.

ACMAEA CONOIDEA, Quoy and Gaimard.

1834. Patelloida conoidea, Quoy and Gaimard. Astrolabe Zool., vol. iii., p. 355, pl. 71, f. 5, 7.
1839. Patelloida conoidea, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 203, No. 9.
1865. Acmaea conoidea, Angas. P.Z.S. Lond., p. 186.
1891. Acmaea conoidea, Pilsbry. Tryon, Man. Conch., vol. xiii., p. 53, pl. 37, f. 84, 85.

Hab.—Barwon Heads; Port Phillip; Cape Otway.

Obs.—The above references might at first sight appear very meagre, but we have purposely omitted a large number on account of erroneous identifications. The above should serve to enable this species to be clearly identified.

ACMAEA SEPTIFORMIS, Quoy and Gaimard.

1834. Patelloida septiformis, Quoy and Gaimard. Astrolabe Zool., vol. iii., p. 362, pl. 71, f. 43, 44.
1839. Patelloida septiformis, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 202.
1855. Patella cantharus, Reeve. Conch. Icon., vol. viii., pl. 40, f. 131.
1865. Acmaea scabrilirata, Angas. P.Z.S. Lond., p. 154, and p. 186, No. 201.
1867. Tectura septiformis, Angas. P.Z.S. Lond., p. 220, No. 219.
1877. Acmaea septiformis, T. Woods. P.R.S. Tas., p. 50.
1877. Acmaea petterdi, T. Woods. *Id.*, p. 155.
1891. Acmaea petterdi, Pilsbry. Tryon, Man. Conch., vol. xiii., p. 54.

1891. Acmaea septiformis, Pilsbry. *Id.*, p. 55, pl. 37, f. 93, 94.

1891. Acmaea cantharus, Pilsbry. *Id.*, p 55, pl. 37. f. 1, 2.

1891. Acmaea scabrilirata, Pilsbry. *Id.*, p. 56.

Hab.—Coast generally.

Acmaea flammea, Quoy and Gaimard.

1834. Patelloida flammea, Quoy and Gaimard. Astrolabe Zool., vol. iii., p. 354, pl. 71, f. 15, 16.

1839. Patelloida flammea, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 203.

1855. Patella mixta, Reeve. Conch. Icon., vol. viii., pl. 39, f. 129*a*, 129*b*.

1855. Patella jacksoniensis, Reeve (non Lesson). *Id.*, pl. 39, f. 127*a*, 127*b*.

1865. Acmaea subundulata, Angas. P.Z.S. Lond., p. 155, and p. 186, No. 202.

1867. Tectura subundulata, Angas. *Id.*, p. 220, No. 218.

1867. Tectura jacksoniensis, Angas. *Id.*, p. 220.

1877. Acmaea crucis, T. Woods. P.R.S. Tas., p. 52.

1878. Acmaea crucis, T. Woods. *Id.*, p. 53.

1891. Acmaea flammea, Pilsbry. Tryon, Man. Conch., vol. xiii., p. 57, pl. 37, f. 78-83.

1891. Acmaea jacksoniensis, Pilsbry. *Id.*, p. 58, pl. 42, f. 71-75.

1891. Acmaea jacksoniensis, var. mixta, Pilsbry. *Id.*, p. 58, pl. 35, f. 32, 33.

1891. Acmaea crucis, Pilsbry. *Id.*, p. 58, pl. 37, f. 12, 13, and 17-19.

Hab.—Sandringham, Port Phillip; Western Port; Cape Otway.

Obs.—This species has apparently been made out to be Acmaea cruciata, Lin., by Professor Tate and Mr. May, but upon what basis we do not know. Pilsbry says of Patella cruciata, Lin., that it is a brown shell with a white cross, and he figures a shell of this character, but there is also a remark apparently to be attributed to Hanley, that when the shell is worn it is white with a brown cross. We are unable to reconcile these remarks and fail to see that such changes would take place. Our shell is white, with usually a well-marked brown cross, and wear, if anything, only tends to intensify the contrast. Perhaps it is synonymy or supposed synonymy that is responsible for the identification of A. cruciata, for Pilsbry says that Patella insignis, Menke, is probably only a synonym of that species. Menke, however, was not of that opinion, for he distinctly notes the affinity of his species to the Linnaean neglected species P. cruciata. Whether Menke's species may or may not come in as a synonym of A. flammea, Quoy and Gaimard is not quite certain, but we think it not unlikely.

ACMAEA CALAMUS, Crosse and Fischer.

1864. Patella calamus, Crosse and Fischer. Jour. d. Conch., p. 348.

1865. Patella calamus, Crosse and Fischer. *Id.*, p. 42, pl. 3, f. 7, 8.

1865. Acmaea calamus, Angas. P.Z.S. Lond., p. 186.

1891. Acmaea calamus, Pilsbry. Tryon, Man. Conch., vol. xiii., p. 54, pl. 37, f. 3, 4.

Hab.—Port Phillip; Western Port.

ACMAEA GEALEI, Angas.

1865. Patella gealei, Angas. P.Z.S. Lond., p. 57, and p. 186, No. 198.

1865. Patella latistrigata, Angas. *Id.*, p. 154, and 186, No. 196*a*.

1876. Acmaea marmorata, T, Woods. P.R.S. Tas., pp. 156, 157.

1877. Acmaea marmorata, T. Woods. *Id.*, p. 53.

1891. Acamea marmorata, Pilsbry. Tryon, Man. Conch., vol. xiii., p. 52. pl. 42, f. 66-70.

Hab.—Sandringham, Sorrento, Portsea, Port Phillip; Back Beach, Sorrento, and Cape Schanck; Cape Otway; Kilcunda to Cape Patterson (W. H. Ferguson).

Obs.—We have to thank Mr. E. Ashby for assistance in the loan of South Australian specimens of Angas' species, which have enabled us to arrive at the above conclusion.

Order POLYPLACOPHORA.

Family Lepidopleuridae.

Genus **Lepidopleurus**, Risso, 1826.

Lepidopleurus inquinatus, Reeve.

1847. Chiton inquinatus, Reeve. Conch. Icon., vol. iv., pl. 23, f. 154.
1864. Lepidopleurus liratus, Adams and Angas. P.Z S. Lond., p. 192.
1892. Ischnochiton inquinatus, Pilsbry. Tryon, Man. Conch., vol xiv., p. 90, pl. 18, f. 49, 50.
1893. Lepidopleurus liratus, Pilsbry. *Id.*, vol. xv., p. 101.
1896. Lepidopleurus inquinatus, Sykes. Malac. Soc. Lond., vol. ii., No. 2, p. 86, pl. 6, f. 4.
1897. Lepidopleurus inquinatus, Bednall. P. Malac. Soc. Lond., vol. ii., No. 4, p. 141.
1898. Lepidopleurus inquinatus, Suter. Trans. N.Z. Inst., vol. xxxi., p. 60.

Hab.—Port Phillip; Port Phillip Heads (J. B. Wilson); Ocean Beach, Phillip Island; Hobson's Bay (W. T. Bednall).

Obs.—Reeve's type originally came from Tasmania, and Mr. Sykes when dealing with a collection of our Port Phillip Polyplacophora mentions that he had the opportunity of handling Reeve's specimens, and so had no doubt about the identification. Bednall in his paper on the South Australian Polyplacophora mentions a specimen which, by comparison with the types, proved to be conspecific with Reeve's C. inquinatus, after having been submitted to Mr. Pilsbry.

Family Ischnochitonidae.

Genus **Callochiton**, Gray, 1847.

Callochiton platessa, Gould.

1846. Chiton platessa, Gould. Proc. Bost. Soc., N.H., vol. ii., p. 143.
1847. Chiton crocinus, Reeve. Conch. Icon., vol. iv., pl. 22, f. 146.

1852. Chiton versicolor, A. Adams. P.Z.S. Lond., p. 92, pl. 16, f. 5.
1856. Chiton platessa, Gould. U.S. Explor. Exped., p. 320, atlas, pl. 431.
1862. Lepidopleura platessa, Gould. Otia Conch. (Rectifications), p. 242.
1867. Leptochiton versicolor, Angas. P.Z.S. Lond., p. 223.
1886. Callochiton platessa, Haddon. Chall. Zool., vol. xv., p. 15.
1892. Callochiton platessa, Pilsbry. Tryon Man. Conch., vol. xiv., pp. 49, 50, pl. 10, f. 1-5.
1892. Callochiton crocinus, Pilsbry. *Id.*, p. 50, pl. 10, f. 7.
1893. Callochiton crocinus, Pilsbry. *Id.*, vol. xv., p. 67.
1894. Callochiton platessa, Pilsbry. P. Acad. Nat. Sci. Philad., p. 71.
1896. Callochiton platessa, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 86.
1897. Callochiton platessa, Bednall. *Id.*, vol. ii., No. 4, p. 141.
1898. Callochiton platessa, Suter. Trans. N.Z. Inst., vol. xxxi., p. 60.

Hab.—Port Phillip Heads (J. B. Wilson).

Obs.—Mr. Sykes states that from his examination of the specimens in the British Museum, he can make no specific distinction between C. platessa, Gould, and C. crocinus, Reeve. This also was Pilsbry's first opinion, but subsequently he appears to regard C. crocinus as a good species. Some erroneous references have been made to the plate in Gould's Exploring Expedition, and, as Pilsbry notes, the plate is wrongly numbered in that work, it should be 431 and not 434.

Lepidopleurus empleurus, Hutton, is included in the synonymy by Mr. Sykes, but on the other hand Mr. Suter regards this as a good species on account of the presence of "a row of deep longitudinal pits in front of lateral areas," and as the types are accessible to him he should be best able to judge.

Genus **Ischnochiton**, Gray, 1847.

Ischnochiton juloides, Adams and Angas.

1864. Stenochiton juloides, Adams and Angas. P.Z.S. Lond., p. 193.
1865. Stenochiton juloides, Adams and Angas. *Id.*, p. 58, pl. 11, f. 15.
1865. Stenochiton juloides, Angas. *Id.*, p. 188.
1892. Ischnochiton (Stenochiton) juloides, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 55, pl. 16, f. 6-8.
1896. Ischnochiton (Stenochiton) juloides, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, pp. 86, 87.
1897. Ischnochiton (Stenochiton) juloides, Bednall. *Id.*, vol. ii., No. 4, p. 142, pl. xii., f. 1, *a*, *b*, *c*, *d*, also figured in text.

Hab.—Port Phillip Heads (J. B. Wilson).

Ischnochiton cariosus, Pilsbry.

1892. Ischnochiton (Heterozona) cariosus, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 65, pl. 24, f. 20-23.
1893. Ischnochiton (Heterozona) cariosus, Pilsbry. *Id.*, vol. xv., p. 82, pl. 14, f. 8.
1896. Ischnochiton (Heterozona) cariosus, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 87.
1897. Ischnochiton (Heterozona) cariosus, Bednall, *Id.*, vol. ii., No. 4, p. 143.

Hab.—Port Phillip Heads (J. B. Wilson); Flinders, Western Port; Port Fairy (W. T. Bednall).

Obs.—Mr. Bednall, in his paper on the South Australian Polyplacophora, appears to have overlooked Mr. Sykes' previous record of this species from Port Phillip Heads, but records it from Port Fairy, where he notes that the species "attains a large size."

Ischnochiton crispus, Reeve.

1847. Chiton crispus, Reeve. Conch. Icon., vol. iv., pl. 19, f. 120.

1892. Ischnochiton crispus, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 89, pl. 24, f. 98, 99.
1892. Ischnochiton haddoni, Pilsbry. *Id.*, p. 88, pl. 22, f. 67-73.
1894. Ischnochiton haddoni, Pilsbry. P. Acad. Nat. Sci. Philad., p. 71.
1895. Ischnochiton crispus, Pilsbry. Nautilus, vol. viii., p. 129.
1896. Ischnochiton crispus, Sykes. P. Malac. Soc., Lond., vol. ii., No. 2, p. 87.
1897. Ischnochiton crispus, Bednall. *Id.*, vol. ii., No. 4, p. 145.

Hab.—Port Phillip Heads (J. B. Wilson); very common on the rocks at low tide in Port Phillip and Western Port generally; Port Fairy (W. T. Bednall).

Obs.—This is an extremely variable form, especially in colour markings, Mr. Sykes has proposed the varietal name of decorata for one of the extreme forms. This species has been confused by several authors with Ischnochiton longicymba, Blainville, from New Zealand, but it is quite distinct from that form. Mr. Bednall mentions some of the main points of difference between these two species in his paper above quoted.

ISCHNOCHITON TATEANUS, Bednall.

1896. Ischnochiton tateanus, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 87.
1897. Ischnochiton tateanus, Bednall. *Id.*, vol. ii., No. 4, pp. 147, 148, pl. 12, f. 3, *a*, *b*, *c*, *d*, also figured in text.

Hab.—Port Phillip Heads (J. B. Wilson).

ISCHNOCHITON CONTRACTUS, Reeve.

1847. Chiton contractus, Reeve. Conch. Icon., vol. iv., pl. 15, f. 78.
1847. Chiton pallidus, Reeve. *Id.*, pl. 16, f. 92.
1892. Ischnochiton contractus, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 93, pl. 23, f. 81, 82.
1892. Ischnochiton pallidus, Pilsbry. *Id.*, p. 89, pl. 23, f. 91.

1895. Ischnochiton contractus, Pilsbry. Nautilus, vol. viii., p. 129.

1896. Ischnochiton contractus, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, pp. 87, 88.

1897. Ischnochiton contractus, Bednall. *Id.*, vol. ii., No. 4, pp. 145, 146.

Hab.—A nice series from Port Phillip Heads (J. B. Wilson); Port Fairy (W. T. Bednall); Western Port.

Obs.—Mr. Bednall mentions some difficulty in running I. contractus and I. pallidus together, but in view of Mr. Sykes' clear statement—"I have carefully compared the original tablets in the British Museum, and am unable to separate I. contractus and I pallidus"—which was accepted by Mr. Pilsbry, there should be no doubt about the matter.

Ischnochiton ustulatus, Reeve.

1847. Chiton ustulatus, Reeve. Conch. Icon., vol. iv., pl. 17, f. 102.

1867. Lepidopleurus ustulatus, Angas. P.Z.S. Lond., p. 222.

1892. Ischnochiton ustulatus, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 96, pl. 24, f. 100, 1-4, 11, 12.

1896. Ischnochiton ustulatus, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 88.

1897. Ischnochiton ustulatus, Bednall. *Id.*, vol. ii., No. 4, p. 144.

Hab.—Port Phillip Heads (J. B. Wilson).

Ischnochiton pura, Sykes.

1896. Ischnochiton (Haploplax) pura, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 88, pl. 6, f. 3, 3a.

Hab.—Port Phillip Heads (J. B. Wilson).

Ischnochiton wilsoni, Sykes.

1896. Ischnochiton wilsoni, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 89, pl. 6, f. 1, 1*a*.

Hab.—Port Phillip Heads (J. B. Wilson).

ISCHNICHITON PTYCHIUS, Pilsbry.

1895. Ischnochiton ptychius, Pilsbry. Nautilus, vol. viii., p. 53.

1897. Ischnochiton ptychius, Bednall. P. Malac. Soc. Lond., vol. ii., No. 4, p. 147.

Hab.—Western Port.

ISCHNOCHITON VIRGATUS, Reeve.

1848. Chiton virgatus, Reeve. Conch. Icon., vol. iv., pl. 28, f. 192.

1892. Ischnochiton virgatus, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 78, pl. 8, f. 72, 73.

1893. Ischnochiton virgatus, Pilsbry. *Id.*, vol. xv., p. 82.

1897. Ischnochiton virgatus, Bednall. P. Malac. Soc. Lond., vol. ii., No. 4, pp. 148, 149.

Hab.—Ocean Beach, Phillip Island.

Obs.—Mr. Bednall gives full additional particulars of the colour characteristics and variations of this species.

ISCHNOCHITON AUSTRALIS, Sowerby.

1840. Chiton australis, Sowerby. Mag. Nat. Hist., n.s., vol. iv., p. 290.

1841. Chiton australis, Sowerby. Conch. Ill., p. 2, No. 19, pl. 139, f. 46.

1847. Chiton australis, Reeve. Conch. Icon., pl. 2, f. 10.

1847. Chiton metallicus, Reeve. *Id.*, pl. 17, f. 104.

1859. Chiton (Lophyrus) lugubris, Gould. P. Bost. Soc. Nat. Hist., vol. vii., p. 163.

1867. Lophyrus australis, Angas. P.Z.S. Lond., p. 221.

1878. Lepidoradsia australis, Dall. U.S. Nat. Mus., pp. 79, 113, 115, pl. 2, f. 19 (dentition).

1886. Lepidoradsia australis, Haddon. Chall. Zool., vol. xv., p. 19 (Polyplacophora).

1892. Ischnochiton (Ischnoradsia) australis, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 144, pl. 18, f. 57, 59.

1893. Ischnochiton (Ischnoradsia) australis, Pilsbry. *Id.*, vol. xv., p. 87, pl. 17, f. 68, 69.

1894. Ischnochiton (Ischnoradsia) australis, Pilsbry. P. Acad. Nat. Sci. Philad., p. 72.

1896. Ischnochiton (Ischnoradsia) australis, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, pp. 89, 90.

Hab.—Common along the coast generally.

Obs.—Mr. Sykes confirms Mr. Pilsbry's inclusion of C. metallicus, Reeve, in the synonymy of the above on an examination of the types. Mr. Pilsbry also includes C. evanidus, Sowerby, as a synonym, but with regard to this we are not in a position to speak.

Ischnochiton novaehollandiae, Reeve.

1847. Chiton novaehollandiae, Reeve. Conch. Icon., sp. 142.

1892. Ischnochiton (Ischnoradsia) novaehollandiae, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 145, pl. 19, f. 67-69.

1897. Ischnochiton (Ischnoradsia) novaehollandiae, Bednall. P. Malac. Soc. Lond., vol. ii., No. 4, p. 150.

Hab.—Wilson's Promontory.

Obs.—This is a good species, though it has frequently been unnecessarily confounded with the foregoing, and further references might rather tend to perpetuate the confusion than to clear the ground.

Family Mopaliidae.

Genus Plaxiphora, Gray, 1847.

Plaxiphora petholata, Sowerby.

1840. Chiton petholatus, Sowerby. Mag. Nat. Hist., n.s., vol. iv., p. 289.

1841. Chiton petholatus, Sowerby. Conch. Ill., f. 64, 65, and var. porphyrius, f. 59.

1847. Chiton petholatus, Reeve. Conch. Icon., pl. 14, f. 74.

1892. Plaxiphora petholata, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 323, pl. 68, f. 62-67.

1894. Plaxiphora petholata, Pilsbry. P. Acad. Nat. Sci. Philad., p. 74.

1896. Plaxiphora petholata, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 90.

1897. Plaxiphora petholata, Bednall. *Id.*, vol. ii., No. 4, p. 154.

Hab.—A very common and large species on all rocky parts of our coast line.

Obs.—Mr. Sykes enters fully into considerable synonymy for this species, but we have not been in a position to follow many of his views, reference should therefore be made to his paper.

PLAXIPHORA CONSPERSA, Adams and Angas.

1864. Chætopleura conspersa, Adams and Angas. P.Z.S. Lond., p. 193.

1892. Plaxiphora petholata, var. conspersa, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 324.

1897. Plaxiphora conspersa, Bednall. P. Malac. Soc. Lond., vol. ii., No. 4, p. 154.

Hab.—Under rocks Western Port; Airey's Inlet.

Obs.—Mr. Bednall draws attention to many points of value in distinguishing this species from the foregoing, and we agree with him in his treatment.

Family ACANTHOCHITIDAE.

Genus Acanthochites, Risso, 1826.

ACANTHOCHITES BEDNALLI, Pilsbry.

1894. Acanthochites bednalli, Pilsbry. P. Acad. Nat. Sci. Philad., p. 81, pl. 2, f. 7-11.

1896. Acanthochites bednalli, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 91.

1897. Acanthochites bednalli, Bednall. *Id.*, vol. ii., No. 4. p. 155.

Hab.—Port Phillip Heads (J. B. Wilson).

ACANTHOCHITES PILSBRYI, Sykes.

1896. Acanthochites pilsbryi, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 91, pl. 6, f. 6, 6*a*.

Hab.—Port Phillip Heads (J. B. Wilson).

Acanthochites speciosus, H. Adams.

1861. Cryptoplax (Notoplax) speciosus, H. Adams. P.Z.S. Lond., p. 385.

1892. Acanthochites (Notoplax) speciosus, Pilsbry, Tryon, Man. Conch., vol. xiv., p. 32, pl. 1, f. 23-26.

1894. Acanthochites (Notoplax) speciosus, Pilsbry. P. Acad. Nat. Sci. Philad., p. 83, pl. 4, f. 31, 33.

1896. Acanthochites (Notoplax) speciosus, Sykes. P. Malac. Soc., Lond., vol. ii., No. 2, p. 91.

1897. Acanthochites speciosus, Bednall. *Id.*, vol. ii., No. 4, p. 156.

Hab.—Port Phillip Heads (J. B. Wilson); Portland.

Obs.—In T. Woods' Census of Tasmanian Shells, he gives Cryptoplax spinosa, H. Adams, apparently an erroneous quotation, as the reference given refers to C. speciosa. Messrs. Tate and May in their revised census refer on p. 445 to Cryptoplax spinosa, A. Adams, and put it down as a variety of Cryptoplax striatus.

Acanthochites matthewsi, Bednall and Pilsbry.

1894. Acanthochites (Notoplax) matthewsi, Bednall and Pilsbry. Nautilus, vol. vii., p. 120.

1894. Acanthochites (Notoplax?) matthewsi, Pilsbry. P. Acad. Nat. Sci. Philad., p. 83, pl. 4, f. 27-30.

1896. Acanthochites (Notoplax) matthewsi, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 91.

1897. Acanthochites (Notoplax) matthewsi, Bednall. *Id.*, vol. ii., No. 4, p. 156.

Hab.—Port Phillip Heads (J. B. Wilson).

Acanthochites glyptus, Sykes.

1896. Acanthochites (Notoplax) glyptus, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 92, pl. 6, f. 5, 5*a*.

Hab.—Port Phillip Heads (J. B. Wilson).

ACANTHOCHITES WILSONI, Sykes.

1896. Acanthochites (Notoplax) wilsoni, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 92, pl. 6, f. 2, *2a*.

Hab.—Port Phillip Heads (J. B. Wilson).

ACANTHOCHITES ASBESTOIDES, E. A. Smith.

1884. Chiton (Acanthochiton) asbestoides, E. A. Smith. Alert Zool., p. 83, pl. 6, f. G.

1893. Acanthochites asbestoides, Pilsbry. Tryon, Man. Conch., vol. xv., p. 17, pl. 2, f. 55.

1894. Acanthochites asbestoides, Pilsbry. P. Acad. Nat. Sci. Philad., p. 79, pl. 3, f. 16-20.

1897. Acanthochites asbestoides, Bednall. P. Malac. Soc. Lond., vol. ii., No. 4, p. 155.

Hab.—Mr. Bednall records this species from Hobson's Bay.

ACANTHOCHITES GRANOSTRIATUS, Pilsbry.

1894. Acanthochites granostriatus, Pilsbry. Nautilus, vol. vii., p. 119.

1894. Acanthochites granostriatus, Pilsbry. P. Acad. Nat. Sci. Philad., p. 81, pl. 2, f. 1-6, and pl. 4, f. 37.

1897. Acanthochites granostriatus, Bednall. P. Malac. Soc. Lond., vol. ii., No. 4, pp. 155, 156.

Hab.—Black Rock, Sandringham, Port Phillip.

Note.—In addition to the above we have four species of the genus Acanthochites as yet unidentified.

Family CRYPTOPLACIDAE.

Genus **Cryptoplax**, Blainville, 1818.

CRYPTOPLAX STRIATUS, Lamarck.

1819. Chitonellus striatus, Lamarck. Anim. S. Vert., vol. vi., p. 317.

1836. Chitonellus striatus, Lamarck. *Id.* (ed. Deshayes), vol. vii., p. 481.

1841. Chitonellus striatus, Sowerby. Conch. Ill., p. 7, No. 85, f. 62.

1842. Chitonellus striatus, Reeve. Conch. Syst., vol. ii., pl. 135, f. 1.

1847. Chitonellus striatus, Reeve. Conch. Icon., f. 4*a*, *b*.

1886. Cryptoplax striatus, Haddon. Chall. Zool., vol. xv., Polyplacophora, p. 39, pl. 1, f. 9, and pl. 3, f. 9*a*-9*m*.

1893. Cryptoplax striatus, Pilsbry. Tryon, Man. Conch., vol. xv., p. 53, pl. 9, f. 11-15, and pl. 11., f. 37-39.

1894. Cryptoplax striatus, Pilsbry. P. Acad. Nat. Sci. Philad., p. 85.

1896. Cryptoplax striatus, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 93.

1901. Cryptoplax striatus, Pilsbry. *Id.*, vol. iv., No. 4, pp. 152, 153, 155, 157, pl. 15, f. 20-23.

Hab.—Port Phillip Heads (J. B. Wilson); Port Phillip and Western Port; very large specimens to be obtained at low tide from the rocks on the back beach, Williamstown.

Obs.—The morphology of this and allied species is very fully and lucidly dealt with by Dr. Pilsbry in his recent contribution to the Malacological Society of London, and our best thanks are due to him for having cleared up many of our difficulties in such a satisfactory manner. He regards C. gunnii, Reeve, as a distinct species; it has so frequently been lumped with C. striatus that this change may take some by surprise, but we can readily confirm the points made out, and have no difficulty whatever in separating the two forms. Dr. Pilsbry mentions "that C. striatus occurs as far south as Port Jackson, while C. gunnii replaces it in South Australian waters;" he also mentions Mr. Sykes' Victorian record of C. striatus, but because C. gunnii was included in the synonymy, he was naturally in doubt as to which form was meant. We can now definitely extend the range of C. striatus, Lam., to Port Phillip, and we are also in a position to assert that we have C. gunnii, Reeve, rather more commonly represented along our shores, while the South Australian representatives, according to Mr. Bednall, are the C. gunnii type alone.

Cryptoplax gunnii, Reeve.

1847. Chitonellus gunnii, Reeve. Conch. Icon., pl. 1, f. 5.

1893. Cryptoplax striatus, var gunnii, Pilsbry. Tryon, Man. Conch., vol. xv., p. 54, pl. 8, f. 14.

1897. Cryptoplax striatus, var gunnii, Bednall. P. Malac. Soc. Lond., vol. ii., No. 4, p. 157.

1901. Cryptoplax gunnii, Pilsbry. *Id.*, vol. iv., No. 4, pp. 152, 153, and 156, 157, pl. 15, f. 17-19, and 24-26.

Hab.—Common in Port Phillip and Western Port.

Note.—We have one specimen of what appears to be a small but distinctive species of Cryptoplax, as yet undetermined.

Family Chitonidae.

Genus **Chiton**, Linnaeus, 1758.

Chiton bednalli, Pilsbry.

1895. Chiton bednalli, Pilsbry. Nautilus, vol. ix., p. 90.

1896. Chiton bednalli, Sykes. P. Malac. Soc. Lond., vol. ii., No 2, p. 93.

1897. Chiton bednalli, Bednall. *Id.*, vol. ii., No. 4, p. 153.

Hab.—Port Phillip Heads (J. B. Wilson).

Chiton limans, Sykes.

1854. Chiton muricatus, A. Adams (non Tilesius). P.Z.S. Lond., p. 91, pl. 13, f. 6, 1852. [May, 1854].

1865. Lophyrus muricatus, Angas. P.Z.S. Lond., p. 186.

1867. Lophyrus muricatus, Angas. *Id.*, p. 222.

1892. Chiton muricatus, Pilsbry (non Tilesius). Tryon, Man. Conch., vol. xiv., p. 175, pl. 37, f. 12, 13.

1896. Chiton limans, Sykes. P. Malac. Soc. Lond., vol. ii., No. 2, p. 93.

Hab.—Port Phillip Heads (J. B. Wilson).

Chiton tricostalis, Pilsbry.

1894. Chiton tricostalis, Pilsbry. Nautilus, vol. viii., p. 54.

1897. Chiton tricostalis, Bednall. P. Malac. Soc. Lond., vol. ii., No. 4, p. 151.

Hab.—Port Fairy.

Chiton jugosus, Gould.

1846. Chiton jugosus, Gould. P. Boston Soc. Nat. Hist., vol. ii., p. 142.

1847. Chiton concentricus, Reeve. Conch. Icon., pl. 16, No. 95.

1852. Chiton jugosus, Gould. Wilkes' Expl. Exped., Moll., vol. xii., p. 317, pl. 28, f. 430.

1862. Lophyrus jugosus, Gould. Otia Conch., pp. 3, 242.

1867. Lophyrus concentricus, Angas. P.Z.S. Lond., p. 221, No. 228.

1867. Lophyrus jugosus, Angas. *Id.*, p. 222, No. 231.

1884. Chiton jugosus, E. A. Smith. Alert Zool., p. 78.

1886. Chiton jugosus, Haddon. Chall. Zool., vol. xv., Polyplacophora, p. 22.

1892. Chiton jugosus, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 178, pl. 36, f. 91-95.

1897. Chiton jugosus, Bednall. P. Malac. Soc. Lond., vol, ii., No. 4, p. 151.

Hab.—Port Fairy.

Genus Lorica, H. and A. Adams, 1852.

Lorica volvox, Reeve.

1847. Chiton volvox, Reeve. Conch. Icon., sp. 31.

1847. Chiton cimolius, Reeve. *Id.*, sp. 141.

1852. Lorica cimolia, H. and A. Adams. A.M.N.H., 2 series, vol. ix., p. 355.

1867. Lorica cimolia, Angas. P.Z.S. Lond., p. 224.

1871. Lorica cimolia, Angas. *Id.*, p. 97.

1892. Lorica volvox, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 237, pl. 52, f. 14-21.

1897. Lorica volvox, Bednall. P. Malac. Soc. Lond., vol. ii., No. 4, p. 153.

Hab.—Back Beach, Williamstown.

Obs.—The specimens from the above locality are usually very large, of a uniform dark colour, and in excellent condition.

Genus Loricella, Pilsbry, 1894.

Loricella angasi, Adams and Angas.

1864. Lorica angasi, H. Adams and Angas. P.Z.S. Lond., p. 193.
1865. Lorica angasi, Angas. *Id.*, p. 187.
1871. Lorica angasi, Angas. *Id.*, p. 97.
1892. Lorica (Loricella) angasi, Pilsbry. Tryon, Man. Conch., vol. xiv., p. 238, pl. 51, f. 9-13.
1894. Loricella angasi, Pilsbry. P. Acad. Nat. Sci. Philad., p. 87.
1897. Loricella angasi, Bednall. P. Malac. Soc., Lond., vol. ii., No. 4, p. 153.

Hab.—Dredged off Rhyll in about six fathoms, Western Port.

Note.—In addition to those enumerated above, we have at least seven other chitons as yet unidentified.

Order OPISTHOBRANCHIATA.

Family Actaeonidae.

Genus Actaeon, Montfort, 1810.

Actaeon austrinus, Watson.

1886. Actaeon austrinus, Watson. Chall. Zool., vol xv., p. 628, No. 6, pl. 47, f. 2.
1893. Actaeon austrinus, Pilsbry. Tryon, Man. Conch., vol. xv., p. 149, pl. 20, f. 24-26.

Hab.—Off East Moncoeur Island, Bass Straits, 38 to 40 fathoms, sand and shells.

Obs.—This is not a good species, and should go into the synonymy of Turbonilla (Ondina) casta, A. Adams. There is obviously some mistake in the Challenger references to the figures of this shell as figure 3 is given in the text, but this really represents A. affinis, Adams, and the reference should be to figure 2.

In addition to the above, we would also note that Fossarus bulimoides, T. Woods, P.R.S. Tas., 1877, p. 148, and Tate and May, P.L.S. N.S.W., 1901, pt. 3, p. 390, pl. 26, f. 66, is another synonym of Turbonilla (Ondina) casta, A. Adams.

Family Tornatinidae.

Genus **Tornatina**, A. Adams, 1850.

Tornatina fusiformis, A. Adams.

1854. Bulla (Tornatina) fusiformis, A. Adams. Thes. Conch., vol. ii., p. 570, pl. 121, f. 37.
1867. Tornatina fusiformis, Angas. P.Z.S. Lond., p. 226.
1877. Tornatina fusiformis, Brazier. P.L.S. N.S.W., vol. ii., p. 82.
1877. Tornatina mariae, T. Woods. P.R.S. Tas., p. 155.
1893. Tornatina fusiformis, Pilsbry. Tryon, Man. Conch., vol. xv., p. 194, pl. 22, f. 27.
1893. Tornatina mariae, Pilsbry. *Id.*, p. 198.

Hab.—Port Phillip, Sandringham, Sorrento, Portsea; Western Port, Balnarring, Shoreham, Flinders.

Tornatina brenchleyi, Angas.

1877. Tornatina brenchleyi, Angas. P.Z.S. Lond., pp. 40, 189, pl. 5, f. 20.
1893. Tornatina brenchleyi, Pilsbry. Tryon, Man. Conch., vol. xv., p. 202, pl. 22, f. 35, 36.

Hab.—Portsea, Port Phillip.

Tornatina hofmani, Angas.

1877. Tornatina hofmani, Angas. P.Z.S. Lond., pp. 39, 189, pl. 5, f. 19.
1893. Tornatina hofmani, Pilsbry. Tryon, Man. Conch., vol. xv., p. 203, pl. 22, f. 37, 38.

Hab.—Western Port.

Genus **Retusa**, Brown, 1827.

Retusa eumicra, Crosse and Fischer.

1865. Bulla eumicra, Crosse and Fischer. Jour. d. Conch., p. 40, pl. 2, f. 7.

1865. Utriculus eumicrus, Angas. P.Z.S. Lond., p. 188.
1893. Retusa eumicra, Pilsbry. Tryon, Man. Conch., vol. xv., p. 227, pl. 23, f. 43, 44.

Hab.—Sorrento, Port Phillip; Shoreham, Western Port.

RETUSA APICULATA, Tate.

1879. Utriculus apiculatus, Tate. Trans. Phil. Soc. Adelaide, p. 138, pl. 5, f. 3.
1893. Retusa apiculata, Pilsbry. Tryon, Man. Conch., vol. xv., p. 227, pl. 23, f. 45.

Hab.—Sorrento and Portsea, Port Phillip.

Genus **Volvulella**, Newton, 1891.

VOLVULELLA ROSTRATA, A. Adams.

1854. Bulla rostrata, A. Adams. Thes. Conch., vol. ii., p. 596, pl. 125, f. 154.
1893. Volvula rostrata, Pilsbry. Tryon, Man. Conch., vol. xv., p. 241, pl. 26, f. 60.
1901. Volvulella rostrata, Tate and May. P.L.S. N.S.W., vol. xxvi., pt. 3, p. 416.

Hab.—San Remo, Western Port.

Family SCAPHANDRIDAE.

Genus **Roxania**, Leach, 1847.

ROXANIA EXIGUA, A. Adams.

1854. Bulla (Atys) exigua, A. Adams. Thes. Conch., vol. ii., p. 589, pl. 125, f. 129.
1869. Atys exigua, Reeve. Conch. Icon., vol. xvii., pl. 4, f. 19.
1878. Bulla (Atys) exigua, A. Adams. P.Z.S. Lond., p. 869.
1893. Atys exigua, Pilsbry. Tryon, Man. Conch., vol. xv., p. 270, pl. 28, f. 24.

Hab.—Dredged in Western Port, off Rhyll, Phillip Island; Sorrento, Port Phillip.

Genus **Bullinella**, Newton, 1891.

Bullinella arachis, Quoy and Gaimard.

1833. Bulla arachis, Quoy and Gaimard. Astrolabe Zool., vol. ii., p. 361, pl. 26, f. 28-30.

1854. Bulla (Cylichna) arachis, Adams. Thes. Conch., vol. ii., p. 590, pl. 125, f. 133, 134.

1867. Cylichna arachis, Angas. P.Z.S. Lond., p. 226, No. 255.

1884. Cylichna arachis, E. A. Smith. Alert Zool., p. 86, No. 121.

1886. Cylichna arachis, Watson. Chall. Zool., vol. xv., p. 662, No. 2.

1893. Cylichna arachis, Pilsbry. Tryon, Man. Conch., vol. xv., p. 318, pl. 27, f. 92, 93.

1896. Cylichna arachis, Kobelt. Conch. Cab., p. 37, pl. 7, f. 10, 11.

Hab.—Port Phillip generally and Western Port; in fine condition and of very large dimensions from Shelly Beach, near Shoreham.

Bullinella pygmaea, A. Adams.

1854. Bulla (Cylichna) pygmaea, A. Adams. Thes. Conch., vol. ii., p. 595, pl. 125, f. 150.

1876. Cylichna atkinsoni, T. Woods. P.R.S Tas., p. 156.

1893. Cylichna atkinsoni, Pilsbry. Tryon, Man. Conch., vol. xv., p. 318.

1893. Cylichna pygmaea, Pilsbry. *Id.*, p. 319, pl. 59, f. 9.

1896. Cylichna pygmaea, Kobelt. Conch. Cab., p. 60, pl. 11, f. 14.

Hab.—Sorrento, Portsea and Clifton Springs, Port Phillip; Western Port.

Family Bullidae.

Genus **Bulla**, Linnaeus, 1758.

Bulla australis, Gray.

1825. Bulla australis, Gray. Annals of Philosophy, n.s., vol. ix., p. 408.

1827. Bulla australis, Gray. King's Survey of Australia, vol. ii., appendix, p. 490, No. 92.
1833. Bulla australis, Quoy and Gaimard. Astrolabe Zool., vol. ii., p. 357, pl. 26, f. 38, 39.
1836. Bulla australis, Lamarck. Anim. S. Vert. (2nd ed. Deshayes), vol. vii., p. 673.
1839. Bulla australis, Lamarck. *Id.* (3rd ed Deshayes and Edwards), vol. iii., p. 248, No. 12.
1843. Bulla australis, Gray. Dieffenbach's New Zealand, vol. ii., p. 243, No. 114.
1854. Bulla oblonga, A. Adams. Thes. Conch., vol. ii., p. 577, No. 50, pl. 123, f. 74
1854. Bulla australis, A. Adams. *Id.*, p. 576, sp. 45, pl. 122, f. 64-66.
1854. Bulla oblonga, H. and A. Adams. Genera, vol. ii., p. 16.
1859. Bulla australis, Chenu. Man. de Conch., pt. 1, p. 389, f. 2938.
1859. Bulla oblonga, Chenu. *Id.*, f. 2940.
1865. Bulla australis, Angas. P.Z.S. Lond., p. 188.
1867. Bulla oblonga, Angas. *Id.*, p. 226.
1868. Bulla oblonga, Reeve. Conch. Icon., pl. 3, sp. 9, f. *a*, *b*, *c*.
1873. Bulla oblonga, Hutton. Cat. Moll. N.Z., p. 52.
1873. Bulla australis, von. Martens. Critical List of N.Z. Moll., p. 38.
1877. Bulla oblonga, T. Woods. P.R.S. Tas., p. 47.
1880. Bulla oblonga, Hutton. Man. N.Z. Moll., p. 121.
1885. Bulla australis, Brazier. P.L.S. N.S.W., vol. x., pt. 1, pp. 89-92.
1886. Bulla australis, Watson. Chall. Zool., vol. xv., p. 638, No. 2.
1893. Bulla australis, Pilsbry. Tryon, Man. Conch., vol. xv., p. 346, pl. 35, f. 12, 13, 14, and 17, 18.
1896. Bulla australis, Kobelt. Conch. Cab., p. 74, pl. 8, f. 1, 2.

Hab.—Extremely abundant in Corio Bay and Outer Geelong Harbour to Portarlington, also Werribee to Altona Bay. Less abundant on the eastern shores of Port Phillip; Western Port; common near Whitehaven, Phillip Island; Kilcunda and Anderson's Inlet (W. H. Ferguson).

Obs.—Mr. Brazier, in his paper on four of Dr. Gray's species above quoted, deals very fully with this species, pointing out many of the erroneous figures and localities given by various authors. Mr. Watson in his Challenger report includes Bulla quoyi, A. Adams, as a synonym of the above, but with this we cannot agree, for our own examination of New Zealand examples of that species, received from and identified by Mr. H. Suter, lead us to conclude that it is a good species.

In the Manual of Conchology there appears to be some confusion in the treatment of this species, for although all the figures on plate 35 are given as Bulla australis in the reference to the plate, yet we note that figures 15, 16, 19, 20 are referred to in the text as Bulla adamsi, Menke. We are more inclined to agree with the latter reading.

Family Akeridae.

Genus **Haminea**, Leach, 1847.

Haminea brevis, Quoy and Gaimard.

1833. Bulla brevis, Quoy and Gaimard. Astrolabe Zool., vol. ii., p. 358, pl. 26, f. 36, 37.

1839. Bulla brevis, Lamarck. Anim. S. Vert. (3rd ed. Deshayes and Edwards), vol. iii., p. 249, No. 19.

1843. Bulla (Scaphander) ovoidea, Menke (non Quoy and Gaimard). Moll. Nov. Holl., p. 6, No. 7.

1854. Bulla brevis, Adams. Thes. Conch., vol. ii., p. 581, pl. 124, f. 93.

1868. Haminea brevis, Reeve. Conch. Icon., vol. xvi., pl. 3, f. 15*a*, *b*.

1865. Haminea brevis, Angas. P.Z.S. Lond., p. 188.

1867. Haminea brevis, Angas. *Id.*, p. 227, No. 261.

1893. Haminea brevis, Pilsbry. Tryon, Man. Conch., vol. xv., p. 373, pl. 40, f. 9, 10, 96.

1896. Haminea brevis, Kobelt. Conch. Cab., p. 114, pl. 16, f. 14, 15.

Hab.—Common in Port Phillip and Western Port. Dredged off Frankston, 2 to 3 fathoms, sand.

HAMINEA CUTICULIFERA, Smith.

1872. Haminea cuticulifera, E. A. Smith. A.M.N.H., ser. 4, vol. ix., p. 350.

1884. Haminea cuticulifera, E. A. Smith. Alert Zool., p. 87, pl. 6, f. H.

1877. Haminea cuticulifera, Angas. P.Z.S. Lond., p 189.

1886. Cylichna cuticulifera, Watson. Chall. Zool., vol. xv., p. 663.

1893. Haminea cuticulifera, Pilsbry. Tryon, Man. Conch., vol. xv., p. 372, pl. 41, f. 13.

1896. Haminea cuticulifera, Kobelt. Conch. Cab., p. 117, No. 33, pl. 16, f. 22.

Hab.—Sorrento and Portsea, Port Phillip.

HAMINEA TENERA, A. Adams.

1850. Bulla (Haminea) tenera, A. Adams. Thes. Conch., vol. ii., p. 583, pl. 124, f. 103.

1868. Haminea tenera, Reeve. Conch. Icon., vol. xvi., pl. 1, f. 3.

1893. Haminea tenera, Pilsbry. Tryon, Man. Conch., vol. xv., p. 371, pl. 40, f. 82.

1896. Haminea tenera, Kobelt. Conch. Cab., p. 116, No. 30, pl. 16, f. 19.

Hab.—Common in Port Phillip and Western Port.

Obs.—This shell has been very commonly known as H. cymbalum, Quoy and Gaimard, but on looking up that species, though there is some resemblance to our form, it is quite distinct.

Genus **Cylindrobulla**, Fischer, 1856.

CYLINDROBULLA FISCHERI, Adams and Angas.

1864. Cylindrobulla fischeri, Adams and Angas. P.Z.S. Lond., p. 37.

1865. Cylindrobulla fischeri, Angas. P.Z.S. Lond., p. 189.

1871. Cylindrobulla fischeri, Angas. P.Z.S. Lond., p. 98.

1893. Cylindrobulla fischeri, Pilsbry. Tryon, Man. Conch., vol. xv, p. 381.

Hab.—Port Phillip Heads.

Genus **Lobiger**, Krohn, 1847.

LOBIGER WILSONI, Tate.

1889. Lobiger wilsoni, Tate. T.R.S. S.A., vol. xi., p. 66, pl. 11, f. 12.

Hab.—Lower end of South Channel, Port Phillip, 7-16 fathoms (J. B. Wilson).

Family RINGICULIDAE.

Genus **Ringicula**, Deshayes, 1838.

RINGICULA AUSTRALIS, Hinds.

1844. Ringicula australis, Hinds. P.Z.S. Lond., p. 97.

1865. Ringicula australis, Crosse and Fischer. Jour. d. Conch., p. 44, pl. 2, f. 5.

1893. Ringicula australis, Pilsbry. Tryon, Man. Conch., vol. xv., p. 410, pl. 47, f. 80, 81.

1878. Ringicula australis, Morlet. Jour. d. Conch., p. 125, pl. 5, f. 10.

1878. Ringicula angasi, Brazier. P.L.S. N.S.W., vol. ii., p. 78.

Hab.—Western Port.

Family PHILINIDAE.

Genus **Philine**, Ascanius, 1772.

PHILINE ANGASI, Crosse.

1865. Bullaea angasi, Crosse. Jour. d. Conch., p. 38, pl. 2, f. 8.

1865. Philine angasi, Angas. P.Z.S Lond., p. 189, No. 222.

1867. Philine angasi, Angas. *Id.*, p. 227, No. 263.

1878. Philine angasi, Brazier. Chevert Exped. P.L.S. N.S.W., vol. ii., p. 88, No. 54.

1870. Philine angasii, Reeve. Conch. Icon., vol. xviii., pl. 1, fig. 4.

1886. Philine angasi, Watson. Chall. Zool., vol. xv., p. 671, No. 1.

1896. Philine angasi, Kobelt. Conch. Cab., p. 152, No. 21, pl. 19, f. 21.

Hab.—Port Phillip (common); Western Port; Polwarth Coast.

Obs.—We do not regard this species as synonymous with P. aperta, Lin., and though the shells of these two species are frequently very much alike, yet there are points which serve for distinction even with such a relatively characterless form.

Family Aplysiidae.

Genus **Aplysia**, Linnaeus, 1767.

Aplysia concava, Sowerby.

1822. Aplysia concava, Sowerby. Genera, vol. ii., 6th pl., f. 3, No. 39.

1869. Aplysia concava, Reeve. Conch. Icon., vol. xvii., pl. 6, f. 24 *a*, *b*.

1898. Aplysia concava, Küster. Conch. Cab., p. 18, No. 37, pl. 7, f. 12, 13.

Hab.—Western Port.

Aplysia tigrina, Rang.

Aplysia tigrina, Rang. Hist. Nat. Apl., p. 57, pl. 11.

1869. Aplysia tigrina, Reeve. Conch. Icon., vol. xvii., pl. 2, f. 5 *a*, *b*.

1898. Aplysia tigrina, Küster. Conch. Cab., p. 8, pl. 4, f. 1, 2.

Hab.—Portland (Maplestone).

Family Pleurobranchidae.

Genus **Pleurobranchus**, Cuvier, 1805.

Pleurobranchus angasi, E. A. Smith.

1884. Pleurobranchus angasi, E. A. Smith. Alert Zool., p. 88, pl. 6, f. KK[1].

Hab.—Port Phillip.

Pleurobranchus maculatus, Quoy.

1832. Pleurobranchidium maculatum, Quoy. Astrolabe Zool., vol. ii., p. 301, pl. 22, f. 11-14.

Hab.—Victoria (Prof. R. Tate).

Family Umbrellidae.

Genus **Umbrella**, Lamarck, 1812.

Umbrella corticalis, Tate.

1889. Umbrella corticalis, Tate. T.R.S. S.A., vol. xi., pp. 65, 66, pl. 11, f. 11.

Hab.—Port Phillip Heads.

Family Siphonariidae.

Genus **Siphonaria**, Sowerby, 1824.

Siphonaria diemenensis, Quoy and Gaimard.

1833. Siphonaria diemenensis, Quoy and Gaimard. Astrolabe Zool., vol. ii., p. 327, pl. 25, f. 1-12,

1833. Siphonaria denticulata, Quoy and Gaimard. *Id.*, p. 340, pl. 25, f. 19, 20.

1856. Siphonaria diemenensis, Reeve. Conch. Icon., vol. ix., pl. 1, f. 1.

1856. Siphonaria scabra, Reeve. *Id.*, pl. 1, f. 2.

1856. Siphonaria denticulata, Reeve. *Id.*, pl. 1, f. 4.

1877. Siphonaria diemenensis, T. Woods. P.R.S. Tas., pp. 56-58.

1877. Siphonaria denticulata, T. Woods. *Id.*, pp. 54-56.

1878. Siphonaria diemenensis, T. Woods. *Id.*, p. 46.

1878. Siphonaria denticulata, T. Woods. *Id.*, p. 47.

1901. Siphonaria diemenensis, Tate and May. P.L.S. N.S.W., vol. xxvi., pt. 3, p. 418.

Hab.—Very common at and above high tide mark along all rocky portions of our coast.

Siphonaria funiculata, Reeve.

1856. Siphonaria funiculata, Reeve. Conch. Icon., vol. ix., pl. 2, f. 6.

1867. Siphonaria funiculata, Angas. P.Z.S. Lond., p. 232, No. 313.

1877. Siphonaria funiculata, T. Woods. P.R.S. Tas., p. 58.

1901. Siphonaria funiculata, Tate and May. P.L.S. N.S.W., vol. xxvi., pt. 3, p. 419.

Hab.—Usually an associate of the foregoing species, but much less common. Hobson's Bay (Nat. Mus.).

SIPHONARIA BACONI, Reeve.

1856. Siphonaria baconi, Reeve. Conch. Icon., vol. ix., pl. 6, f. 30.

1878. Siphonaria albida, Angas. P.Z.S. Lond., p. 314, pl. 18, f. 14, 15.

1893. Siphonaria albida, Adcock. Hand List Aquat. Moll. S.A., p. 11, No. 456.

1901. Siphonaria albida, Tate and May. P.L.S. N.S.W., vol. xxvi., pt. 3, p. 419.

Hab.—Back Beach, Sorrento, to Cape Schanck; Western Port; Point Addis; Airey's Inlet; Anderson's Inlet (W. H. Ferguson).

SIPHONARIA ZONATA, T. Woods.

1877. Siphonaria denticulata, var. tasmanica, T. Woods. P.R.S. Tas., p. 54.

1878. Siphonaria zonata, T. Woods. P.R.S. Tas., p. 99.

1878. Siphonaria zonata, T. Woods. *Id.*, p. 47 (name only).

1901. Siphonaria tristensis, Tate and May (non Sowerby). P.L.S. N.S.W., vol. xxvi., pt. 3, p. 419.

Hab.—Port Phillip; Corio Bay; Western Port; Anderson's Inlet and Kilcunda (W. H. Ferguson); Back Beach, Sorrento; Spring Creek to Cape Otway.

Obs.—The type of this species is in the National Museum, Melbourne.

Mr. May has informed one of us that the inclusion of this species in the Tasmanian Census was a mistake and refers to S. zonata, T. Woods.

Family GADINIIDAE.

Genus **Gadinia**, Gray, 1824.

GADINIA ANGASI, Dall.

1867. Gadinia conica, Angas. P.Z.S. Lond., pp. 115 and 220, pl. 13, f. 27.

1870. Gadinia angasi, Dall. Amer. Jour. Conch., vol. vi., p. 11.

Hab.—Portsea, Port Phillip; Western Port.

Class **SCAPHOPODA.**

Family DENTALIIDAE.

Genus **Dentalium**, Linnaeus, 1758.

DENTALIUM LUBRICATUM, Sowerby.

1860. Dentalium lubricatum, Sowerby. Thes. Conch., vol. iii., p. 97, No. 3, pl. 3, f. 56.

1872. Dentalium lubricatum, Reeve. Conch. Icon., vol. xviii., pl. 7, f. 55.

1896. Dentalium lubricatum, Lesson. Conch. Cab. (ed. Küster), p. 14, No. 22, pl. 4, f. 3.

Hab.—Cowes, Phillip Island, Western Port (T. S. Hall).

Obs.—We have to thank Mr. C. Hedley for the identification of this species.

Genus **Cadulus**, Phillipi, 1841.

CADULUS ACUMINATUS, Tate.

1871. Cadulus acuminatus (Deshayes, MS.), Angas. P.Z.S. Lond., p. 97.

1878. Cadulus acuminatus, Angas. *Id.*, p. 868.

1887. Cadulus acuminatus, Tate. T.R.S. S.A., vol. ix., p. 194, pl. 20, f. 10.

1890. Cadulus acuminatus (Deshayes), Whitelegge. P.R.S. N.S.W., p. 117 in reprint.

1893. Cadulus acuminatus (Deshayes), Adcock. Hand List Aquat. Moll. S.A., p. 10.

1898. Cadulus acuminatus, Pilsbry and Sharp. Tryon, Man. Conch., vol. xvii., p. 183, pl. 32, f. 47-49.

1899. Cadulus acuminatus, Tate. T.R.S. S.A., vol. xxiii., p. 266, pl. 8, f. 11.

1901. Cadulus petterdi (Brazier), Lodder. List of Tas. Shells, etc., P.R.S. Tas., p. 15 in reprint.

1901. Cadulus acuminatus, Tate and May. P.L.S. N.S.W., vol. xxvi., pt. 3, p. 420.

Hab.—Western Port; Port Albert (T. Worcester).

Obs.—This species has been distributed amongst collectors under the name of C. petterdi, Brazier, and C. petterdi, T. Woods, but neither of these gentlemen figured or described such a species. There has also been some confusion as to the author of the species, many referring to Deshayes, but this fog is apparently cleared up by Professor Tate's remarks in his 1899 paper, where he states:—"I borrowed the name after Deshayes, who, on the authority of Angas, had so attached his MS. name to New South Wales specimens in the British Museum, and Angas so listed the species for South Australia on the testimony of examples forwarded by me."

Art. XX.—*The Phyllopoda of Australia, including descriptions of some new Genera and Species.*

By O. A. SAYCE.

(With Plates XXVII.–XXXVI.).

[Read 11th December, 1902.]

The earliest descriptions of Australian Phyllopoda are those of the Rev. R. L. King, published in the Proceedings of the Royal Society of Van Diemen's Land for 1855. Since then the list has been considerably added to by various workers;[1] but frequently the want of figures and more detailed descriptions than have been given, makes it almost impossible to accurately identify the species.

Our thanks are especially due to Prof. G. O. Sars for his very careful redescriptions and figures of old species, as well as for his care in presenting new ones. Besides describing some spirit specimens he has received dried mud from different parts of the continent and successfully hatched out in Norway a considerable number of species, and given valuable information of the life-history of several.

The important treatise of Messrs. Baldwin Spencer and Hall on the Phyllopoda of Central Australia in the Report of the Horn Expedition should also be mentioned here, wherein, besides descriptions and figures of new species, records of their distribution and some interesting biological observations are made.

My aim in this paper has been to present a complete catalogue of the Australian Phyllopoda, including bibliographical references, and redescribing and figuring more amply those that appeared to need it, and of which I had specimens; also giving sufficient descriptive detail for a fairly accurate identification of each of the others. Unfortunately the material to hand of the several

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1 In the Proc. Zool. Soc. London, 1886, Prof. Brady gives a list of species, not only of the Phyllopoda, but all the Entomostraca known at that time.

species has been generally insufficient in numbers and often too badly preserved to do justice to them. In most of the groups, particularly the Conchostraca, there is considerable variability of form, and it is difficult to find constantly reliable features, also, what is constant in one genus may be inconstant in another, and throughout the whole order sexually matured species often alter very considerably before reaching the true adult size; so that a considerable sum of characters must be taken into account, and larger and smaller forms examined, before laying down a good diagnosis.

For material I am specially indebted to Prof. Baldwin Spencer, M.A., F.R.S., and Mr. T. S. Hall, M.A., of the Melbourne University, and to the authorities of the South Australian Museum; also to several other persons duly mentioned hereafter. I desire further to acknowledge my obligation to Professor Spencer, in his capacity of Director of our National Museum, for affording me the opportunity of consulting certain literature and examining some foreign specimens.

I have considered it necessary to institute two new genera, viz.: Parartemia and Branchinella, and have described six new species, as well as redescribed and figured several others; while the list has been somewhat shortened by the cutting out of a few apparent synonyms.

Our present knowledge of the group, however, must not be considered as exhausting the Australian Continent; very many localities, apparently, have not been searched. It is hoped that further attention will be given to them by field workers, and those possessing collections.

The nomenclature is in conformity with that of Prof. Sars, except as regards the endites of the branchial legs. In these appendages, for the sake of uniformity throughout the group, the so called coxal lobe of the Limnadiidae is considered as the first endite; allowing by this means the normal number, which is six, each to bear a constant morphological relationship throughout.

List of Species and their distribution in accordance with the zoological areas instituted by Prof. Baldwin Spencer.[1]

Each area is denoted by its first letter, and one letter placed above another denotes the borderland of two areas.

Branchipodidae.

No.	Species	Area	PAGE.
1.	Artemia australis (sp. nov.)	$\frac{\text{E.}}{\text{B.}}$	229
2.	,, westraliensis (sp. nov.),	E.	230
3.	,, proxima	B.	231
4.	Parartemia zietziana (gen. et sp. nov.),	$\frac{\text{E.}}{\text{B.}}$	231
5.	Branchinella australiensis (gen. nov.),	T.B.E.	233
6.	,, eyrensis (sp. nov.),	E.	239
7.	Streptocephalus archeri,	T.	240

Apodidae.

No.	Species	Area	PAGE.
8.	Apus australiensis,	E.	241
9.	Lepidurus viridis,	E.B., also New Zealand	242

Limnadiidae.

No.	Species	Area	PAGE.
10.	Eulimnadia dahli,	T.E.	244
11.	,, sordida,	B.	245
12.	,, rivolensis,	B.E.	245
13.	,, victoriensis (sp. nov.),	B.	246
14.	Paralimnadia stanleyana,	B., also India ?	248
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19.	,, elliptica,	E.	252
20.	,, sarsii (sp. nov.),	E.	252
21.	,, lutraria,	E.	254

[1] These areas are named and defined as follows:—1, Northern and north-eastern coastal, extending as far south as about the Clarence River, and including also New Guinea—Torresian. 2, Southern-eastern coastal area, including Southern Victoria and Tasmania—Bassian. 3, The whole of the interior, together with West Australia and almost all South Australia—Eyrean. *See* Rep. Horn Exped. Summary, pp. 196-199.

Sub-order PHYLLOPODA.

Entomostraca of various shapes, with or without a carapace or shell ; the possessors either having it fashioned as a dorsal shield, or in the form of two large valves enveloping the entire animal. Eyes sometimes pedunculated, sometimes sessile. Ocellus (simple eye) present. All the appendages placed behind the mouth parts respiratory, of approximately uniform structure and leaf-like form ; their number very variable, 10-63. (This description does not include the Cladocera).

Remarks.—Prof. G. O. Sars has divided this sub-order into three groups. They are of widely separated types, those without any carapace or shell (Anostraca), those with a large chitinous shield arching over the back, which in outline is of horseshoe shape (Notostraca), and those with the body surrounded by a large chitinous bivalve shell, connected dorsally, and capable of being opened or shut by the aid of powerful adductor muscles, so that the animal may be entirely enclosed.—(Conchostraca).

None are marine inhabitants, and, with the exception of but very few forms which live in salt inland waters, are only found in fresh water, and usually in quiet shallow lakes or pools (often less than a yard across), which completely dry up periodically. They range in length from a quarter inch to three inches.

Their growth is often surprisingly rapid ; Messrs. Spencer and Hall mention in the Report of the Horn Expedition to Central Australia that in only a few days after a fall of rain numberless specimens of Apus, measuring $2\frac{1}{2}$ inches in length, were seen swimming about the rain pools which could only have come from eggs. Probably the high temperature of the water is a stimulus for this strikingly rapid development.

Tribe 1—*Anostraca* (Naked Phyllopods).

Body long, very soft and flexible, and without any trace of carapace or shell. Eyes distinctly pedunculated. First pair of antennae small and filiform; second pair in the male formed into a clasping organ; in the female of a simple character.

Family 1—*Branchipodidae.*

Body narrow, cylindrical, somewhat thicker in front, with the tail well developed, and distinctly segmented in both sexes, terminating in two bristle-beset caudal rami. Prehensile antennae of male distinctly segmented, and usually furnished with a rudimentary sub-branch. Frontal appendages present in the male or wanting. Eleven pairs of branchial feet present, all having a single serrated external covering plate. Marsupium of the female distinctly sac-formed, directed backwards, and issuing from the two foremost caudal segments.—(Sars).

Synopsis of Local Genera.

(A) *Tail with eight segments*—

1. Male claspers with 2nd joint flat and triangular; caudal rami very small.—Artemia.
2. Male claspers with 2nd joint claw-shaped; immovable spiniform projection on frontal area of 1st joint, caudal rami very small.—Parartemia.

(B) *Tail with nine segments*—

3. Frontal appendages simple, spinulose, united proximally, varying greatly in length; claspers quite simple, 2nd joint claw-shaped, not angularly bent near the tip; 2nd antennae of female very long and ribbon-like; ovisac stout, pear-shaped. —Branchinella.
4. Frontal appendages long, variously lobed, and spinulose; claspers with 2nd joint possessing a sharp basal spur; ovisac short and broad, eggs large, and few in number.—Chirocephalus.
5. Second joint of male claspers long, twisted, and forked irregularly; ovisac long and slender.—Streptocephalus.

Genus 1—Artemia.

1. Artemia australis, sp. nov. (Pl. XXVII.).

Description of Female.—Body normally slender; tail of eight segments, equal in length to cephalon and trunk combined, terminal segment as long as the two preceding ones combined; caudal rami narrow-lanceolate, about half the length of the terminal segment, not articulated to it. Eyes large and prominent.

First antennae relatively long. Second antennae lanceolate, a little shorter than the first pair, gradually tapering from about the middle of the length to an acute tip, but not drawn out. Branchial feet each possessing the normal number of divisions. First pair very small, rather smaller than the last. Each with distal lobe of endopodite very broad, much broader than the length of the exopodite, except in the last pair, where it is of about equal length; in each it is laterally produced considerably beyond the level of the upper endites, with the margin evenly curved, and merging into the distal margin, which runs in an almost straight line to the proximal end of the exopodite. In each pair of feet except the last, the second endite, as usual, is scarcely marked off from the first one, and at its origin there is a little tubercle; in the last pair it is much smaller but more conspicuous, and from its edge arise three much larger setae than those on the first endite. In each of the other legs the two first endites are uniformly fringed with feathered setae, curving upwards. The third endite bears one very long, stout spiniform setae and one shorter one, the former twice as long as the latter; the fourth endite has two and the fifth one stout setae, similar to the shorter one on the third endite. The exopodite is about twice as long as its greatest breadth, and bluntly pointed at the end.

Ovisac, very stout, fully as broad as its length, the anterior part much swollen and possessing two lateral subconical lobes. On the deeply convex ventral surface there are two acute tubercles, set one on each side of the mid axis. The neck is short and extends to about the end of the fourth tail segment.

Length.—9.5 mm., exclusive of caudal rami.

Locality.—Brackish-water, Sandhills, Glenelg, coastal district of South Australia. (S.A. Museum, collected by Mr. Becker, 1890).

Remarks.—Of this species I have received about 100 specimens, all of which are females and several bearing eggs, but the greatest number are young forms not fully matured, and probably of parthenogenetic origin. It is to be regretted that there are no males amongst them, but I think there is little doubt as to their being a normal Artemia.

2. **Artemia westraliensis**, sp. nov. (Pl. XXVIII., Figs. A1 and 2).

Description of Female.—Body of normal form; tail of eight segments, about equal in length to cephalon and trunk combined, terminal segment only about one-third longer than the preceding one, caudal rami narrow-lanceolate, very long for the genus, being of sub-equal length to the terminal segment, and thickly fringed with feathered setae. Eyes smaller and scarcely so prominent as those of A. australis.

First antennae short and slender, subequal in length to the eye and its stalk. Second antennae short, slightly longer than the first pair, broad-lanceolate, apically gradually tapering to an acute point. Branchial legs agreeing closely in shape to A. australis.

Ovisac differing proportionately in shape from A. australis, due to the lateral lobes being very much more developed (in this species swelling out on each side to enormous saccular distentions), and a correspondingly smaller neck; also there are no acute tubercles on the ventral face. It is considerably broader than long, and does not extend as far as the end of the third tail segment.

Length.—11 mm., exclusive of caudal rami.

Locality.—Lake Aurean, Murchison, West Australia. (Collected by Mr. J. T. Markes, January, 1896).

Remarks.—I have but two female specimens of this species, both are of similar size, and well preserved. It may be that it is congeneric with the following species, but without the male it is impossible to say.

I am informed by a resident of Murchison that the water of Lake Aurean, from which this species was taken, is always more or less brackish, but never very salt. During the rainy season it is quite fit for cattle to drink. In the same bottle as contained the specimens there was a specimen of Apus australiensis and a new species of Estheria, described later in this paper, all, according to the label, collected from the same place at the same time.

Unrecognisable Species.

Artemia proxima, King.

Ref.—Proc. Royal Soc. Van Diemen's Land, 1855, p. 70. Trans. Entom. Soc. New South Wales, I., p. 162, pl. xi.

No figure except a branchial leg of the fifth pair has been published, and the few words of description are quite meaningless. The specimens were collected from salt pans at Newington, near Sydney.

Genus 2—Parartemia, nov.

Body slender; tail slender and elongated, of eight segments, the terminal one long; caudal rami not articulated to the terminal segment, of flattened form and very short.

Prehensile antennae of male large; first joint short and very stout, directed obliquely outwards, inner margins definitely formed, so that the pair together fit closely over the back of the female during copulation, also on the frontal face of each an immovable spiniform process, presumably homologous with the frontal appendages of other genera; second joint quite simple, claw-shaped, incurved, slender, and of firm consistency.

Branchial feet with the normal number of parts; distal lobe of endopodite, short and rather broad, produced somewhat laterally, but apparently not so much as in Artemia; exopodite narrow. Last pair without covering plate or gill.

Ovisac of female very short and broad, of trilobate form, due to two very large lateral saccular lobes narrowly united ventrally, and medianly therefrom abruptly arising a short and stout neck.

Remarks.—This new genus is formed to receive the following new species. It agrees in many respects with Artemia, but differs from it materially in the shape of the prehensile antennae of the male, and the ovisac of the female, and also in some other characters.

Parartemia zietziana, sp. nov. (Plates XXVIII., Fig. B, and XXIX.).

Body slender; tail greatly elongated, about one-third longer than the cephalon and trunk combined, terminal segment fully twice as long as the preceding one. Cephalon large, as long as first four segments of trunk combined. Eyes small and prominent.

First antennae short. Prehensile antennae of male, as usual, directed downwards; first joint with bases coalesced to each other, short, stout, fleshy, subquadangular in frontal outline and widely divergent, so that the distail ends face obliquely outwards, to which are articulated the second joints. These are twice as long as the first joint, of firm consistency and slender cylindric shape, curving but a little inwards, gradually tapering from the base to a finely pointed extremity, and the surface unbroken by any ridges or spines. From the middle of the anterior surface of each basal joint, and directed anteriorly, arises a prominent immovable spineform process, while from the inner side which faces directly downwards, there is projected a definite ridge extending nearly to the distal end of the joint, having the margin concave. The pair of ridges are only separated medianly by a very narrow fissure, and together form a concave space which fits over the back of the female during copulation. The distal angle of each ridge is narrowly rounded and a little produced towards the end of the joint.

Second antennae of female about the length of the head, obliquely truncated at the end with the inner angle drawn out to an acute point.

Branchial feet of shape normal to the genus, no difference in the two sexes; covering plates rather small, gills of about similar size. Endopodite with terminal lobe broad and laterally expanded more or less, those pairs of about the middle area being very much so, side margin meeting the distal end in a broad even curve, and fringed with spiniform setae, the end being only a little curved, and bearing longer and finer bristles. The first endite is of usual shape, that of the first pair bearing at about the middle of the length a particularly stout, long, and acutely pointed spine directed upwards and slightly curved, and bearing on the distal half many minute barbs. The second endite is about one-third of the length of the first. The third, fourth and, fifth small and subconical, each gradually becoming smaller and bearing several of the usual long feathered setae, also one long finely feathered spine and one very short one, that of the third being very long. The exopodite is long, rather narrow, and apically bluntly pointed. The last pair of feet have no basal plate, nor gill, and is smaller in size than the first pair.

Penes double, wide at the base, hind margin straight, front, in the middle, having a wide and deep sinus, defined above by a right-angle, and below by a conical pointed projection. Ovisac scarcely extending beyond the second tail segment, lateral lobes very large, widely divergent, and extending dorsally far beyond the level of the back, ventrally narrowly united, not bulging at all outwards, neck very short and thick, and pointing directly outwards.

Caudal rami less than one-third the length of the ultimate segment, of flattened form, with the extremity broadly rounded, and the edges thickly fringed with feathered setae.

Length.—♂ 23 mm. ♀ 18 mm.

Locality.—Brackish-water swamp near Lake Alexandrina, South Australia. (S.A. Museum, collected November, 1890).

Remarks.—Of the specimens received about 20 are males of pretty uniform size, and only one female of rather smaller size. It is named in compliment to Mr. A. Zietz, F.L.S., Assistant Director of the South Australian Museum.

Genus 3—**Branchinella**, nov.

Characters.—In general appearance like Branchipus; body stout, tail of nine segments besides the caudal rami, the latter well developed and articulated to the terminal segment. Cephalon large. Eyes large and prominent. Prehensile antennae of male without any spur or accessory branch other than the frontal appendages, basal joint stout and fleshy and of cylindric form, second joint very much narrower, quite simple, firm and chitinous, curved evenly inwards, not at all angularly bent near the tip, inner surface usually bearing transverse ridges. Frontal appendages simple, spinulose, minute to very long and flexuose, proximally coalescent and united to the frontal base of the claspers.

Second antennae in the female very long, flattened, flexuose, apically tapering to a point; in fully matured forms often extending as far back as the limit of the trunk.

Branchial feet possessed with the usual parts; covering lamellae large; exopodite large, broadly ovoid; distal lobe of endopodite well extended, ventral margin distinctly emarginated, inner margin substraight, scarcely or not at all produced beyond the level of the endites; endites clearly marked off from the stem.

Ovisac large and stout, of pyriform shape, posteriorly tapering to a rather long neck. Eggs numerous, generally marked with facets bordered by raised ridges.

Male with a pair of penes, each lying introverted within a simple unnotched sheath protruding a little from the segment; when everted, of subcylindrical shape, long and spinulose.

Remarks.—This new genus is instituted to receive the two following Branchipods. From Branchipus, with which they accord closely in very many respects, they differ in the male claspers being without any accessory branch or spine, and the terminal joint not being at all angularly bent near the tip; also in the long and ribbon-like second antennae in the female, and apparently in the peculiarly characterised penes of the male. From Chirocephalus, with which the second species might be placed if we relied on the frontal appendages, there are other differences of more generic importance which appear to separate it from that genus.

1. **Branchinella australiensis**, Richters.

(Plate XXX.)

Branchipus australiensis, Dr. F. Richters, Journal de Musèum Godeffroy, xii., 1876, pp. 43, 44, pl. 3.

Specific Characters.—Body stout, cephalon of about equal length to the first four segments of trunk, trunk of equal length to the tail. Branchial feet each with covering plate very large, distal lobe of endopodite (6th endite) rather short, broadly rounded in average sized sexually matured specimens, but in larger ones much longer, and narrower distally, often produced considerably beyond the end of the exopodite. Distal margin emarginate.

In each of above characters the two sexes agree. *Male* of smaller size than female, and antennules longer. Claspers large and powerful, basal joint with inner surface clothed with minute teeth, second joint longer than the first, inner surface possessing transverse ridges. Frontal appendages minute, simple, curled inwards and downwards, their inner margin minutely spinulose, united proximally, and attached to frontal base of antennae. Caudal rami at least as long as the last four segments of tail combined, (in female somewhat shorter). Sheath of penes not notched, penes, when everted, stout, bent outwards and hindwards in the shape of a sickle, distal half thickly clothed with short recurved spines, proximal half possessing large, stout, acute spines pointing proximally.

Female.—Second antennae very long, flattened, flexuose, gradually narrowing to a somewhat drawn-out, pointed end; sometimes they extend as far back as the end of the trunk, but in younger although sexually mature forms often very much shorter. The ovisac large, pear shaped, with apex elongated, and furnished on the ventral surface, in a line with the extremity of the first segment of the tail, with a small protruding transverse ridge or lip. In forms bearing eggs the ovisac varies in size, extending in some to the end of the fourth, and in others to the sixth segment of the tail. Eggs sculptured with irregular hexagonal facets bounded by conspicuous ridges.

Length of largest ♂ exclusive of caudal rami, 30 mm. Length of largest ♀ exclusive of caudal rami, 40 m.m.

Colour.—Translucent, caudal rami vivid reddish-orange, ovisac flecked with patches of sky blue.

Distribution.—Queensland, inland area (Dr. Richters); Elwood and Rosstown, Southern Victoria (collected by Mr. R. Cummins, B.Sc.); Goornong, near Bendigo (collected by Mr. Alex. Purdie), St. Arnaud (collected by Mr. C. J. Gabriel), both Northern Victoria; coastal area of South Australia and Central Australia (S.A. Museum).

Remarks.—This large and handsome Branchipod has not previously been recorded outside of Queensland. Besides other localities it is quite common near Melbourne (Elwood and Rosstown), except when the little rain pools in which they live dry up, such being the case for several months every year. I have never known them to live in the larger swamps that contain water all the year round.

The original paper of Dr. Richters describing this species from Queensland has apparently been entirely overlooked, for in Professor Packard's important monograph of the Phyllopods of North America, published seven years later than the above paper,[1] in which he gives a list of known species of the family, it is not included, and he remarks that no Branchipodidae occur in Australia, which misstatement has been made since. Sars also has missed the above record in his list of Australian Phyllopoda.[2]

My thanks are due to Mr. T. S. Hall, M.A., for bringing under my notice Richters' paper, and I have no doubt from comparison with his figures and description that the Victorian form specifically agrees with it. I have, however, thought it advisable to more fully describe it. The foregoing description and following supplementary remarks have been made after an examination of numerous living specimens.

Supplementary Description.—The males and females live in about equal proportion. They are of graceful form, and, like other Branchipods, swim on their back by the aid of eleven pairs of large, leaf-like appendages, which, as is well known, serve also for respiration, and are kept in rhythmic undulation. When occasion warrants they are able to propel themselves rapidly by strong jerks with their long tail, which is provided at the end with a pair of large feathered appendages. By the movement of the branchial feet a current of water is formed that flows from behind forwards between the two rows of feet, and in this way the food reaches the mouth.

The trunk or mesosome is somewhat broader than the cephalon, and is formed of eleven segments which are of subequal length and breadth. The tail, or metasome, is formed of nine segments,

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1 Twelfth Annual Report of U.S. Geol. and Geog. Survey for the year 1878, part i. (1883).

2 Arch. for Math. og Naturvid, Christiania, xvii., No. 2.

the first two (genital segments) are partly coalescent and bear on the ventral surface the two penes and ovisac of the respective sex, the remaining seven gradually become narrower hindwards. The cephalon is divided into an anterior part and a so-called cervical segment; the anterior part is broadest posteriorly, the stalked eyes are large and prominent, the ocellus, or simple eye, minute, the antennules long and filiform, and extending in the males to about the end of the basal joint of the claspers. In the females they are relatively slightly shorter.

The labrum, or anterior lip, is large and curves below, where it covers the lower part of the powerful mandibles. Viewed from below it is of the usual triangular shape, with the apex pointed hindwards.

The branchial limbs are borne by the eleven segments of the trunk, and gradually increase in size towards the middle, then gradually become smaller posteriorly. They are of normal form and size, the covering plates very large and their outer margins serrated, the gills much smaller and of ovoid shape, the exopodite broadly ovoidal, with outer margin almost straight, inner strongly and evenly curved from the proximal to the distal extremity. The distal lobe of endopodite (6th endite) is short and broad in average sized specimens (Fig. 7), in larger ones longer and proportionately narrower. The inner side is never produced beyond the level of the endites above, and the distal margin is distinctly excavated, most noticeable in the limbs of the middle area; inner margin more or less strongly curved (least so in matured forms), and evenly merged into the distal margin. There is no fundamental difference in the two sexes.

The terminal segment is short, and from it the caudal rami extend posteriorly and somewhat divergent, and are rather longer in the males than females; they are dorso-ventrally flattened, and taper gradually from the base to the narrowly rounded extremity, the lateral margins and end being fringed with long feathered setæ.

In mature females the ovisac is pear-shaped, with the apex elongated, but is subject to considerable differences of size and, in a lesser degree, shape. I have found ripe eggs in forms where its distal extremity only extended to slightly below the end of the third segment of the metasome (Fig. 1), and others, but larger forms, where it extended to the end of the sixth segment (Fig. 3), and in these the shape was more conical. The opening at the end of the ovisac is guarded by two somewhat protuberant lips, the dorsal one somewhat overlapping the ventral one. On the ventral surface in the mid axis, towards the anterior end, the wall of the ovisac projects to form a prominent and somewhat narrow ridge, or lip; this possibly is of use during copulation.

In males the testes (Fig. 4) of each side mostly lie near the surface in the first segment of the metasome, which is somewhat swollen, and this portion of them is very much coiled, and plainly to be seen from the outside. From this segment they extend into the third segment, but run further from the surface in a straight line on each side of the intestine, and are only to be seen on careful dissection. On this account it may be that Dr. Richters' description is due to a mistake, for he says that this species is peculiar to the genus in that the testes are only situated in the first segment of the tail.

The vas deferens of each side runs directly into the second segment, and protrudes outwards for a short distance; this portion, which I refer to in this paper as the sheath of the penis, is partly guarded by an angular projection of the wall of the segment. Several specimens were noticed with two long and comparatively stout cylindical processes, the penes, comparable to the cirri of some writers, which were bent outwards and hindwards in the form of a sickle (Figs. 5 and 6). These have the distal half of the surface facing inwards very rugose, while more proximally there are several stout spines. The outer surface has the distal half thickly studded with minute spines, and along the whole length of each side there is a longitudinal row of stout, acute, re-curved spines, with swollen bases, which increase in size proximally.

On dissecting a specimen in which the penes were not projecting outwards it was found that each were lying reflected backwards (introverted) within the lumen of their respective sheath, with the distal extremity extending to almost as far back as the testes. It is clear, therefore, that the contents of each testis are forced outwards by muscular contraction, and each penis becomes pushed outwards (everted) in consequence of the pressure of the seminal fluid behind, so that what was the innermost wall of the penis when lying within the lumen of the sheath becomes the outermost, and each penis becomes inflated with seminal fluid. When one or both of the penes enter the ovisac it would seem on structural grounds as if they were prevented from being withdrawn in consequence of the large recurved spines, and must perforce be left behind after copulation. I have, however, never found any remains of them in the ovisac bearing mature eggs. When once the penes are everted, there do not appear to be any muscles to enable them to be again introverted.

2. **Branchinella eyrensis**, sp. nov. (Pl. XXXI.).

Body of normal form, tail, exclusive of caudal rami, about one-fourth shorter than the cephalon and trunk combined. Caudal rami in the male as long as the four terminal segments combined. Frontal appendages very long and ribbon-like, extending much beyond the limit of the claspers, united proximally for about one-third of their length and bearing stout spines only. Claspers of normal form, second joint evenly curving inwards, of similar length to first joint, inner surface with very strongly marked transverse ridges. Second antennae of female apparently similar to those of B. australiensis (incomplete in my specimens).

Branchial feet with distal lobe of endopodite narrower and longer than in B. australiensis, those of the middle area in specimens of about 33 mm. in length, with the inner and outer margins converging to a narrow apex, which is emarginated in the middle. Gills subcircular in outline.

Ovisac without any projecting lip or ridge on ventral surface. Penes when everted from their sheaths of very great length, extending as far back as the penultimate tail segment, normally spinulose.

Length.—Male, exclusive of caudal rami, 33 mm.; female a little longer, but one specimen, locality unknown, fully 50 mm.

Distribution.—Water holes, Upper Onkaringa Creek, Central Australia (S.A. Museum, collected during Elder expedition, May, 1891). One female, Wintinorina, near Lake Eyre (collected by Mr. H. J. Grayson).

Remarks.—Five specimens were received, and all of about similar size. In general appearance they are very like B.

australiensis, but are conspicuously characterised in the male by the very much greater length of the frontal appendages and penes, and in the female by no lip existing on the ventral surface of the ovisac. The feet also of the middle area have the terminal lobe of the endopodite considerably narrower distally.

Genus 4—**Streptocephalus**, Baird, 1854.

Streptocephalus (?) archeri, G. O. Sars. Arch. for Math. og Naturvid, Christiania, xviii., No. 8, pp. 4-13, pl. 1.

This species was described from a single female specimen that had been raised from dried mud from a waterhole, salt at high tide, 20 miles from Rockhampton. On account of the sex its generic position is uncertain. The following is an abreviation of of Sars' description.

Female.—Body very slender, with the trunk about the length of the tail (excluding the caudal rami). Head exhibiting on the dorsal face a small, but well-defined, rounded quadrangular and somewhat elevated area. Eyes comparatively large. Antennulae narrow and elongated. Antennae about the length of the antennulae, applanted, foliaceous, not compressed, and having at the obtusely rounded tip a very short pointed projection. Legs apparently of the usual structure, outer part of endopodite broadly rounded, exopodite lamelliform, much smaller on the first than on the succeeding pairs, basal plate minutely and regularly serrated. Ovisac rather short and narrow, scarcely reaching beyond the second caudal segment; enclosed ova of a very peculiar shape, being each surrounded by a tetrahedric shell. Caudal rami very much elongated, being about half the length of tail proper, and rather narrow, tapering distally, and fringed all round with strong plumose setae. Body, in the living state of the animal, highly pellucid, nearly colourless, caudal rami, however, tinged with a vivid reddish-orange. Length of adult female, 9 mm.

Unrecognisable Species.

Chirocephalus, sp.

Mr. T. Whitelegge says in his list of Invertebrate Fauna (Journal Royal Soc. N.S.W., xxiii., 1889, p. 318) that there are three examples in the Australian Museum, which were collected from near Yass, N.S.W., that are distinct from the European species.

Tribe 2.—*Notostraca.*

Phyllopods with body more or less covered above by a broad vaulted carapace, which is united anteriorly with the head.

Family *Apodidae.*

Carapace broadly rounded in front, slightly vaulted and indented behind, with a distinct transverse cervical furrow defining the head posteriorly; the latter shovel-formed and exhibiting a crescent-shaped ventral duplicature, behind which the antennae and oval parts are situated. Hind part of the body projecting more or less behind the carapace, and divided into numerous segments, encircled by fine spikes. Caudal filaments very much elongated. Males very rare, considerably smaller than the females, and without special prehensile organs. (G. O. Sars, in part).

Remarks.—This family contains only two genera, which are closely allied, and have a world-wide distribution. Each is represented in Australia.

Synopsis of the Genera.

1. Last caudal segment not prolonged between the caudal filaments to a lamellar expansion.—Apus.
3. Last caudal segment bearing a lamellar expansion.—Lepidurus.

Genus 1—**Apus**, Schaeffer, 1756.

Apus australiensis, Spencer and Hall.

References.—Spencer and Hall, Victorian Naturalist, vol. xi. (1895), p. 161. Spencer and Hall, Report Horn Expedition to Central Australia, part ii., Zoology, pp. 231-234, pl. 20, figs. 1-3. Sars, Arch. for Math. og Naturvid, Christiania, xix., No. 1, pp. 5-12, pl. i. and ii.

Distribution.—West Australia, South Australia, inland area of New South Wales, and northern area of Victoria.

Genus 2—**Lepidurus**, Leach.

Lepidurus viridis, Baird.

1850. Lepidurus viridis, Baird. Proc. Zool. Soc. Lond., p. 254, fig. 1.
1866. Lepidurus angasii, Baird. Proc. Zool. Soc. Lond., p. 122, fig. 1.
1878. Lepidurus kirkii, G. M. Thomson. Trans. New Zealand Inst., xi., p. 260, pl. ii., fig. E4.
1878. Lepidurus compressus, G. M. Thomson. Trans. New Zealand Inst., xi., p. 260, pl. ii., fig. E5.
1879. Lepidurus viridulus, Tate. Proc. Royal Soc. South Australia, 1878-9, p. 136.
(?) 1894. Lepidurus angasii, G. O. Sars. Arch. Naturv., Christiania, xii., pt. 2, No. 7, pp. 4-13, pl. i., fig. 1-15.
1896. Lepidurus viridis, Spencer and Hall. Report Horn Expedition to Central Australia, pt. ii., Zoology, p. 233.

This species is by no means uncommon in rain-water pools in the neighbourhood of Melbourne, and also inland.

Distribution.—Inland and coastal areas of N.S.W.; northern and southern areas of Victoria; southern area of South Australia; Tasmania; and New Zealand.

Tribe 3—*Conchostraca.*

Characters.—Phyllopoda, with body surrounded by a large bivalved shell, so that the animal may be completely enclosed. Often bearing a striking resemblance to certain bivalved Mollusca.

Family 1—*Limnadiidae.*

Characters.—Shell generally compressed and furnished, in the full-grown animal, with a varying number of lines of growth. Head of medium size, and only slightly different in the two sexes.

Trunk elongated and very movable; caudal part well developed, curved downwards, forming posteriorly two juxtaposed dentated lamellae, and terminating in two movable claws. First pair of antennae more or less elongated, and generally lobed in one margin; second pair with slender rami, considerably longer than the scape. Masticatory part of the mandibles without distinct teeth. Legs numerous (16-28 pairs), with comparatively short endites; dorsal lobe of exopodite in the female elongated, in two or three of the middle pairs, into filiform appendages, supporting the egg-mass. (G. O. Sars).

Synopsis of Local Genera.

(A) *Head possessing a frontal clavate process* ("haft" or "affixing" organ). First two pairs of legs in male prehensile.

1. Shell much compressed, thin, ovoidal, pellucid, lines of growth inconspicuous, few; no trace of umbones. Animal not crowded within the shell; about 18 pairs of feet. Bisexual.—Eulimnadia.
2. Shell much compressed, parchment-like, dorsum possessing a longitudinal series of spiny processes; lines of growth conspicuous ridges; umbones minute. Feet numerous, 26-32 pairs.—Limnadopsis.
3. Shell compressed, rather thin, male differing very considerably from female in form; lines of growth inconspicuous, very numerous; umbones large and prominent. Otherwise like Eulimnadia. — Paralimnadia.

(B) *Head without a frontal appendage.* Shell with more or less prominent umbones.

4. Shell orbicular, thin, smooth, lines of growth few (about 7). Antennulae simple; only first pair of legs in male prehensile.—Cyclestheria.
5. Shell oval, more or less globose, generally brownish in colour, lines of growth conspicuous, numerous (about 10-20). Antennulae lobed. First two pairs of legs prehensile in the male.—Estheria.

Genus 1—**Eulimnadia**, Packard, 1874. (Pl. XXXIV., Figs. 1*a*, *b*, *c*).

1. **Eulimnadia dahli**, G. O. Sars.

Reference.—Arch. for Math. og Naturvid, Christiania, xviii., No. 8, pp. 14-30, pls. ii.-vi.

Specific Characters.—Shell in both sexes of same appearance, very thin and pellucid, without any trace of umbones; seen laterally, of a rather regular elliptical shape, with the height but little more than two-thirds of the length, dorsal margin evenly vaulted, and having its greatest convexity somewhat in front of the middle, ventral margin forming a perfectly even curve, and joining the anterior and posterior edges without any intervening angle, both extremities nearly equal, obtusely rounded at the tip, and having above a distinct angle; seen from above, narrow fusiform, the greatest width in front of the middle. Maximum number of lines of growth only four pairs. Head having in both sexes the frontal part considerably produced; rostrum in female very short and obtuse, being only defined in front by a slight sinus; that of male considerably more prominent, terminating in an acute point. Antennae and oral parts of the usual structure, excepting that the posterior maxillae are quite rudimentary. Legs, 20 pairs, having the epipodites of considerable size; the two anterior pairs in male very strong, subchelate. Tail with two short, juxtaposed dentiform projections in front of the caudal claws, the latter, throughout the greater part of their length, fringed posteriorly with long ciliated setae, caudal plates terminating below in a very acute, straight corner, and having the posterior edge divided into 12-16 small denticles; dorsal spines present only in a single distinctly developed pair.

Length of shell in female attaining 7 mm.; in male, 5.50 mm. (G. O. Sars).

Locality.—Neighbourhood of Port Darwin, Northern Australia (Sars); Charlotte Waters, Central Australia (collected by P. M. Byrne, Esq., March, 1896).

Remarks.—A considerable number of specimens that I have from Charlotte Waters are undoubtedly this species. They agree very closely with Sars' description and figures in all respects except in not possessing a rudimentary joint to the fifth endite of the fourth pair of legs in the male; also the shells of the female are frequently considerably more vaulted, but except for this, which appears to be a variable feature in other species of this genus, the shape is in exact agreement.

2. Eulimnadia sordida, King.

Limnadia sordida, King. Proc. Royal Soc. Van Diemen's Land, 1855, p. 70.

King gives no figure, and the only description is—"Branchial legs as in Limnadia stanleyana, 3rd finger of tridactyle feet, three-jointed; last segment of the body with 19 or 20 spines on each side. This species is larger than L. stanleyana, and bears considerable resemblance to L. mauritiana (Grevin)."

Locality.—Pond near Botany Bay, N.S.W. (King); Moore Park, near Sydney, N.S.W. (Whitelegge).

Remarks.—I am inclined to regard E. rivolensis, Brady, as a synonym of this species, but without examining specimens from the original locality it is impossible to say; it is certainly congeneric with it. The subapical process of the two first pairs of legs are three-jointed; also it agrees in the number of dorsal denticles of the tail.

3. Eulimnadia rivolensis, Brady. (Pl. XXXII.).

Brady, Proc. Zool. Soc. London, 1886, p. 87, fig. D.; Spencer and Hall, Report Horn Expedition, pt. ii., p. 238.

Description.—Shell greatly compressed, thin, smooth, and parchment-like, without any trace of umbones, lines of growth scarcely discernable without staining, comparatively numerous, crowded very closely together for a short distance at the margin (number about 6), afterwards abruptly much wider apart (about 5); none on the umbonal region nor for some distance surrounding it; all meeting closely together at the antero-dorsal angle. *Male* in lateral view rather narrowly ovoidal in fully matured specimens, but in younger ones shorter and relatively broader behind; back evenly arched, varying considerably in degree of convexity; greatest convexity a little in front of the middle; front deep and boldly rounded, curving a little beyond the end of the hinge without any definite angle, thence receding in a bold curve to join the ventral margin ; the latter almost straight, posteriorly ascending somewhat and merging into an evenly rounded tip. *Female* of similar shape, but with back more vaulted.

Head with rostral expansion in female short and generally acute at the tip, but sometimes obtuse like E. dahli ; in the male, compared with that species, very much longer, and not acutely, but bluntly, pointed.

Legs, 20 pairs. Male with two first pairs of legs subchelate, subapical appendage long, three-jointed ; hands in lateral view subquadrate, inner margin above the thumb-like projection with an angular prominence. Fourth leg not having a rudimentary joint to fifth endite as in E. dahli, remaining pairs as in the female, except that in the latter the ninth and tenth pairs have the proximal lobe of the exopodite with a long thread-like appendage. Tail long, with the two longitudinal dorsal ridges almost straight, each possessing very many (about 20) acute little denticles, also from 3-5 pairs in front of the anal setae only slightly larger than the others. Movable caudal claws evenly curved upwards, and not more than the proximal half bearing feathered setae ; in E. dahli they are much straighter, and the greater part of their length bears feathered setae.

Size.—♀, length about 9 mm., width variable ; ♂, rather less in length and proportionately narrower.

Distribution.—Neighbourhood of Rivoli Bay, South Australia (Brady) ; Upper Onkaringa Creek, Central Australia (S. and H.); Cheltenham, Southern Victoria ; and, if my supposition of its being synonymous with E. sordida, King, is correct, also New South Wales.

Remarks.—I have been enabled to examine specimens of this species collected from the same neighbourhood as the types came from, also a few specimens from Victoria. The latter agree in all respects with the former except that the shape of the shell posteriorly is deeper and more broadly rounded. As in other species of Eulimnadia males occur in much fewer numbers than females.

4. **Eulimnadia victoriensis**, sp. nov. (Pl. XXXIII.).

Description.—Shell smooth, very thin and translucent, much compressed, without any umbones ; lines of growth inconspicuous, maximum number four, meeting closely together at antero-dorsal angle. In male, seen from the side of oblong shape, back evenly arched, front deep, not produced in the least beyond the antero-dorsal angle, subtruncated, then receding in a bold even curve, and merging into the ventral margin; posterior considerably narrower than anterior margin, and merging into the ventral margin in a wide, even sweep. That of female agreeing with the male, except that the back is more vaulted, often very much more so, the width being sometimes fully three-quarters of the length; its greatest convexity a little in front of the middle.

Male with two first pairs of legs having hands rather slender, a little longer than broad, gradually widening distally, only a barely perceptible rounded prominence above the thumb on the inner margin; subapical appendage two-jointed, that of second not very much longer than in the first pair. Third legs with fifth endite short and broad, and its cylindric appendage rather short; exopodite comparatively long, and extending not far short of the extremity of the cylindric appendage. Fourth legs without any rudimentary joint on the fifth endite. Remaining pairs without any apparent difference from E. rivolensis. Each of the legs in the female also similar to that species. Rostrum of female short, generally acute, but sometimes obtuse; that of male varying in length, rarely so long as in E. rivolensis, and mostly more pointed. Tail-piece with dorsal plates fringed with about 16 subequal little denticles, and anterior to the setae generally three slender and relatively long curved ones, gradually increasing in length anteriorly. Caudal claws and terminal teeth of dorsal plates slender, the former with inner margin feathered for not more than half their length.

Length of largest female in my collection, 9.5 mm.; that of male, which are much fewer in numbers, 8.25.

Locality.—Elwood, southern area of Victoria.

Synopsis of Local Species.

Anterior and posterior edges of shell nearly equal, and narrowly rounded, lines of growth about four, not meeting closely together at the antero-dorsal angle; end of tail, below, at the articulation of caudal claws, with a pair of conspicuous acute processes; caudal claws almost straight, and feathered for most of their length. Male with rostrum short and acute; subapical cylindric appendage to hands two-jointed.—*dahli.*

Shape of shell rather like preceding species, although deeper and subtruncated in front, never produced in front of the anterior end of the hinge as in following species, back of female generally greatly vaulted; lines of growth about four, meeting closely together at antero-dorsal angle; caudal claws slender, feathered for not more than half their length.—*victoriensis.*

Shell in front produced in a broadly rounded curve somewhat beyond the level of the end of the hinge, never immediately receding therefrom; rostral expansion of male very long and usually bluntly rounded; subapical cylindric appendage of hands three-jointed.—*rivolensis.*

This species may be a synonym of *sordida.*

Genus 2—**Paralimnadia**, G. O. Sars.

This genus has been suggested by Sars for the following species, but so far is undefined by a description.

Paralimnadia stanleyana, King. (Pl. XXXIV., Fig. 2 *a*, *b*).

Limnadia stanleyana, King. Proc. Roy. Soc. Van Diemen's Land, 1855.

Limnadia stanleyana, King. Trans. Entom. Soc. N. S. Wales, vol. i., p. 162, pl. xi.

Limnadia stanleyana, Claus. Ueber den Körperbau einer australischen Limnadia und über das Männchen derselben. Zeitschr. f. wissensch. Zoologie, Bd. 22, 1872, p. 355, pl. xxix. and xxx.

Eulimnadia stanleyana, Sars. Arch. for Math. og Naturvid, Christiania, xvii., pt. 2, No. 7, pp. 16-28, pls. 2 and 3.

Paralimnadia stanleyana, Sars. *Id.*, xviii., No. 8, p. 15.

Specific Characters.—Shell much compressed, and, seen from the side, in fully grown females, subtriangular in form, umbones very prominent and occurring much nearer the anterior than posterior extremity, dorsal margin obliquely declining, ventral margin strongly curved in the middle, anterior extremity short, rounded, anterior rather produced and obtusely truncated at the tip; shell in young specimens more regularly oval or elliptical in form, with the umbones not at all projecting. Shell in adult male much narrower than in female, seen from the side, oblong oval in form, umbones not very prominent, dorsal margin nearly horizontal, posterior extremity broadly expanded. Valves rather thin, and provided in fully grown specimens with numerous lines of growth, in young ones, as usual, with a much smaller number of such lines. Head triangular, with the frontal part narrowly produced, and having the usual affixing organ; rostral expansion in female much shorter and blunter than in male, and in both sexes defined from the frontal part by an obtuseangular notch. Legs, 17 pairs in female, 18 pairs in male; epipodites, or gills, not particularly large. The two anterior pairs of legs in male subsimilar, prehensile; hand rather expanded, with a triangular projection inside; claw very strong, and tipped by a small sucking disk, thumb obtuse, densely clothed with curved spinules and carrying a small setous lobe, subapical appendage biarticulate. Tail with about ten denticles on each side.

Length of adult female 10 mm., of male 11 mm. (G. O. Sars).

Remarks.—Professor Sars refers with doubt as a synonym Estheria compressa, Baird, from India, and also says Eulimnadia sordida, King, from N.S.W., may be specifically identical. I think it more likely, however, as previously stated, that the latter agrees with E. rivolensis, which I have had an opportunity of examining and Sars had not.

Distribution.—Coogee, N. S. Wales (King); near Sydney (Sars); and, if Baird's Estheria compressa is really a synonym, also in India.

Genus 3—**Limnadopsis**, Spencer and Hall, 1896.

1. **Limnadopsis birchii** (Baird).

Estheria birchii, Baird. Proc. Zool. Soc. London, 1860, p. 392, pl. lxxii., fig. 1 *a-e*.

Limnadopsis squirei, Spencer and Hall. Report Horn Expedition, ii., p. 239, figs. 15-19.

Messrs. Spencer and Hall agree with me that their L. squirei is in specific agreement with Baird's Estheria birchii—which, however, is a normal Limnadopsis.

The species has been well described and figured by Spencer and Hall.

Distribution.—Namoi River, N. S. Wales, in error originally printed Wamoi River, South Australia (Baird); Alice Springs country between Oodnadatta and Charlotte Waters, Central Australia (S. and H).

2. **Limnadopsis tatei**, S. and H.

Reference.—Loc. cit., p. 241, figs. 20-27.

Distribution.—Between Oodnadatta and Charlotte Waters. Central Australia (S. and H.); Wintinorina, near Lake Eyre (collected by Mr. H. J. Grayson).

2. **Limnadopsis brunneus**, S. and H.

Reference.—Loc. cit., p. 243, figs. 28, 29.

Locality.—Near Port Darwin, Northern Territory of South Australia.

Synopsis of Species (partly after S. and H.)

1. Dorsum of shell well arched. Length over 20 mm. Legs, 32 pairs. Telson with dorsal spines numerous and about equal in size. Carapace very minutely pitted. Maximum number of ridges, 15.—*birchii.*
2. Dorsum generally straight. Length less than 15 mm. Legs, 26 pairs. Telson with dorsal spines few and very irregular in size. Maximum number of ridges, 13. —*tatei.*
3. Shape subequal to preceding, but dorsal spines regular and very small, Carapace pustulate. Ridges about 34. Colour, rich brown.—*brunneus.*

Genus 4—**Estheria**, Rüppell.

1. **Estheria packardi**, Brady. (Pl. XXXIV., Figs. 3 *a*, *b*, *c*).

Brady, Proc. Zool. Soc. London, 1886, p. 85, fig. C. Sars, Arch. for Math. og Naturvid, Christiania, xvii., pt. 2, No. 7, pp. 28-35, pl. 4, 5. Sars, Development from ova, *op. cit.*, xviii., No.

2, pp. 1-17, pls. 1-4. Spencer and Hall, Report Horn Expedition, Zoology, ii., p. 236, figs. 9-14.

Synonym ? E. boysii, Baird.

Specific Characters.—Shell tumid, seen from the side ovoidal, varying somewhat in shape, of firm consistency. Umbones well defined, occuring much nearer anterior than posterior end. Ridges numerous, varying in number in different varieties. Sculpture between ridges formed by more or less radiating lines. Dorsal tail-plates thickly fringed with small acute denticles. Segments of trunk dorsally with many spines. Distal dorsal limit of head always distinctly produced backwards as a lappet to overlie the following cervical segment. Scarcely swollen in front of eyes.

Distribution.—Lake Bonney, near River Murray, and Fowler's Bay, both in southern area of South Australia (Brady, typical variety). Common in waterholes along the Finke and its tributaries, also in the Macumba and Stevenson Rivers, Central Australia (S. and H., three varieties); Hay, N. S. Wales (Sars, typical variety). Typical variety common in many places in Northern and Southern Victoria; and if Sars is right in thinking E. boysii specifically identical, also India.

The following four varieties have been determined by Spencer and Hall:—

Estheria packardi, var. typica.

Length of adult shell about 9 mm. Spirit specimens dark brown. Ridges, about 24; sculpture, well defined radial straight lines, with their inner ends branching.

Estheria packardi, var. cancellata.

Shell more tumid than the preceding variety, but about similar in size. Ridges, 30-40, crowded towards the margin; sculpture strongly marked, towards the margin with the crowded ridges cancellated, and their inner edge moniliform.

Estheria packardi, var. minor.

Shell moderately tumid, smaller than above (about 4 mm.). Dorsum declining posteriorly behind the umbones. Umbones very prominent. Ridges very numerous (about 30), beset with long white setae; sculpture not so strongly marked as in the preceding variety and without any moniliform appearance.

2. **Estheria elliptica**, G. O. Sars. (Pl. XXXVI. Fig. B).

Arch. for Math. og Naturvid, Christiania, xix., No. 1, pp. 12-17, pl. 2.

Specific Characters, Female.—Shell, seen laterally, of a rather regularly elliptical form, anything but equilateral, the umbones placed far in front, dorsal margin behind the umbones nearly straight, and not angular behind, free edges of valves evenly curved throughout, both extremities being rounded and nearly equal, though the anterior one appears a little more obtuse than the posterior; seen from above, rather tumid, greatest width in front of the middle, posterior extremity more pointed than the anterior. Valves of rather firm consistency, with 14 very strongly marked and elevated, ridge-like, concentric lines of growth, each provided in their posterior part with short, stout bristles, surface between the lines finely and irregularly reticulate, marginal area rather broad, and furnished with numerous densely crowded concentric striae, which are not at all raised. Upper surface of head bent at nearly a right angle close to cervical impression, rostrum somewhat blunted at the tip. Number of legs, 22-23 pairs. Tail of usual shape, with a single pair of dentiform projections at the base dorsally, caudal plates produced beneath into strong unguiform processes, and each having along the dorsal edge numerous (from 20-30) denticles of unequal size, caudal claws slender, without any setae at the base, but having their outer part distinctly denticulated along the concave edge. Colour, dark reddish brown. Length of adult female scarcely exceeding 5 mm. (G. O. Sars).

Locality.—Near Roebuck Bay, West Australia (G. O. Sars).

3. **Estheria sarsii**, sp. nov. (Pl. XXXV., Figs. 1 *a–f*).

Description of Male.—Shell moderately tumid, of firm consistency, seen from the side ovoidal, umbones much nearer the anterior than posterior margin, very wide, and extending very much above the dorsal line. Dorsal hinge considerably longer than half the length of the shell, terminating posteriorly in a distinct obtuse angle, thence declining obliquely hindwards, and later merging into ventral margin in a narrow curve. Front deep, leaving dorsal line without any angle, thence forming a regular broad curve, set vertically. Ventral margin evenly convex. Lines of growth, about ten ridges, each fringed with short, thick bristles ; sculpture reticulate near the margin, becoming irregularly hexagonal more distally.

The animal is crowded within the shell, and quite normal to the genus. It is characterised by a very prominent rounded area in front of the confluent eyes, and the upper posterior limit of the head segment projects backwards a little, but not nearly so marked as in E. packardi.

The branchial feet, compared with E. packardi, are considerably broader, and the stylet produced from the fifth endite (calling the coxal lobe the first) is only one—not two—jointed. The hands of the two first pairs of legs are subquadrate, being wider proximally than E. packardi ; the margin of the outer side is almost straight, the inner straight for half its distance, when it is abruptly cut inwards, forming a right-angled projection. This marks the origin of the thumb, which is half the length of the hand, and is directed directly downwards, not deflected outwards as in E. packardi ; also in that species the inner margin gradually widens from the proximal to the distal end, unbroken by any angular projection.

The last few segments of the trunk have no spines, or only minute ones, but more anteriorly they have a transverse series of slender ones gradually increasing in size and number (about 10), but these are not set on such prominent elevated projections, nor are they quite so numerous, as in E. packardi.

The tail segment is short and deeply concave above ; in front of the anal setae there is a single pair of short, straight denticles, broad at the base and acutely pointed. The paired ridges bear but a few very small irregularly set denticles, and terminate in a stout upturned and curved one of normal size, that of each plate being, as is usual in the genus, deflected at different angles. The movable claws are comparatively short, and the inner margins clothed with feathered setae for about half their length.

Size.—Length of shell, 8 mm.; depth, 5 mm.

Locality.—Lake Aurean, Murchison, West Australia, in association with Artemia westraliensis (collected by J. T. Markes, Esq., January, 1896).

Remarks.—I have but one example of this species, a male. It differs materially from E. elliptica, another West Australian species (of which only the female has been described), in the shape of the shell, and, although of much larger size, in a rather less number of ridges, also by not possessing the numerous secondary lines of growth near the outer margins. It is named in compliment to Professor G. O. Sars, the renowned carcinologist.

4. **Estheria lutraria**, Brady. (Pl. XXXV., Fig. 2 *a–e*).

Brady, Proc. Zool. Soc. London, 1885, p. 85, fig. B; Spencer and Hall, Report Horn Expedition, Zoology, ii., p. 234, figs. 4, 5.

Shell very large, reaching 14 mm. in length, and moderately tumid. Dorsum straight for almost its total length, abruptly curving into posterior margin without any angle, thence obliquely receding anteriorly. Umbones small, narrowly pointed, and very near the anterior limit. Front broadly and evenly rounded, meeting the dorsum in an obtuse angle. Ridges equidistant, 12-16, sometimes with fine bristles, sculpture between irregularly reticulate. Mature forms with tail very short, dorsal lamellae deeply concave (younger forms longer and not so concave), denticles small, few (about 5), one pair in front of anal setae straight and comparatively short, caudal claws thickly clothed on inner margin for half their distance with feathered setae. Dorsum of last few trunk segments without spines, or sometimes very minute ones. Distal dorsal limit of head meeting the hind margin in a right angle. Eyes confluent, area in front conspicuously swollen. Third pair of legs in male with fourth endite having the lower angle produced downwards as a definite little finger-like process tipped with a few setae; articulated stylet of fifth endite one-jointed.

Length of largest shell seen by me, 14 mm.

Distribution.—Innamincka, Central Australia (Brady); valley of Stevenson River, and head of the Anna Creek, Central Australia (S. and H).

5. **Estheria dictyon**, S. and H. (Pl. XXXVI., Fig. A).

Report Horn Expedition, Zoology, ii., p. 236, figs. 6-8.

Shell much smaller (about 8 mm.) than E. lutraria, more compressed, of a thinner consistency, but quite similar in lateral outline to E. lutraria. Ridges equidistant (about 10), bearing stout bristles, sculpture forming irregularly hexagonal spaces. Dorsal plates bearing about eight long, slender denticles, anterior pair in front of anal setae very long, slender, and curved hindwards. Dorsum of last few segments of trunk each with a stout spine, more anteriorly with four transversely set ones; caudal claws unclothed, or bearing but few feathered setae. Head agreeing with E. lutraria, but eyes not confluent, separated by a narrow line.

Locality.—Palm Creek, in the James Range, Central Australia (S. and H).

Remarks.—I am inclined to regard this as but a young form of E. lutraria; the specimens I have are rather macerated, and scarcely well enough preserved to allow of the dissection of the animal; also there are no males for comparison.

Synopsis of Local Species.

1. Shell more or less tumid, umbones well defined and placed far in front; ridges comparatively very many, sculpture, radiating lines variously formed. Upper distal extremity of head produced to a distinct linguiform projection overlying the distal part of cervical segment. Dorsal denticles of tail-piece small, very numerous, and unequal in size.—*packardi.*
2. Shell seen laterally of a rather regular elliptical form, ridges about 14 in number and near the margin many secondary lines of growth. sculpture irregularly reticulate. Upper distal extremity of head, seen laterally, bent at nearly a right angle; rather prominent in front of eye; tail similar in shape and armature to previous species, caudal claws rather slender, without any feathered setae at the base, their outer part distinctly denticulated.—*elliptica.*

3. Dorsal line terminating posteriorly in a distinct angle, margin thence declining obliquely; front deep and boldly curved, umbones very large and prominent, ridges about 12, equidistant; sculpture reticulate near the margin, becoming irregularly hexagonal more distally. Head in lateral view with upper distal extremity produced hindwards a little, forming an acute angle with the apex rounded off; very prominent in front of eyes. Tail possessing very few irregularly placed little denticles.—*sarsii.*
4. Shell large, long, and tumid, back straight for almost its total length, umbones very small and quite near the anterior limit, ridges equidistant, 12-16, sculpture irregularly reticulate. Head in lateral view sharply bent at a right angle and projecting considerably beyond the level of the cervical segment; a little prominent in front of the confluent eyes. Tail-piece with dorsal denticles small, few (about 5), only one comparatively short pair in front of anal setae.—*lutraria.*
5. Lateral outline of shell quite similar to above, but more compressed, of thinner consistency and smaller size: ridges equidistant, about 10, sculpture well defined irregularly hexagonal spaces. Eyes separated by a narrow space. Tail-piece bearing about eight long slender denticles, one pair in front of anal setae very long, slender, curved hindwards. Caudal claws with none or very few feathered setae at the base.—*dictyon.*

Genus—**Cyclestheria**, G. O. Sars, 1887.

Cyclestheria hislopi (Baird). (Pl. XXXVI., Fig. C 1, 2).

Estheria hislopi, Baird. Proc. Roy. Soc. London, xxlvii. (1859), pl. lxiii., fig. 1.

Limnadia hislopi, Brady. Journal Linn. Soc., xix., p. 294, pl. xxxvii., figs. 1-3.

Cyclestheria hislopi, Sars. Vid. Selsk. For., Christiania, 1888, No. 1, pp. 6-60, pls. i-viii.

Shell somewhat tumid, with the valves rather thin and pellucid, irregularly rounded, dorsal line in adult females very strongly curved and sometimes almost angular in the middle, umbones close to the anterior extremity, rather prominent lines of growth, in adult specimens, 6-7. Cephalic crest evenly curved dorsally, rostral part obtusely rounded and finely serrated above. Ocellus nearly as large as eye. Antennae with both branches seven-jointed, scape provided at the end above with two or three expansions, densely supplied with recurved spines. Caudal plate with 7-8 pairs of dorsal spines, besides the slender terminal claws, last pair largest, and armed at base with a row of about 10 small secondary denticles. Colour, clear yellowish or corneous, more or less tinged with green.

Size.—Length of shell in adult ♀ attaining 5 mm., height nearly the same. (Sars).

Distribution.—Near Rockhampton, Queensland (Sars); Nagpur, India (Baird); Ceylon (Brady); Celebes, East Africa, Brazil (Sars).

Family 2—*Lynceidae.*[1]

Characters.—Shell very tumid; the valves without lines of growth, and connected dorsally by an imperfect hinge. Head of enormous size, ending in a downward-curved rostrum of a different form in the two sexes. Trunk comparatively short and massive; tail rudimentary. Number of legs not exceeding 12 pairs, only the first pair in the male prehensile. (Abbreviated from Sars).

Genus—**Lynceus**, Müller, 1785.

Syn.—Limnetis, Loven; Hedessa, Lièvin.

Generic Characters.—Shell more or less spherical, smooth, and without distinct umbones. Head carinated medially, and produced in the female to a more or less pointed rostrum, in the male to one abruptly truncated; at the sides of the head a well-developed arcuate fornix. Caudal part very small, not bent downwards, and without dentated lamellae, but covered beneath by an opercular lamella. Twelve pairs of legs in the female, in the male ten. (Abbreviated from Sars).

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1 I have followed the Rev. T. R. R. Stebbing, who, by the law of priority, restores the genus Lynceus in place of Limnetis.—The Zoologist, Mar., 1902.

1. Lynceus macleayana (King). (Pl. XXXVI., Fig. D 1, 2, 3).

Limnetis macleayana, King, Proc. Roy. Soc. Van Diemen's Land, 1855, p. 70. Trans. Ent. Soc. N. S. Wales, vol. i., p. 161, pl. xi. Sars, Archiv. for Math. og Naturvid, Christiania, xvii., No. 2, pp. 35-43, pls. 6-7.

I have collected this species from swamps at Elwood, Southern Victoria, and have also identified it in a collection of Entomostraca received from Mr. C. Gabriel from St. Arnaud, Northern Victoria. The specimens are without any differences either in form or size from Professor Sars' very careful drawings and descriptions. King's specimens came from near Sydney, and those of Sars' from Hay, N. S. Wales.

Length of adult female, 7 mm.; male about the same.

2. Lynceus tatei (Brady). (Pl. XXXVI., Fig. E, 1, 2, 3).

Limnetis tatei, Brady, Proc. Zool. Soc. London, 1886, p. 84. Sars, Archiv. for Math. og Naturvid, Christiania xvii., No. 2, pp. 43-46, pl. 8.

Specimens collected by me at Rosstown and Elwood, Southern Victoria, differ in no fundamental features from Sars' description, but many were much larger, the females reaching the length of 6.3 mm. and males 5.75 mm.

Brady's specimens came from near Rivoli Bay, South Australia, and Sars' from near Sydney, New South Wales.

3. Lynceus eremia (S. and H). (Pl. XXXVI., Fig. F, 1, 2, 3).

Limnetis eremia, Report Horn Expedition, Central Australia, pt. ii., 1896, p. 244, figs. 30, 31, 32.

Locality.—Cooper's Creek, Central Australia (S. and H.).

Synopsis of Local Species.

1. Shell very tumid, nearly globose, seen from the side somewhat irregularly rounded, greatest height not nearly attaining the length and occurring in front of the

middle, dorsal margin boldly curved anteriorly, almost straight and obliquely declining behind, ventral margin evenly curved and passing into the anterior and posterior edge without any intervening angle, anterior extremity broader than the posterior. Female with rostral expansion in front view very broad, obtusely rounded at the extremity, without any lateral projections; that in the male transversely truncated, lateral corners scarcely produced.—*macleayana*.

2. Shell less tumid than preceding species, in lateral view subcircular, nearly as high as it is long, dorsal margin sloping rather steeply behind, anterior extremity very broad and blunted, posterior narrow and rounded. Rostral expansion in female much produced, frontal view, narrow linguiform, with a distinct notch on each side of the obtusely rounded tip; in the male with distal lateral edges projecting beyond the apical face.—*tatei*.
3. Form of shell resembling the preceding one, but with posterior extremity much more narrowly rounded. Rostral expansion in both sexes shorter and more constricted in the middle than either of the former species; that of the female notched on each side near the apex; in the male rapidly expanding distally, lateral edges not projecting beyond the face.—*eremia*.

TERMINOLOGY AND EXPLANATION OF PLATES, XXVII.-XXXVI.

Divisions of Body:

C. Cephalon (1. Head segment. 2. Cervical Segment).
Ms. Mesosome or Trunk. T Metasome or Tail.

Appendages of Cephalon:

A^1 Antennulae or first antennae. A^2. Antennae or second antennae. F.A. Frontal appendages of Branchipodidae.

H. Affixing on Haft organ of certain Limnadiidae. Lp. Lip. M. Mandibles. M^1 M^2 First and second Maxillae. (Eyes and ocellus).

Appendages of Mesosome :

L. Branchial legs with respective number added. (C.P. Covering-plate. G. gill. E. exopodite. En^1—En^6. endites).

Appendages of Metasome :

C.R. Caudal rami and Caudal claws. In Branchipodidae the two first segments (genital segments) bearing Ov. ovary, or P. penes, in respective sex. E. egg.

Plate XXVII.

Artemia australis ♀.

Plate XXVIII.

A. Artemia westraliensis ♀. B. Parartemia zietziana ♀.

Plate XXIX.

Parartemia zietziana ♂.

Plate XXX.

Branchinella australiensis (Richters). 1. Small ovigerous female, side view. 1*a*. Extremity of second antennae. 2. Head and appendages of male. 2*b*. Armature of inner surface of first joint of claspers. 2*a*. Right hand branch of frontal appendage. 3. Portion of tail showing ovary of large sized female. 4. Portion of tail of male showing internal generative organs of one side, with sheath of penis protruding outwards. 5. Similar to preceding but with the two penes everted from their sheaths. 6. Penis of left side more highly magnified. 7. Fifth branchial leg of small sized male.

Plate XXXI.

Branchinella eyrensis.

PLATE XXXII.

Eulimnadia rivolensis.

PLATE XXXIII.

Eulimnadia victoriensis.

PLATE XXXIV.

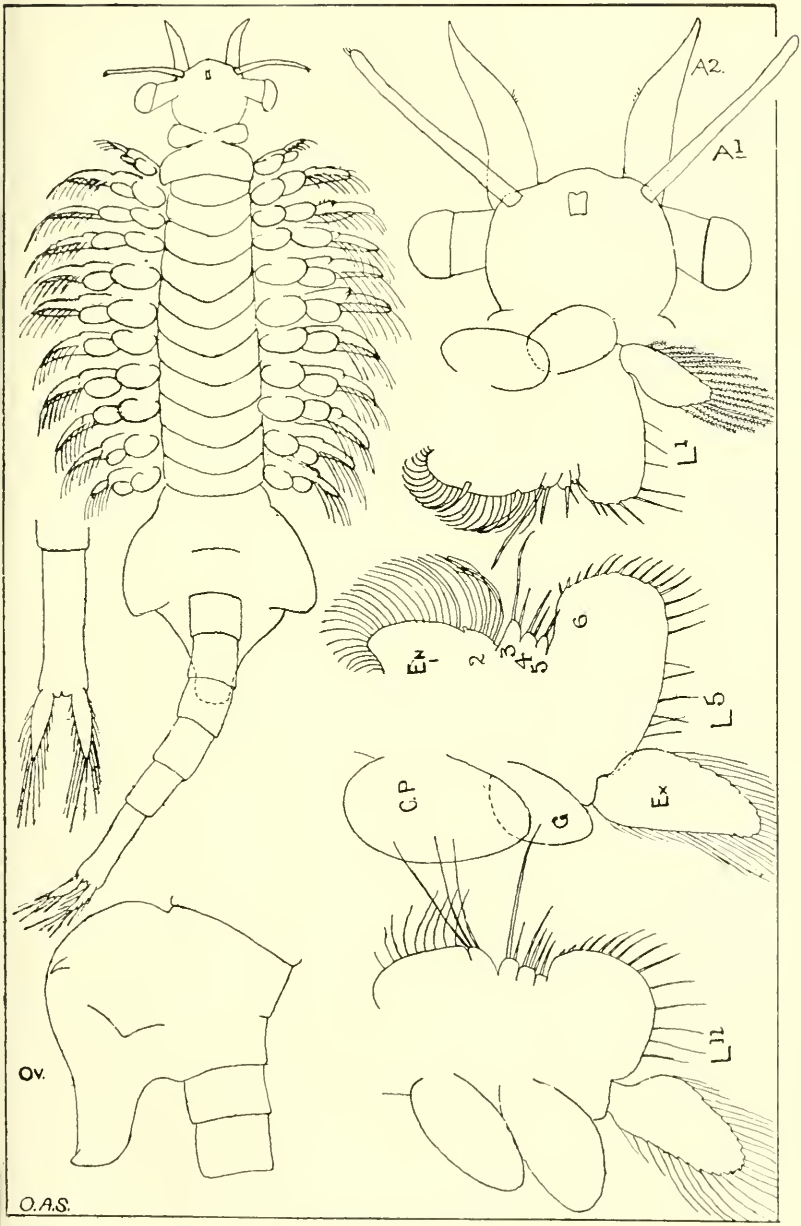
1. Eulimnadia dahli, after Sars. 2. Paralimnadia stanleyana, after Sars. 3. Estheria packardi.

PLATE XXXV.

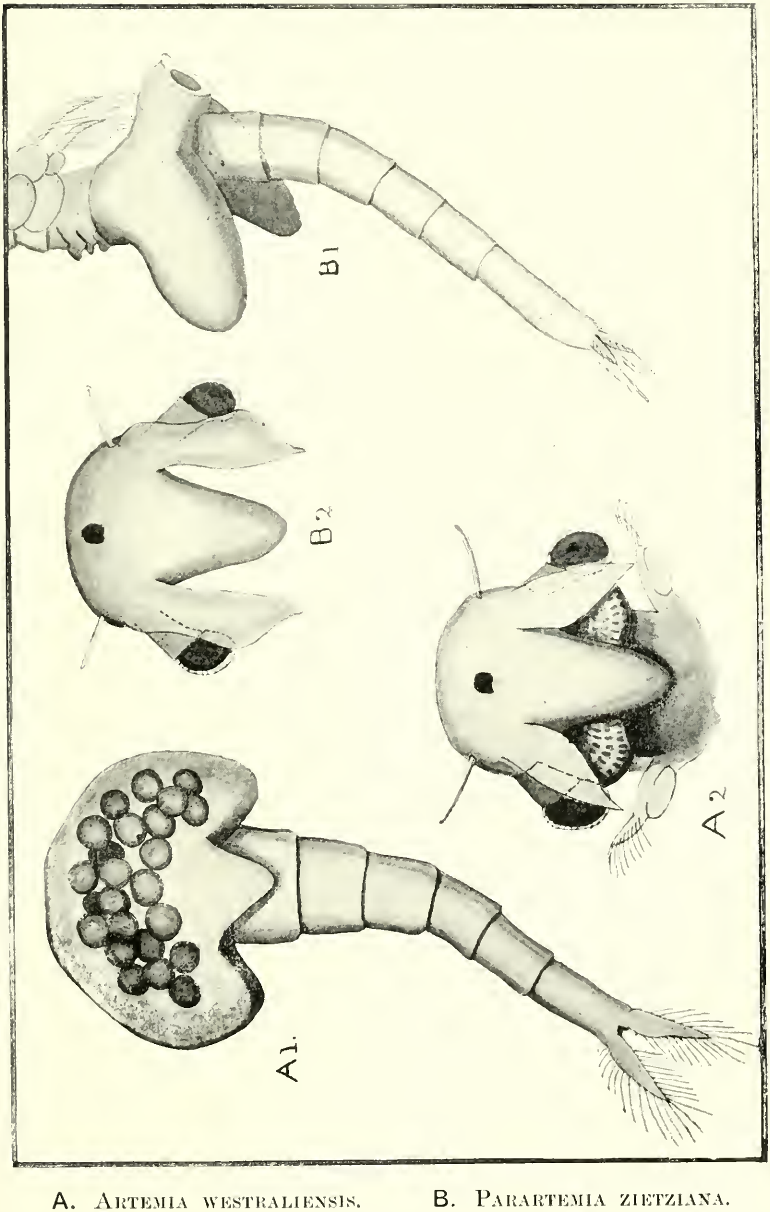
1. Estheria sarsii. 2. Estheria lutraria.

PLATE XXXVI.

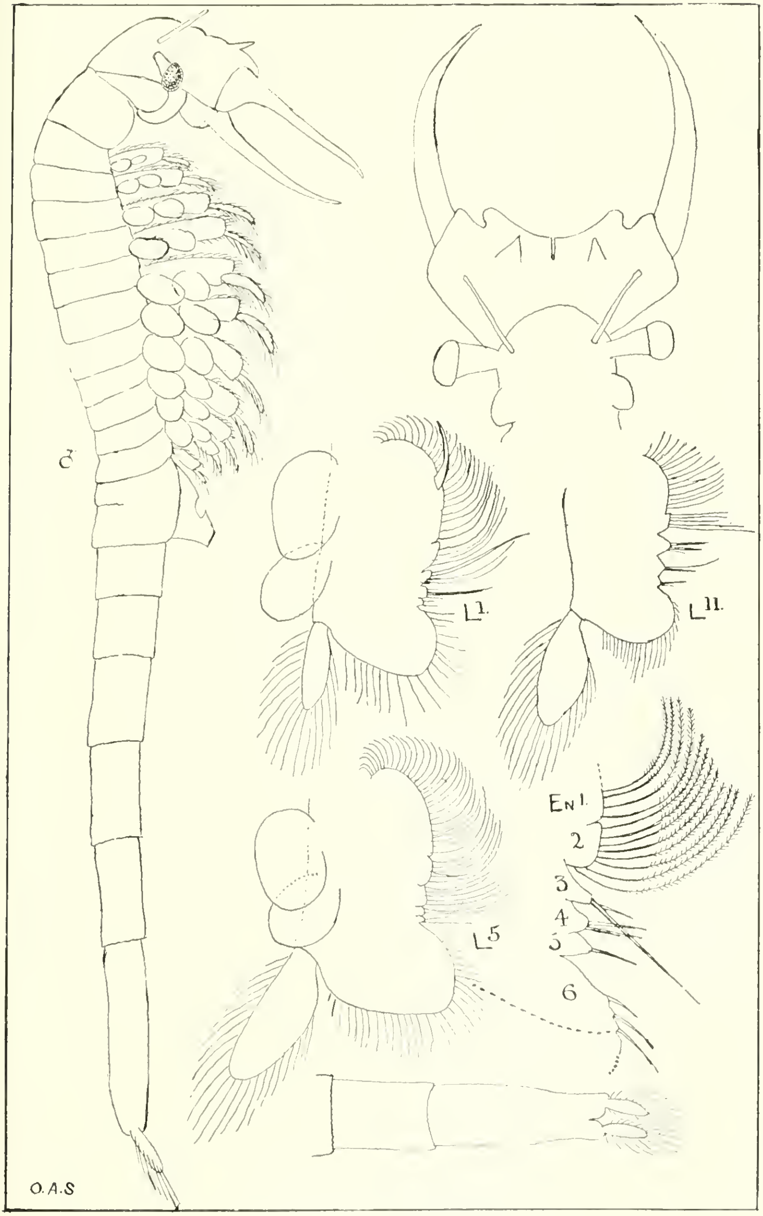
A. Tail-piece of Estheria dictyon. B. Estheria elliptica. C. Cyclestheria hislopi. D. Lynceus macleayana, lateral view of shell, and front view of head of male and female. E. Lynceus tatei. F. Lynceus eremia. (B, C, D and E drawn after Sars, F after Spencer and Hall).



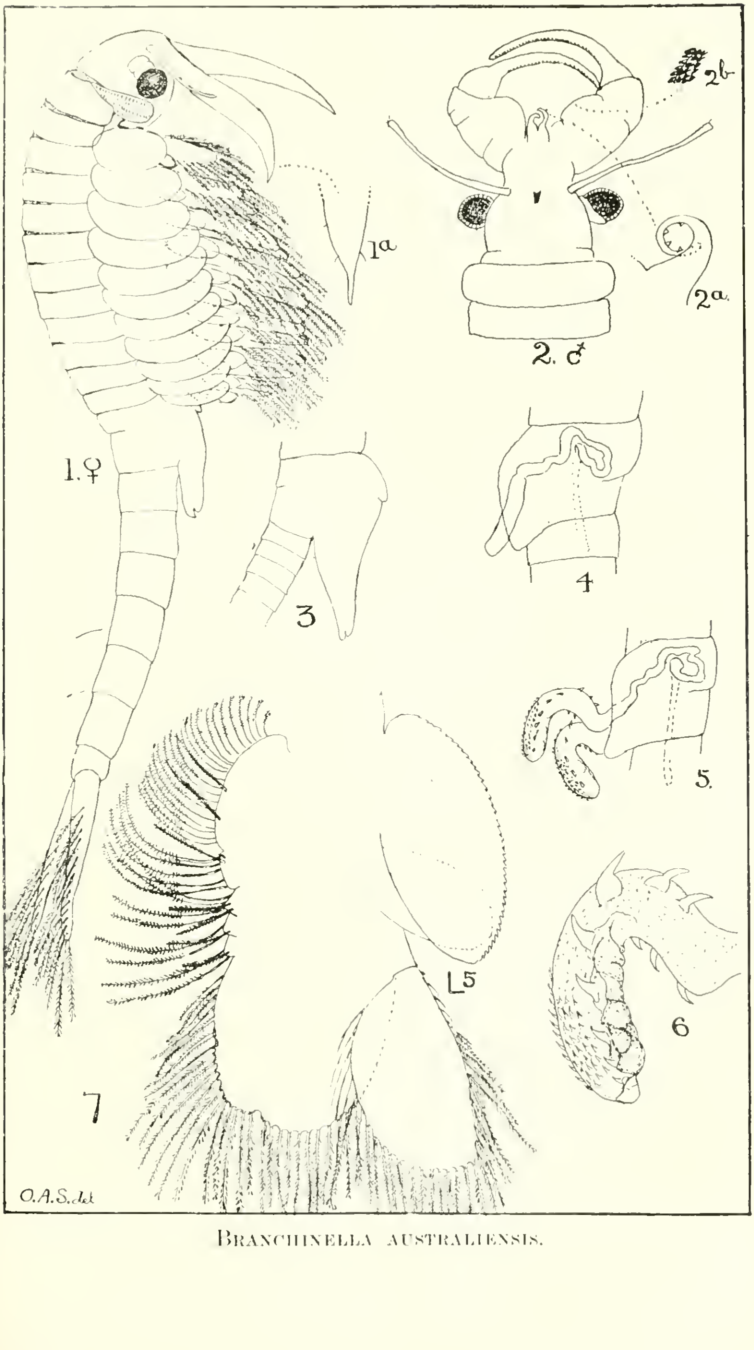
ARTEMIA AUSTRALIS ♀.



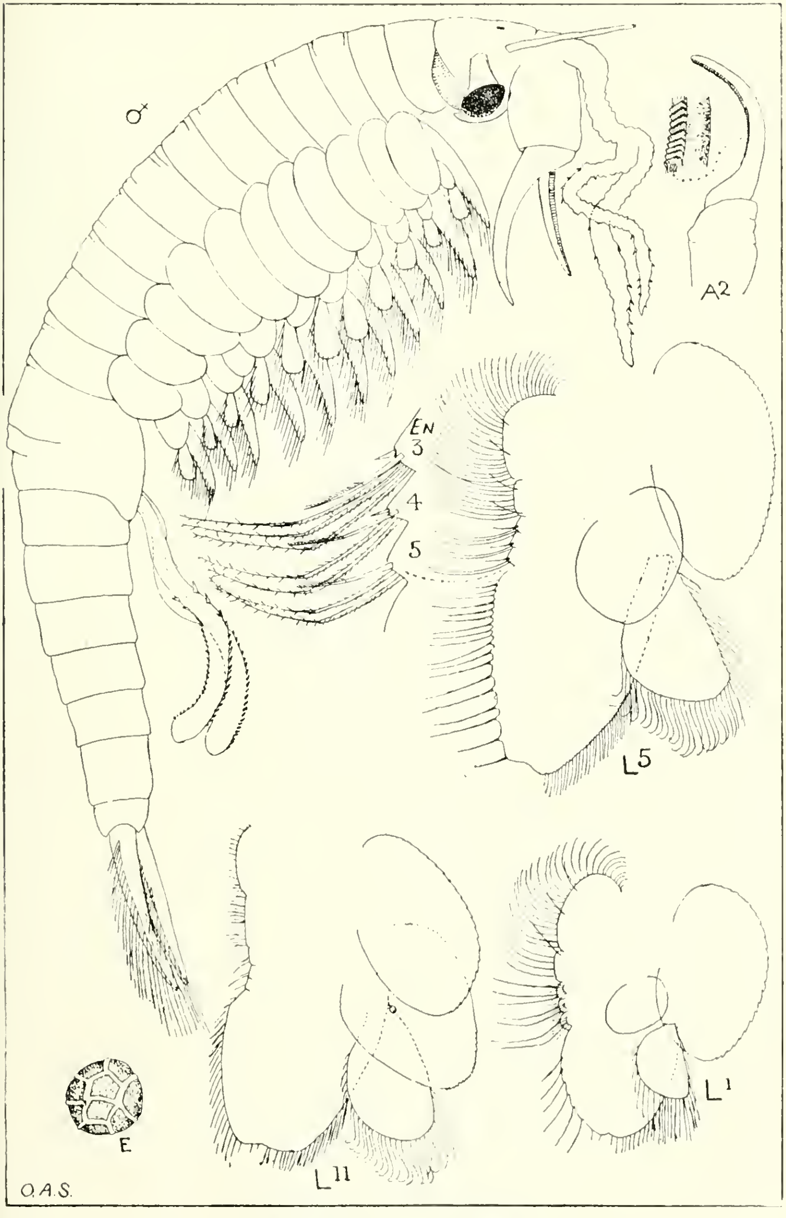
A. Artemia westraliensis. B. Parartemia zietziana.



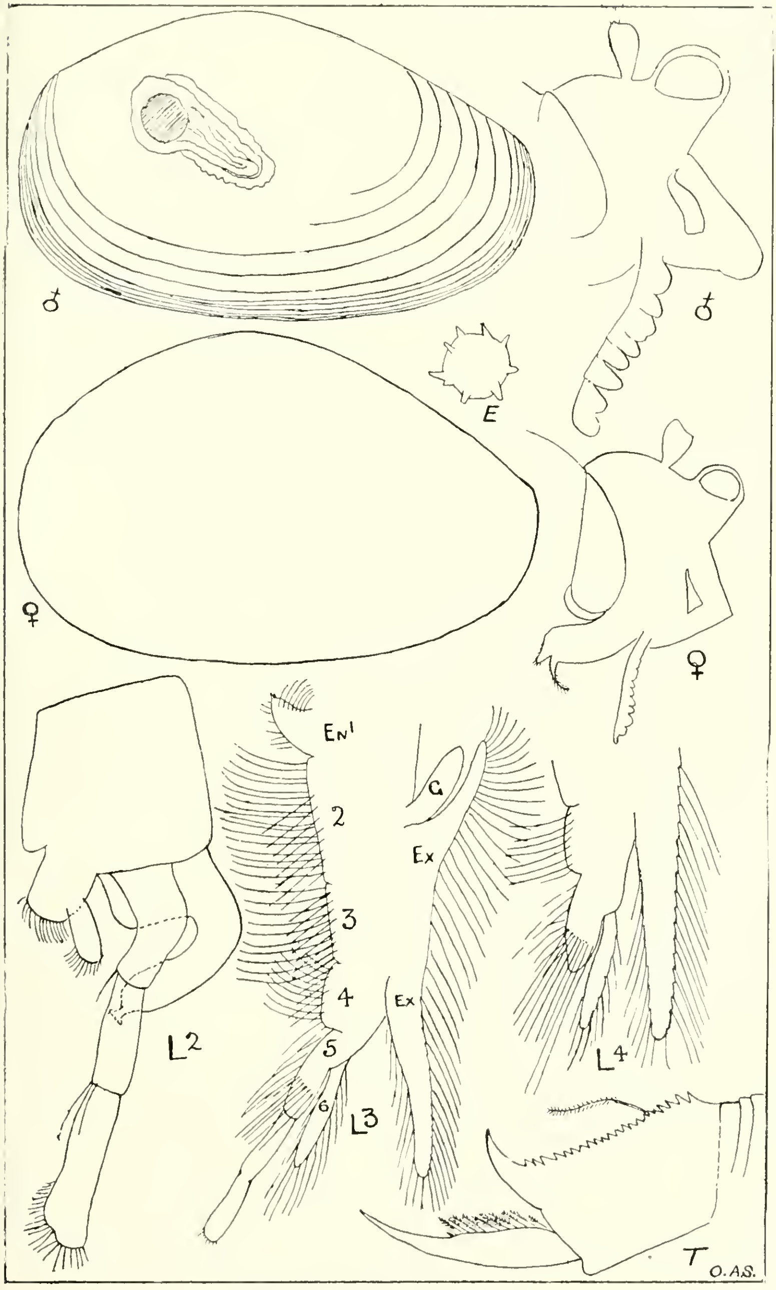
Parartemia zietziana ♂.



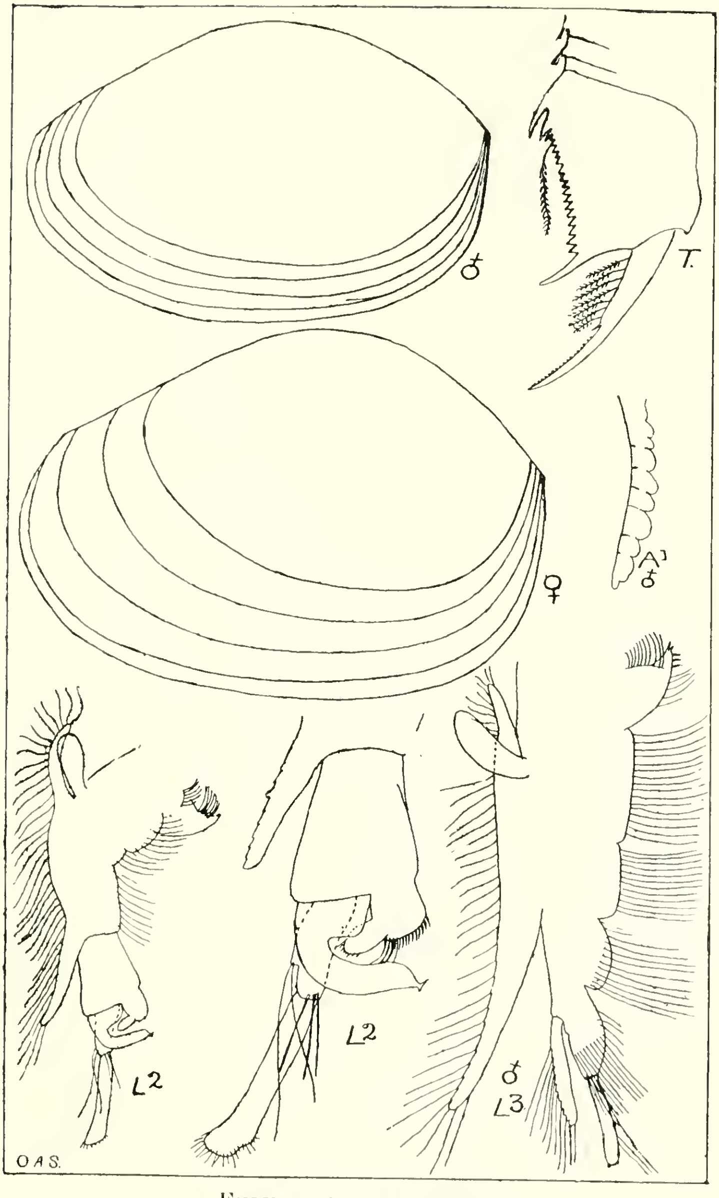
BRANCHINELLA AUSTRALIENSIS.



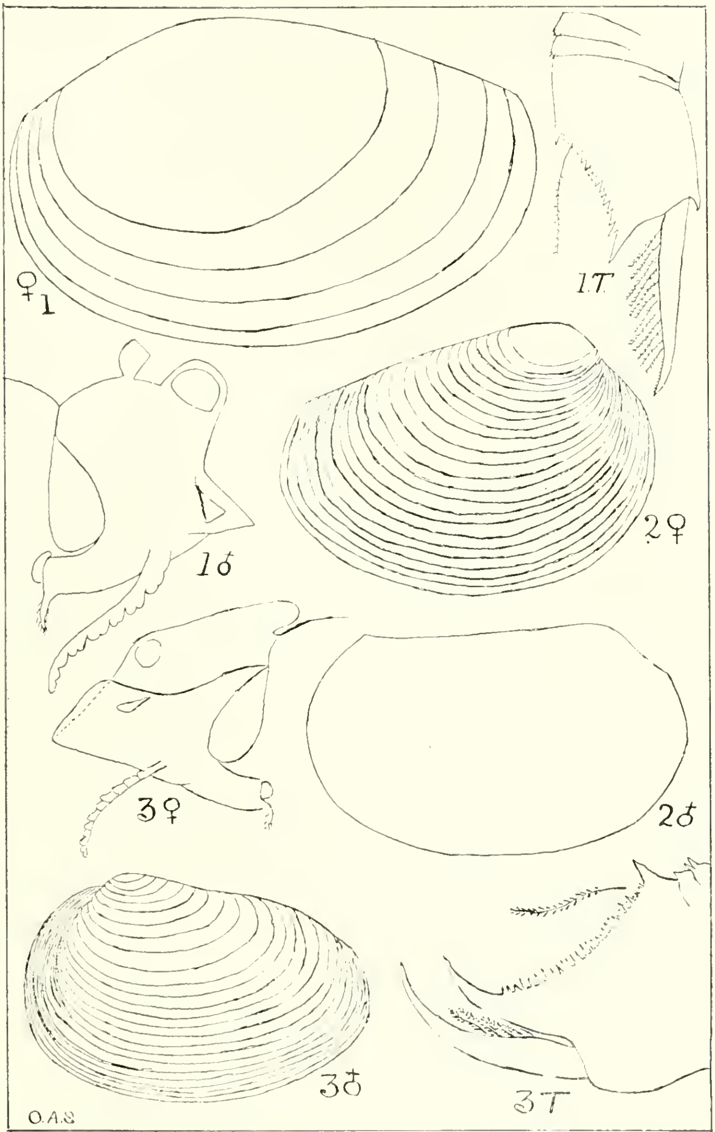
BRANCHINELLA EYRENSIS.



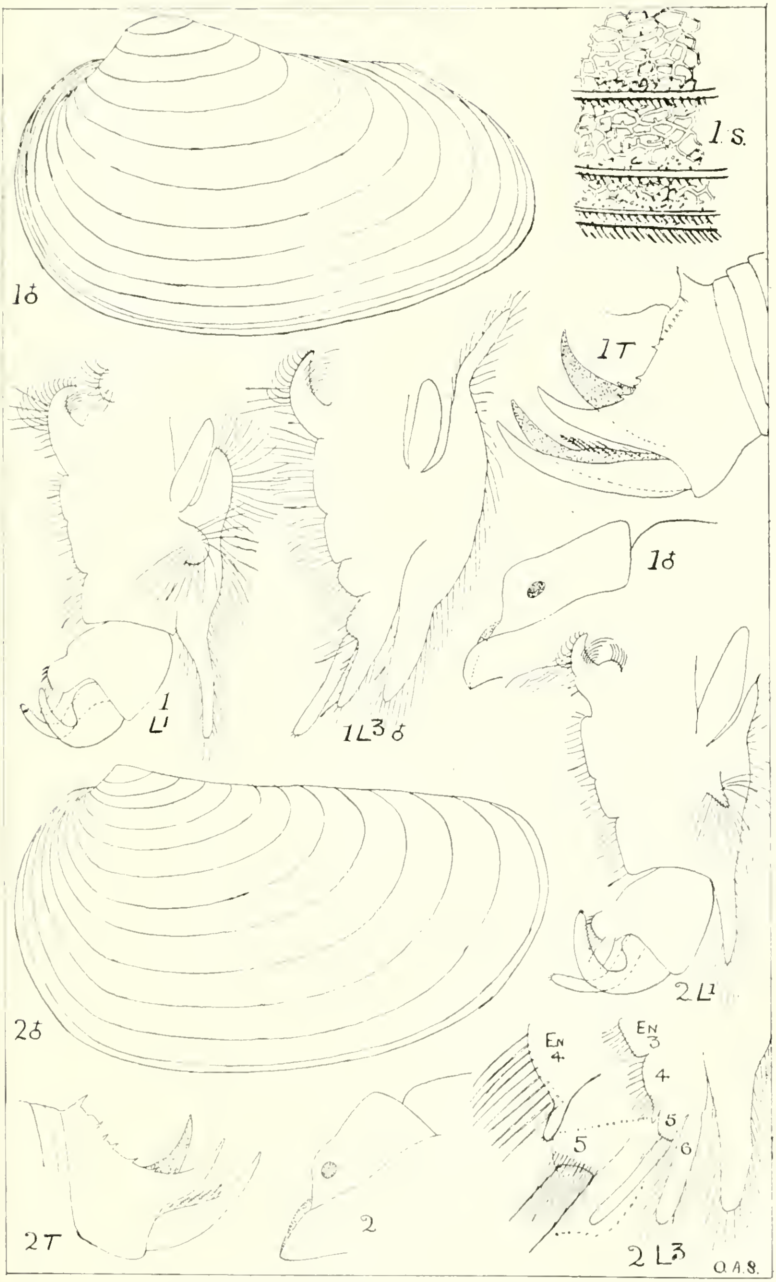
EULIMNADIA RIVOLENSIS.



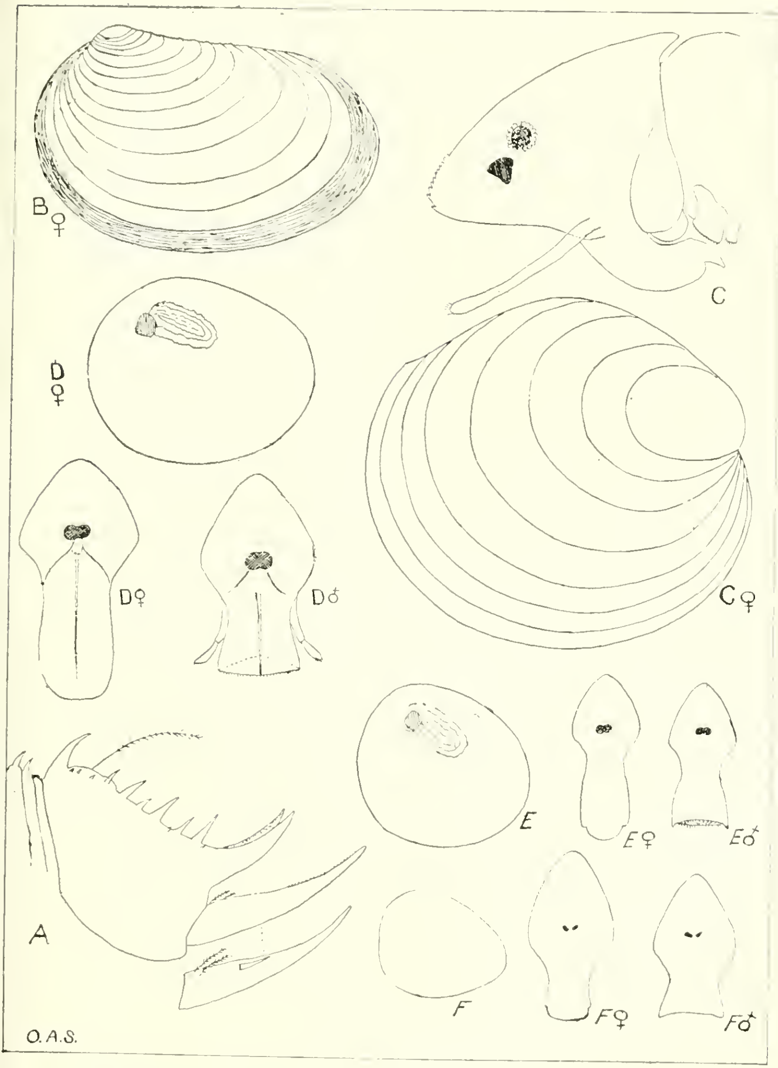
EULIMNADIA VICTORIENSIS.



1. Eulimnadia dahli. 2. Paralimnadia stanleyana.
3. Estheria packardi.



1. Estheria sarsii. 2. E. lutraria.



A. Estheria dictyon.
B. E. elliptica.
C. Cyclestheria hislopi.
D. Lynceus macleayana.
E. L. tatei.
F. L. eremia.

ANNUAL REPORT OF THE COUNCIL

FOR THE YEAR 1901.

The Council of the Royal Society herewith presents to the Members of the Society the Annual Report and Balance Sheet for the year 1901.

The following Meetings were held:—

March 14.—*Paper read:* "On the Formation of the Coal Seams of Gippsland," by W. H. Ferguson.

April 11.—Dr. W. R. Fox delivered a Lectnre with Experiments, entitled "The Influence of the X-Rays on the Development of Induction Apparatus."

May 16.—*Papers:* 1. "A Revision of the Genus Gymnorhina," by Robt. Hall. 2. "Some Geological Sections on the Mornington Peninsula," by T. S. Hall and G. B. Pritchard. 3. "Contributions to the Palaeontology of the Older Tertiary of Victoria, Lamellibranchs, Part II.," by G. B. Pritchard.

June 13.—*Papers:* 1. "Further Notes on the Igneous Rocks of South-western Victoria," by J. Dennant, F.G.S. 2. "Growth Stages in Modern Trigonias belonging to the section Pectinatae," by T. S. Hall, M.A. *Exhibits:* A series of Skins of species of the Genus Gymnorhina, by R. Hall.

July 11.—*Papers:* 1. "The Geology of Mount Macedon," by Professor J. W. Gregory, D.Sc., F.R.S. 2. "Some Remains of an Extinct Kangaroo in the Dune Rock of the Sorrento Peninsula," by Professor J. W. Gregory, D.Sc., F.R.S. *Exhibits:* A series of Typical Minerals from Mount Lyell, by E. G. Hogg, M.A. The series was explained by H. C. Jenkins, A.R.S.M.

August 8.—*Paper:* "Some little-known Victorian Decapod Crustacea, with Descriptions of a New Species," by S. W. Fulton and F. E. Grant. Professor W. C. Kernot exhibited and described Elliott's Simplex Steam Engine Indicator. Mr. P. de J. Grut showed a set of "Napier's Bones." Mr. P. Baracchi showed the Gravity Pendulums constructed for use on the Antarctic Expedition.

September 12.—*Papers:* 1. "Remarks on Nipher's Reversed Photography," by Professor T. R. Lyle, M.A. 2. "Further Descriptions of Tertiary Polyzoa of Victoria, Part VII.," by C. M. Maplestone. *Exhibits:* A large series of Tasmanian Rocks, by A. E. Kitson, F.G.S.

October 10.—*Papers:* 1. "A Suggested Nomenclature for the Tertiaries of Southern Australia," by T. S. Hall and G. B. Pritchard. 2. "Newer Pliocene Strata in the Moorabool Valley," by J. F. Mulder. Mr. C. W. G. Officer exhibited and described a large series of ethnological specimens collected by himself on the Solomon Islands.

November 14.—*Papers:* 1. "Catalogue of Victorian Mollusca, Part V.," by G. B. Pritchard and J. H. Gatliff. 2. "A New Genus of the Phreatoicidae," by O. A. Sayce. The Secretary read a note on the Society's Library, discussing its contents and its needs. Mr. H. K. Rusden described a peculiar rainbow.

December 12.—*Papers:* 1. "Some electrical effects produced by various interruptions when used with a Rhumkorff's Coil: (*a*) The Motor interruptor, (*b*) The Wehnelt interruptor, (*c*) The Caldwell interruptor," by Dr. W. R. Fox. The paper was illustrated by a large series of experiments. 2. "The Fossil Contents of the Eocene Clays of the Altona Coal Shaft," by E. O. Thiele and F. E. Grant. 3. "On Some New Species of Victorian Mollusca, Part V.," by G. B. Pritchard and J. H. Gatliff. 4. "Geological Observations on Mount Mary and the Lower Werribee Valley," by A. E. Kitson, F.G.S. 5. "Some Features of the Ordovician Rocks at Daylesford, with a comparison with similar occurrences elsewhere," by T. S. Hart, M.A., B.C.E. *Exhibits:* Mr. H. Bullen showed sections of Fossil Casuarina from beneath the basalt of the Collingwood Quarries. Mr. H. K. Rusden showed a series of Boomerangs made by himself.

A Smoke Concert was held by the members at the Masonic Hall, on 26th July, and a pleasant evening was passed.

During the year the building was repaired, and all the outside woodwork was painted. It is intended to have the interior painted and coloured at an early date.

During the year two members, two country members, and five associates have been elected, and one member and three associates have resigned. The Hon. Sir J. W. Agnew, K.C.M.G., M.C.E., M.D., an Honorary Member, Sizar Elliott, a Life Member, and J. S. Gotch, and John Danks, Ordinary Members have died.

The following publications have been issued: "Proceedings," Vol. XXIII., Pt. 2; Vol. XIV., Pt. 1.

The Librarian reports that 1285 additions have been made to the Library during the year, and that the shelves are rapidly becoming crowded. Fair progress was made with binding, but still the arrears are mounting up. No fewer than 28 additions have been made to the exchange list during the year.

The Honorary Treasurer in Account with the Royal Society of Victoria.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance from 28th February, 1901 ...	£195	2	2	By Printing and Stationery	£109	18	8
Government Grant—				Rates	7	12	2
2nd Instalment, 1900-1901 ...	50	0	0	Gas and Fuel	5	18	0
Subscriptions—				Salary of Assistant-Secretary	27	1	8
Members	81	18	0	Custodian	5	10	0
Country Members	7	7	0	Collector's Commission	11	18	11
Associates	33	12	0	Insurance	4	10	0
Arrears	26	0	0	Postages	10	19	10
Rent of Rooms	7	10	0	Furniture and Repairs	12	15	11
Books	0	13	6	Books and Periodicals	5	7	0
Exchange	0	1	6	Binding Books	9	9	3
Amount from Publishing and Research				Freight	9	10	9
Fund	100	0	0	Refreshments	3	17	11
Interest	8	15	0	Incidentals	3	8	6
				Sewerage Connections	4	5	4
				Balance (28th February, 1902) ...	278	15	3
	£510	19	2		£510	19	2

PUBLISHING AND RESEARCH FUND.

Dr.		Cr.	
To Fixed Deposit in Bank	£100 0 0	By Fixed Deposit in Bank of Australasia ...	£100 0 0
Interest	2 10 0	Interest transferred to General Account	2 10 0
	£102 10 0		£102 10 0

Compared with the Vouchers, Bank Pass-Book and Cash-Book, and found correct,

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4th March, 1902.

Royal Society of Victoria.

1902.

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Smith, G. P., Trinity College, Parkville	1901
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Thiele, E. O., 219 Osborne-street, Williamstown ...	1898
Tisdall, H. T., 7 Washington-street, Toorak	1883
Wedeles, James, 231 Flinders Lane, Melbourne	1896

INDEX.

(*The names of new genera and species are printed in Italics*).

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END OF VOLUME XV.

[Issued February, 1903.]

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PROCEEDINGS

OF THE

Royal Society of Victoria.

VOL. XV. (New Series).

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MELBOURNE:
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Transactions. Vol. 1. 1855.

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Transactions and Proceedings (Vol. 5, *entitled* Transactions). Vol. 5–24.

Transactions. Vol. 1, 2, 3 (part one only), 4. 1888–95.

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MICROSCOPICAL SOCIETY OF VICTORIA.

Journal (Vol. 1, Pt. 1, *entitled* Quarterly Journal). Vol. 1 (Pts. 1 to 4), 2 (Pt. 1), title page and index [*all published*]. 1879–82.

[*The Society then combined with the* ROYAL SOCIETY OF VICTORIA.]

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